

THE SPECIALISATION OF PEDAGOGIC IDENTITIES IN INITIAL MATHEMATICS TEACHER EDUCATION IN POST-APARTHEID SOUTH AFRICA

by

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Declaration

I declare that *The specialisation of pedagogic identities in initial mathematics teacher education in post-apartheid South Africa* is my own work, except where indicated, and that it has not been submitted before for any degree or examination at any university

Signed:



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October 2008

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Abstract

The specialisation of pedagogic identities in initial mathematics teacher education in post-apartheid South Africa

This thesis is concerned with the differential specialisation of the consciousness and conscience of mathematics teachers through initial mathematics teacher education programmes in post-apartheid South Africa. The focus is specifically on the organisation of knowledges and practices in the new Bachelor of Education for secondary teachers (Grades 8 – 12), and the specialisation of pedagogic identity through these programmes. The study is located at different levels within the system as a whole, beginning with policy and regulations for teacher education curricula produced within the Official Recontextualising Field (ORF), moving to consider the production of curricula within the Pedagogic Recontextualising Field (PRF) as a whole and the positioning of different Higher Education Institutions (HEIs) in the PRF with respect to the ORF, and finally moving to focus on two specific HEIs selected in terms of their positioning within the teacher education landscape.

The study is therefore divided into three parts. The first part examines the policy, curriculum and institutional context of the teacher education landscape in post apartheid South Africa. It draws on the theoretical insights of Basil Bernstein (1996, 1999, 2000) to analyse the context of teacher education and the regulatory conditions under which HEIs operate and produce their curricula for initial mathematics teachers in and for South Africa. It provides a description of the ORF and official pedagogic identities projected from South African policy, in terms of the kind of teachers and knowledge expected by the post-apartheid education system. This includes an examination of official school mathematical knowledge and practices embedded within new curriculum statements, and identification of orientations to school mathematical knowledge expected by the new policies.

The second part of the study is a survey of the design of initial mathematics teacher education programmes offered by all public HEIs across the system in response to post apartheid regulatory frameworks and policies analysed in the first phase of the study. An analysis of the curriculum documents produced within the pedagogic recontextualising field, specifically different knowledge forms and practices that different HEIs include in their design documents, is provided. This shows that there are a range of differences in curricula across the system and institutions interpret and implement policy in a variety of ways. The analysis is used to identify the positioning of the various institutions with respect to the official recontextualising field, and provides a basis for the selection of two institutions in which in-depth case studies are carried out.

The third part of the study focuses on the two cases selected from the analysis of curricula in the PRF. These cases represent two extremes within the institutional landscape of teacher education in South Africa. One institution is urban, historically advantaged, relatively wealthy and connected into contemporary networked society and the information economy. The other is rural, historically disadvantaged, relatively poor and isolated. The case studies are carried out in two phases. In the first, the cases are considered from the perspective of the three message systems operating at the institutional level: curriculum, pedagogy and assessment. Using a methodology of interpretation and theoretical referents which draw on Bernstein (1996, 2000) and Hegel as recontextualised by Davis (2005), layered descriptions of the three message systems operating at each institution are produced. The analyses enable a description of pedagogic subjects (knowledge and persons) projected from each institutional context. In the second phase a selection of the institutions 'good' pedagogic subjects (successful student teachers) are considered. Drawing on Bernstein (1996, 2000), Davis (2005), Lacan (2002) and Zizek (1989, 2006), students' talk and writing are analysed and narratives are produced which enable an interpretation of identification and identity fields operating within each pedagogic context. The case studies produce 'thick' descriptions and theorised interpretations of what is offered by the institutions in their initial mathematics teacher education programmes together with descriptions of their intended 'good' subjects (knowledge and persons). These are rubbed up against the identities projected by the 'good' pedagogic subjects (student teachers) themselves. A cross-case analysis enables insights into the way in which the different curricula differentially specialise the consciousness and conscience of their initial teachers and raises questions for the field of mathematics teacher education more broadly.

The contribution of this thesis is twofold. Firstly it contributes methodologically by using a combination of Thompson's (1990) methodology of interpretation together with Bernstein's (1996) notion of languages of description and thus enables the production and extension of a number of complementary models for analysing curricula, pedagogy and assessment in teacher education, as well as a methodology for examining the identities of pedagogised subjects (student teachers). Secondly the thesis points to further research that should focus on relationships between different agents and agencies in the production of new teachers and consider the relations between different aspects of knowledge and practices selected into the initial teacher education programme as central to understanding quality in teacher education.

Table of contents

Declaration	ii
Acknowledgements	iii
Abstract	iv
Table of contents	vi
List of Tables	xv
List of Figures	xvii
List of Plates	xix
List of acronyms used in this thesis	xx
Note on referencing	xxii
Conventions for references to transcripts in the thesis	xxii

VOLUME 1

Chapter 1	Introduction to the study and research questions	1

1	Introduction	1
1.1	Motivation for the study	2
1.2	Focus of the study	4
2	The design of the study	5
2.1	The research questions	6
2.2	Scope of the study	8
2.3	Structure and synopsis of the thesis	10

Chapter 2	Regulation and the problem of teacher education in a context of education reform	12

1	Introduction	12
2	Teacher education reform: International trends	15
2.1	Teachers as ‘the problem’ of education	16
2.2	Accountability and autonomy in teacher education	23
2.3	Accountability and relevance in teacher education	26
2.4	Three international movements within teacher education	27
2.5	Variations in teacher education practices across different contexts	28
2.6	Some final comments on international movements in teacher education	30

3	The design of initial teacher education programmes	31
3.1	Research on the elements included in initial teacher education programmes	31
3.2	Knowledge and practices for teachers and teaching within (mathematics) teacher education programmes	36
3.3	Mathematical knowledge and mathematics for teaching	42
3.4	Pedagogic discourse, knowledge and identity	48
4	Conclusion	54

Chapter 3 Reform, Regulation and the Pedagogic Space for Teacher Education in South Africa Post 2000

1	Introduction	56
2	The changing teacher education context in South Africa	58
2.1	The teacher education landscape prior to transformation	58
2.2	The rationalisation of colleges of education	61
2.3	Movements towards rationalising, transforming and regulating teacher education curricula	64
3	Theorising (mathematics) teacher education	67
3.1	Forms of knowledge and the specialisation of consciousness	67
3.2	The Pedagogic device	69
3.3	The recontextualising field	73
3.4	Teacher education and pedagogic discourse	75
3.5	Pedagogic identity	78
3.6	Vertical and horizontal knowledge discourses	83
4	Regulation of teacher education in SA	89
4.1	A new system of qualifications: their regulation and quality assurance	91
4.2	Teacher education under the 2000 Norms and Standards for Educators Policy ...	94
4.3	The specialist role and subject knowledge	97
4.4	Changing spaces and challenges for mathematics teacher education	99
5	Conclusion	102

Chapter 4 Official pedagogic identities and discourses for mathematics teachers and teaching: Projections from South African Policy

1	Introduction	105
2	A New Curriculum for FET Mathematics	107

2.1	The Structure of the NCSM.....	108
2.2	The general discourse of, and principles underpinning, the new national curriculum statements for Grade 10-12 (schooling)	108
3	A new <i>kind</i> of mathematics teacher for the FET	112
3.1	The roles of a teacher.....	113
3.2	The roles and pedagogic identity.....	116
4	Inside the NCSM.....	119
4.1	The nature of mathematics in the NCSM	119
4.2	Inside the assessment standards.....	122
4.3	Orientations to knowledge within the assessment standards.....	124
4.4	Integration in the mathematics curriculum.....	126
4.5	Domains of mathematical practice and integration in the mathematics curriculum	128
4.6	Some comments with respect to the analysis of the NCSM.....	133
5	Official discourses, official pedagogic identity and teacher education	134
6	Conclusion	139

Chapter 5 The construction of teacher education curricula in the PRF: Forms of knowledge and practice..... 141

1	Introduction	141
2	Knowledge discourses and practices for mathematics teachers and mathematics teaching: a model.....	143
2.1	The model	144
2.1.1	Mathematical Sciences (M)	145
2.1.2	Mathematics Education (ME)	146
2.1.3	Mathematics Teaching (MT)	147
2.2	Selection of contents into the various domains	148
2.3	Organisation of the various domains in an initial four-year MTE curriculum....	149
2.4	Classification of specialist contents in the curriculum	150
3	A survey of mathematics teacher education qualifications offered at South African HEIs: Collecting the information.....	153
3.1	Institutions that offer teacher education programmes	153
3.2	Gaining access to formal documentation and identifying institutions offering initial specialist MTE programmes.....	156
3.3	Limitations of information collected	157

4	Mathematics teacher education qualifications offered at South African HEIs: An overview	158
4.1	Who offers the B.Ed and in what form?	159
4.2	The contents of specialist initial MTE curricula in the B.Ed across the HEIs	162
4.3	Some issues arising for mathematics teacher education.....	166
5	The positioning of teacher educators in the PRF with respect to the ORF.....	169
5.1	Compliance and non-compliance	171
5.2	An analysis of positions taken by various HEIs	173
6	The selection of cases for phase three of the study	175
6.1	Criteria for selecting the case study institutions.....	176
6.2	Introduction to the cases: Rural University and City University	177
7	Conclusion	179

Chapter 6	Methodology 1: Researching Curriculum, pedagogy and assessment practices within mathematics teacher education	180

1	Introduction	180
2	Processes for collecting empirical evidence for the case studies	181
2.1	Access to the case study sites and some ethical considerations	182
2.2	The organisation and structuring of site visits.....	185
3	Nature of evidence collected at empirical sites	187
3.1	Documents	187
3.2	Video records.....	188
3.3	Interviews	188
3.4	Field notes	189
4	The general methodological framework for producing and interpreting data	189
4.1	A methodology of interpretation	189
4.2	General comments on the production of data from the evidence	193
5	Producing the data for the analysis and interpretation of the symbolic message systems within the institutional context.....	196
5.1	The interpretation of the doxa: the pre-interpreted domain.....	196
5.2	Curriculum.....	196
5.3	Analysing and interpreting pedagogic practice	197
5.3.1	Evaluative judgement within interactional practice	198

5.3.2	A model for analysing pedagogic evaluation in a mathematics teacher education class	202
5.3.3	An Example of MTE practice from CU	206
5.3.4	Patterns in classroom interaction	211
5.3.5	Interpreting the results	212
5.4	Analysing and interpreting formal assessments	212
5.4.1	Producing an analytic space for categorising assessment tasks	213
5.4.2	Recognising different categories of formal assessment tasks	217
6	Issues of reliability and validity in this research	224
7	Conclusion	226
Chapter 7	The Case of City University	227
1	Introduction	227
2	The institutional context and the overall design of the Bachelor of Education programme at City University.	228
2.1	How City University meets the formal state requirements in their design of the B.Ed degree	231
2.2	The formal requirements for the B.Ed curriculum for FET or Senior Phase and FET mathematics teachers at CU	234
3	Images of ‘good’ subjects projected from Mathematics Teacher Education at CU	239
3.1	Specialist knowledge(s) and practices in the CU curriculum.....	240
3.1.1	The organisation and selection of mathematically related contents and practices in the curriculum	241
3.1.2	Time and space in the curriculum	261
3.1.3	Classification and framing and the construction of pedagogic discourses for M, ME and MT at CU	264
3.2	Pedagogic mode in the teacher education classroom	268
3.2.1	Pedagogic evaluation at work in the IP of a Curriculum 103 lecture	270
3.2.2	Some insights into the pedagogic context and mode of pedagogic practice in MTE at CU	275
3.3	Assessment and evaluation.....	278
3.3.1	Analysis of formal assessment tasks across CU modules	281
3.3.2	Some conclusions from the analysis of formal assessments from CU	292
4	The characteristics of the institutions ‘good’ subject.....	294
4.1	M, ME and MT (for mathematics teachers) at CU.....	294

4.2	Identities of good pedagogic subject(s) projected from CU.....	296
5	Conclusion	297
Chapter 8	The Case of Rural University	299
1	Introduction	299
2	The institutional context and overall design of the Bachelor of Education programme at Rural University.	299
2.1	How Rural University meets the formal state requirements in their design of the B.Ed degree	302
2.2	The formal requirements of the B.Ed curriculum for mathematics teachers at RU	305
3	Images of ‘good’ subjects projected from Mathematics Teacher Education at Rural University	308
3.1	Specialist knowledge(s) and practices in the RU curriculum.....	308
3.1.1	The organisation and selection of mathematically related contents and practices in the curriculum	309
3.1.2	Space and time in the curriculum	328
3.1.3	Classification and framing and the construction of pedagogic discourses for M, ME and MT at RU	329
3.2	Pedagogic mode in the teacher education classroom	333
3.2.1	Pedagogic evaluation at work in an Assessment in Mathematics Education lecture	336
3.2.2	Some insights into the pedagogic context and mode of pedagogic practice in MTE at RU	345
3.3	Assessment and evaluation.....	346
3.3.1	Analysis of formal assessment tasks across RU modules	347
3.3.2	Some conclusions from the analysis of formal assessment items from RU	354
4	The characteristics of the institutions ‘good’ subject.....	358
4.1	M, ME and MT (for mathematics teachers) at RU.....	359
4.2	Identities of good pedagogic subject(s) projected from RU.....	360
5	Conclusion	362
Interlude		363

VOLUME 2

Chapter 9	Methodology 2: Researching an institution's 'good' subjects.....	365
1	Introduction	365
2	Nature of the evidence collected through the data collection instruments.....	366
2.1	Student teachers biographical writing	366
2.2	Individual interviews with student teachers	366
2.3	Field Notes.....	368
2.4	Examples of student work	368
3	General Methodological orientation	369
4	Towards developing an external language of description to produce an account of the 'good' pedagogic subjects	370
4.1	The first level of interpretation: interpreting the pre-interpreted student stories within the context of individual teacher careers.....	370
4.2	The second level of interpretation: finding resources for the formal discursive analysis of the evidence	372
4.2.1	Analysing the contents of student utterances	373
4.2.2	Extending the analytic frame	376
4.2.3	Testing the analytic framework: Sonny's Story	384
5	Moving on: going deeper and narrower	391
5.1	A return to the theoretical referents: reconsidering aspects of the internal language of description	394
5.2	The way forward: restructuring the external language of description.....	404
6	Concluding remarks	407
Chapter 10	The 'Good' Subjects of City University.....	408
1	Introduction	408
2	The 'good' subjects of CU.....	409
2.1	Karyn's story: breaking boundaries, being creative and uncovering the mathematics	410
2.2	Sonny's Story: Mathematics is not supposed to be narrated.....	420
2.3	Emmanuel's Story: to learn mathematics you need to dig deep from within	431
2.4	Nicole's story: teachers must make mathematics interesting and stimulating	441

3	Identity formation and Identification within the ideological field generated at CU	449
3.1	Quilting points in the local identify field	451
3.1.1	Identification with discourses converging around ‘Mr/s X’	451
3.1.2	Conceptual understanding as the focus of mathematics learning	452
3.1.3	Discussion-based pedagogic practice	454
3.1.4	Rejection of discourses converging around ‘Mr/s Z’	456
3.2	Points of breakdown in the narratives	458
3.3	Identification with Official discourses	460
3.4	Reflecting on the content of the distributive rule in contemporary society.....	462
4	Conclusion	464
	Chapter 11 The ‘Good’ Subjects of Rural University	466
1	Introduction	466
2	The careers of RU’s ‘good’ subjects	466
2.1	Phiri: ‘a great thinker’ and ‘a highly recognised person in mathematics’	467
2.2	The Minister: I want to be the kind of teacher that gets his facts right and who has a heart for his learners – I want to make a difference.....	478
2.3	Mazet: I want to be well equipped in mathematics but “my hope and my dream is not fulfilled”	487
2.4	‘Makhosi: I want to be a teacher who is committed and loves their work.....	493
3	Identity formation and Identification within the ideological field generated at RU	498
3.1	Quilting points in the local identify field	498
3.1.1	Deprivation, degradation and rurality	498
3.1.2	The group	506
3.1.3	Problem Solving in Mathematics and motivating mathematics learning	512
3.1.4	Mathematics teaching as presentation and providing opportunities for practice.....	513
3.1.5	Pedagogic practice and the ethic of care	514
3.2	Points of breakdown in the narratives	515
3.3	Identification with official discourses and projected policy identities.....	516
3.4	Reflecting on the content of the distributive rule in contemporary society.....	517
4	Conclusion	518

Chapter 12	Cross-case analysis	522
1	Introduction	522
2	CU and RU: contrasts across cases at the extremes of the SA mathematics teacher education landscape.....	523
2.1	Context: the comparative advantage of the cases.....	523
2.2	General design features and assumptions underpinning the curricula	526
2.3	Mathematics, Mathematics Education and Mathematics Teaching discourses, practices and identities.....	533
3	Similarity and difference across the cases.....	542
4	Absence and presence across the cases.....	546
5	Pedagogic spaces opened and closed for mathematics teacher education across the contrasting contexts.....	555
5.1	Spaces opened at CU and RU.....	555
5.2	Pedagogic spaces closed at CU and RU	556
6	Conclusion	558
Chapter 13	Conclusion	559
1	Introduction	559
2	An overview of the journey.....	561
3	Some surprises and insights.....	568
3.1	The positioning of institutions with respect to the ORF.....	568
3.2	Context and access to resources count	570
3.3	Quality and regulation of mathematics teacher education	575
3.4	Relationships matter	575
4	Methodological reflections	576
5	Limitations of this research project.....	578
6	Concluding comments	579
References		580

List of Tables

Table 1:	List of Acronyms.....	xx
Table 2:	Table indicating abbreviations used for transcripts and student writing throughout the thesis	xxii
Table 3:	Orientations to mathematics knowledge expressed in the NCSM	125
Table 4:	The focus of integration in the NCSM	127
Table 5:	Coding of assessment standards in terms of Dowling's domains of practice	132
Table 6:	HEIs responsible for teacher education and the incorporation of colleges in January 2001 (source: DoE, 2000b, personal communication with each faculty/ school of education)	154
Table 7:	Types of institutions and the specialist MTE qualifications they offer (September 2003)	159
Table 8:	The overall distribution of contents across different B.Ed programmes.....	163
Table 9:	Mathematically focussed contents across different B.Ed programmes: contents and agents.	164
Table 10:	Positions taken with respect to the NSE/ Criteria regulations	173
Table 11:	Summary of HEIs and their position to the official NSE discourse.....	173
Table 12:	Institutions that meet the criteria to be approached as case study institutions	177
Table 13:	Table recording results of analysis of evaluative Event 1 (Curriculum 103; City University)	210
Table 14:	Summary of B.Ed Curriculum design information submitted to the DoE for purposes of recognition and evaluation of qualifications for employment in Education.....	231
Table 15:	The Bachelor of Education Curriculum (Senior Phase & FET).....	234
Table 16:	The NSE Roles in the organisaiton of the CU B.Ed curriculum.....	237
Table 17:	Sequence of modules for SP&FET Mathematics first subject specialisation in the CU B.Ed: their focus and stage of development in October 2004.	240
Table 18:	Classification strength between different specialist discourses (insulated +/-integrated -)	267
Table 19:	Framing strength within specialist discourses.....	267
Table 20:	Movements in the object of acquisition across the IP of a Curriculum 103 class.....	271
Table 21:	Forms of pedagogic interaction across events in the context of a Curriculum 103 Lecture at CU.....	272
Table 22:	Summary of legitimating appeals across the IP of one Curriculum lecture	273
Table 23:	List of formal assessments in the archive.....	279
Table 24:	Summary of analysis of all assessment items selected from the Curriculum 103 module at CU.....	281
Table 25:	Summary of analysis of all assessment items selected from Maths for Teaching and Applied Maths modules at CU	283

Table 26: Summary of B.Ed (Senior Phase and Further Phase) curriculum design information submitted to the DoE for purposes of recognition and evaluation of qualifications for employment in Education	302
Table 27: The curriculum for the Bachelor of Education (Senior Phase and Further Education and Training: Science and Mathematics Education) at RU. (Source: RU, 2004b)	305
Table 28: Classification strength between different specialist discourses (insulated +/-integrated -)	332
Table 29: Framing strength within specialist discourses.....	332
Table 30: Movements in the object of acquisition across the IP of an Assessment in Mathematics Education class	337
Table 31: Forms of pedagogic interaction across events in the context of an Assessment in Mathematics Education Lecture at RU	338
Table 32: Summary of legitimating appeals across the PI of one Assessment in Maths lecture	344
Table 33: List of formal assessments collected from lectures and students' selected work at RU ...	347
Table 34: Summary of all assessment items analysed across different modules at RU.....	348
Table 35: Data produced from Interview focus 1: Sonny's imagined practices (Utterances: #5 to 35).	387
Table 36: Summary table of data produced from working through all transcripts of interviews.....	389
Table 37: A comparison of some contextual characteristics and resources for MTE at CU and RU	524
Table 38: Comparison of general curriculum design features of the B.Ed at CU and RU.....	527
Table 39: Entry requirements, assumptions about students entering the secondary MTE programme, and the organisation of time and space in the curriculum	528
Table 40: Mathematics in the teacher education curriculum.....	534
Table 41: Mathematics Education and mathematics teaching in the teacher education curriculum	535
Table 42: Orientation to mathematics (as analysed in Chapter 4 in relation to official school mathematics from the ORF)	540
Table 43: Mathematics teaching practices in policy and institutionalised discourses	540
Table 44: Selected examples of aspects populating the field of absence at RU and CU	549

List of Figures

Figure 1: Model of Teacher Knowledge Structures (after Grossman, 1990, p. 5).....	37
Figure 2: The pedagogic device (adapted from Davis et al., 2003, p. 27).....	70
Figure 3: Agents and agencies operating across the fields of the Pedagogic Device	71
Figure 4: A comparison of Vertical and Horizontal discourses following Bernstein (1999).....	85
Figure 5: Dowling's domains of mathematical practice (Dowling, 1998, p. 132).....	129
Figure 6: A model of possible specialist discourses selected into an initial four year mathematics teacher education programme.....	145
Figure 7: Some possible organisations of privileged curriculum contents over time	150
Figure 8: Summary of characteristics of collection type and integrated curriculum codes (following Bernstein, 1977c, pp. 79 - 84).....	151
Figure 9: The pedagogic device and three message systems for pedagogic communication....	186
Figure 10: Diagrammatic representation of a language of description (adapted from Dowling, 1993, p. 88, as presented in Davis, 2005, p. 107).....	195
Figure 11: Pedagogic context (as described in Bernstein, 1996, p. 31)	198
Figure 12: An analytic space for recognising objects of acquisition in MTE.	203
Figure 13: Analytic space for identifying moments of judgement and legitimating appeals (Davis, Adler, & Parker, 2006, p. 2)	206
Figure 14: Analytic space for the description of tasks (after, Adler & Davis, 2006, p. 284).....	214
Figure 15: Analytic space for the description of tasks (elaboration of Adler & Davis, 2006, p. 284)	215
Figure 16: Possibilities available for categorising tasks (elaboration of Adler & Davis, 2006, p. 285).....	217
Figure 17: An M^+ type task from Maths for Teaching 103 module offered at CU (final examination)	218
Figure 18: A T_k^+ type task from Curriculum 103 (June Exam)	219
Figure 19: An M^{+t^-} type task from Maths for Teaching 104 (Tutorial 1) (CU)	220
Figure 20: An M^{t^-} type task from Curriculum 103 (Mathematical Language Task) (CU)	221
Figure 21: A $T_k^+ m^+$ type task from Curriculum 103 (June Exam)	222
Figure 22: A $T_e^+ m^-$ type task from Curriculum 103 (June Exam)	223
Figure 23: An example of a $T^- m^-$ type task (Assignment: Calculus B) from RU	224
Figure 24: Knowledge structure of the B.Ed curriculum at City University.....	238
Figure 25: An M^+ type task from the Linear Algebra module (assessed Tutorial 3)	286
Figure 26: An M^+ type of task from Maths for Teaching 101 (assessed Tutorial).....	286

Figure 27: An M^+ type of task from the Calculus module (June Examination)	288
Figure 28: An M^- type task from Maths for Teaching 103 (June Exam 2004).....	289
Figure 29: An M^- type task from Maths for Teaching 101 (June Exam 2004).....	290
Figure 30: An M^{+t} type task from Maths for Teaching 103 (June Examination, emphasis in original)	291
Figure 31: The B.Ed curriculum at RU is organised around the roles of a teacher as described in the NSE.....	307
Figure 32: An M^- type task (Final Examination: Space and Shape)	350
Figure 33: An M^- type task (Final Examination: Calculus B).....	351
Figure 34: The only example of an M^+ type task found in an RU assessment (Final Examination: Preparing to Teach Mathematics).....	352
Figure 35: An example of a T^m type task (Assignment: Calculus B)	352
Figure 36: An example of a T^m type task (Assignment: Calculus B)	353
Figure 37: An example of a T^m type task (Final examination: Preparing to Teach Mathematics)	353
Figure 38: An example of a T^m type task (Final examination: Preparing to Teach Mathematics)	353
Figure 39: Problem Set (Problems from the Instruction in Mathematics student portfolio – Piri and The Minister)	356
Figure 40: Analytic space for identifying knowledge discourses circulating in student talk.....	373
Figure 41: Table for recording the content analysis	375
Figure 42: Linking the content of utterances to the place from which the utterance originates.	383
Figure 43: Examples to illustrate the analytic space for the field of differences	542
Figure 44: Patterns in the field of difference across sites of MTE practice	545
Figure 45: Examples to illustrate the analytic space for the field of absence	547
Figure 46: Consciousness and context - Patterns in the field of absence across the cases.....	551

List of Plates

Plate 1: Word problem given at the beginning of the lecture.....	207
Plate 2: Precious' solution.....	207
Plate 3: Lecturer focuses on the translation from word to symbols.....	208
Plate 4: Equation describing the word problem in terms of a subtraction.....	209
Plate 5: Three different equations for solving the problem.....	209
Plate 6: Mr Mpe writes up his example of a question to assess conceptual understanding.....	342
Plate 7: Dr A's summary of what to assess when assessing for conceptual understanding.....	343

List of acronyms used in this thesis

Table 1: List of Acronyms

ACE	Advanced Certificate in Education
AERA	American Educational Research Association
ANC	African National Congress
AS	Assessment Standard
B.Ed	Bachelor of Education
C2005	Curriculum 2005
CCERSA	Committee of College of Education Rectors of South Africa
CEART	Committee of Experts on the Recommendations concerning the Status of Teaching Personnel
CHE	Council on Higher Education
COTEP	Committee on Teacher Education Policy
CU	City University
DEC	Department of Education and Culture
DET	Department of Education and Training
DoE	Department of Education
EFA	Education for All
FET	Further Education and Training
GID	General Instructional Discourse
GRD	General regulative discourse
HDE	Higher Diploma in Education
HE	Higher Education
HEI	Higher Education Institution
HEIs	Higher Education Institutions
QC	Higher Education Quality Council
ID	Instructional discourse
ILO	International Labour Organisation
INSET	In-service education and training
IP	Interactional practice
LO	Learning Outcome
LoLT	Language of teaching and learning
M.Ed	Master of Education
MfT	Mathematics for Teaching
MTE	Mathematics teacher education
NCATE	National Council for the Accreditation of Teacher Education (USA)
NCHE	National Commission on Higher Education
NCSM	National Curriculum Statement Grades 10 – 12 (General): Mathematics
NEPI	National Education Policy Investigation
NGO	Non Governmental Organisation
NPDE	National Professional Diploma in Education
NQF	National Qualification Framework
NSE	Norms and Standards for Educators
nsh	notional study hours
NSTE	Norms and Standards for Teacher Education
OBE	Outcomes-based education
OFSTED	Office for Standards in Education (UK)
OK	Official knowledge

OPD	Official pedagogic discourse
OPI	Official pedagogic identity
OPRF	Official Pedagogic Recontextualising Field
ORF	Official Recontextualising Field
PCK	Pedagogic content knowledge
PD	Pedagogic discourse
PGCE	Post Graduate Certificate in Education
PRESET	Pre-service education and training
PRF	Pedagogic Recontextualising Field
RD	Regulative discourse
RF	Recontextualising Field
RNCS	Revised National Curriculum Statements
RPL	Recognition of prior learning
RU	Rural University
SACE	South African Council for Educators
SACE	South African Council of Educators
SAQA	South African Qualifications Authority
SCK	Subject Content Knowledge
SETD	School of Education Training and Development
SID	Specific instructional discourse
SMK	Subject Matter Knowledge
SPGET	Senior Phase of General Education and Training
SRD	Specific regulative discourse
TCK	Teachers' Conceptual-Knowledge-in-Practice
TTA	Teacher Training Authority (UK)
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UPRF	Unofficial Pedagogic Recontextualising Field

Note on referencing

Conventions for references to transcripts in the thesis

Transcripts are referenced using abbreviations shown in the table below. All transcripts referred to in the thesis are indicated in Table 2.

Emphasis in *italic* is an indication of an emphasis in the voice of the speaker. In all cases emphasis in **bold** is added by the researcher.

In all cases the wording is as spoken, with the exceptions where names of modules and lecturers are used. In these situations, the names are consistently changed as indicated in the methodology chapter (Chapter 6).

Table 2: Table indicating abbreviations used for transcripts and student writing throughout the thesis

Institution	Date of recording	Transcript / student writing	abbreviation used in the text
Rural University	7/09/2004	Group interview with RU B.Ed students – video record	GVT1-RU-B.Ed
	08/09/2004	Phiri individual interview #1 – audio record transcript	IAT-P1
	9/09/2004	Phiri individual interview #2 – audio record transcript	IAT-P2
	13/09/2004	Phiri individual interview #3 – audio record transcript	IAT-P3
	14/09/2004	Phiri individual interview #4 – audio record transcript	IAT-P4
	Sept 2004	Phiri Biographical Questionnaire – student writing	PBQ
	9/09/2004	The Minister individual interview #1 – audio record transcript	IAT-TM1
	10/09/04	The Minister individual interview #2 – audio record transcript	IAT-TM2
	13/09/2004	The Minister individual interview # 3 – audio record transcript	IAT-TM3
	16/09/2004	The Minister individual interview #4 – audio record transcript	IAT-TM4
	Sept 2004	The Minister Biographical Questionnaire – student writing	TMBQ
	9/09/2004	Mazete individual interview #1 – audio record transcript	IAT-M1
	10/09/2004	Mazete individual interview #2 – audio record transcript	IAT-M2
	13/09/2004	Mazete individual interview # 3 – audio record transcript	IAT-M3
	16/09/2004	Mazete individual interview #4 – audio record transcript	IAT-M4
	Sept 2004	Mazete Biographical Questionnaire – student writing	MBQ
	10/09/2004	Makhosi individual interview #1 – audio record transcript	IAT-MK1
	14/09/2004	Makhosi individual interview #2 – audio record transcript	IAT-MK2
	15/09/2004	Makhosi individual interview # 3 – audio record transcript	IAT-MK3
	Sept 2004	Makhosi Biographical Questionnaire – student writing	MkBQ
	14/09/2004	Dr A individual interview # 1 – audio record transcript	IAT-A1
	16/09/2004	Dr A individual interview # 2 – audio record transcript	IAT-A2
	16/09/2004	Dr B individual interview # 1 – audio record transcript	IAT-B
	7/09/2004	Lesson Observation – Assessment in mathematics - video record transcript	LO-VT-AM
	17/09/2004	Final group presentation and discussion with RU B.Ed students and lecturers video record transcript	GVT2-RU

Institution	Date of recording	Transcript / student writing	abbreviation used in the text
City University	22/09/2004	Group interview with CU B.Ed students – video record	GVT1-CU-B.Ed
	22/09/2004	Group interview with CU HDE students – video record	GVT1-CU-HDE
	28/08/04	Karyn individual interview #1 – audio record	IAT-K1
	1 /10/2004	Karyn individual interview #2 – audio record	IAT-K2
	6/10/2004	Karyn individual interview #3 – audio record	IAT-K3
	Oct 2004	Karyn Biographical Questionnaire – student writing	KBQ1
	Oct 2004	Karyn Biographical Questionnaire – student writing – additional text	KBQ2
	23/09/2004	Sonny individual interview #1 – audio record	IAT-S1
	27/09/2004	Sonny individual interview #2 – audio record	IAT-S2
	5/10/2004	Sonny individual interview # 3 – audio record	IAT-S3
	Oct 2004	Sonny Biographical Questionnaire – student writing	SBQ
	23/09/2004	Emmanuel individual interview #1 – audio record	IAT-E1
	28/08/04	Emmanuel individual interview #2 – audio record	IAT-E2
	5/10/2004	Emmanuel individual interview #3 – audio record	IAT-E3
	Oct 2004	Emmanuel Biographical Questionnaire – student writing	EBQ
	23/09/2004	Nicole individual interview #1 – audio record	IAT-N1
	27/09/2004	Nicole individual interview #2 – audio record	IAT-N2
	4/10/2004	Nicole individual interview #3 – audio record	IAT-N3
	Oct 2004	Nicole Biographical Questionnaire – student writing	NBQ
	21/09/04	Mrs/X individual Interview #1 – audio transcript	IAT-X1
	30/09/2004	Mrs/X individual Interview #2 – audio transcript	IAT-X2
	29/09/2004	Mr/s Y individual Interview # 1– audio transcript	IAT-Y
	30/09/2004	Mr/s Z individual Interview # 1– audio transcript	IAT-Z
	28/09/2004	Lesson observation Curriculum 103 – video record	LO-VT-C103
	8/10/2004	Final group presentation and discussion with CU B.Ed students and lecturers	GVT2-CU

VOLUME 1

Chapter 1

Introduction to the study and research questions

It is now widely agreed that teachers are among the most, if not the most, significant factors in children's learning and the linchpins in educational reforms of all kinds. Despite the growing consensus that teachers matter, however, there are many debates about why and how they matter or how they should be recruited, prepared and retained in teaching (Cochran-Smith & Zeichner, 2005, p. 1)

At the beginning of the 21st Century, the information technology revolution is well under way, schools are dealing with increasing political, cultural and social diversity, and knowledge is growing exponentially. Teaching is more complex than it has ever been before. We need teachers who are reflective, flexible, technologically literate, knowledgeable, imaginative, resourceful, enthusiastic, team players and who are conscious of student differences and ways of learning (Hoban, 2005, p. 1).

Teaching is more difficult than learning: for only he who can truly learn – as long as he can do it – can truly teach (Heidegger, quoted in Lerman, 2001, p. 49).

1 Introduction

It is widely recognised that teachers are a key component in the education system and that quality teaching promotes quality education more generally. Quality teaching in turn is connected to the provision of quality teacher education, particularly in times of change when demands on teachers are more complex than in the past. While we may agree that teacher education matters, what is defined as quality in teacher education and how this ought to be provided is hotly debated.

The importance of researching teacher education has been recognised for a long time (Cochran-Smith & Zeichner, 2005; Lappan & Yeping, 2002). The International Council on Education for Teaching (ICET) was founded in 1953 with the explicit purpose of promoting quality teacher education internationally. The *Recommendation concerning the status of teachers* (UNESCO, 1966) underlined the key role of teachers in providing quality education and promoted their status, influencing governments around the world to take responsibility for teacher education. In the past few decades there has been a growing emphasis on research into the preparation and development of teachers, and in particular mathematics teachers (Floden & Meniketti, 2005; Lappan & Yeping, 2002). A significant focus of this research is related to the question of what constitutes a teacher's competence and in particular the question of what knowledge teachers can and should learn in order to develop this competence. The seminal

work of Shulman (1986b; 1987a) led the way in research into exploring components of teacher knowledge structures in general and influenced research in mathematics teacher education (MTE) in particular. However, while the research community has begun to name certain aspects of teacher knowledge that appear to be important, issues relating to the nature of such knowledge and how it should be made available to teachers are by no means resolved.

In this study I explore some of these issues in an attempt to describe and understand what is happening in teacher education in the South African context, particularly in relation to issues around the selection and organisation of knowledge and practices within mathematics teacher education curricula, the way in which these privileged selections are made available to student teachers, and how they work to specialise their consciousness and conscience.

1.1 Motivation for the study

I began this study with a problem that emerged from within my local context. The context was framed by a period of rapid institutional and policy change in teacher education within a wider South African transformation arena, and the pressure that teacher education providers were consequently under to design and implement new curricula for the production of teachers for this changing environment.

During the late 1990s, as a teacher educator and academic operating out of a South African University School of Education, I had been intimately involved in designing new qualifications for initial teachers in line with the emerging Norms and Standards for Educators (DoE, 2000b) policy. We were excited by the possibilities that were open to us in the new context. We wanted to be responsive to changes in wider education policies related to transforming the curriculum and teaching in schools, in particular to the implementation of Curriculum 2005 and outcomes based education (OBE), and to the implementation of the National Qualifications Framework (NQF).

Alongside this activity there were moves at a national level to make teacher education a national competence and to move all teacher education into the higher education system (NCHE, 1996). At the time this appeared to be a move made by the state in order to gain national control over all teacher education and to create a regulatory framework to improve quality of teacher education provision as well as the efficiency and cost effectiveness of the system.

In 2001, after the publication of Government Gazette Vol. 426 No. 21913 on 15 December 2000 (DoE, 2000a), all teacher education formally became part of higher education. A former provincially governed College of Education was incorporated into my University on 31st January 2001 under the provisions of this gazette. By the time the incorporation came into effect the university School of Education Training and Development (SETD) and the College of Education had independently designed new qualifications for initial secondary teachers, and had implemented them. With the incorporation the two became part of the same Faculty of Education, and a common curriculum for qualifications had to be negotiated for the institution as a whole. As negotiations proceeded, it became evident that there were two fundamentally different ways of thinking about the organisation and nature of knowledge in teacher education curricula operating across the two contexts.

The ex-university SETD had designed an initial teachers degree for secondary school teachers using the resources of the whole university and dedicated to developing initial teachers' knowledge through a fairly strongly classified (Bernstein, 1996) curriculum where teachers would be expected to develop Mode 1 and Mode 2 knowledge (Gibbons et al., 1994). The curriculum drew on academics from across all departments in the university and expected teachers to develop disciplinary knowledge of their subjects within the various academic departments alongside students studying for other purposes, and to develop their pedagogic, pedagogic content knowledge, curriculum knowledge and broader educational knowledge within the SETD. The design of the curriculum was based on an adaptation of Shulman's (1986b; 1987a) forms of teacher knowledge using Grossman's (1990) development of his framework in her study *The Making of a Teacher*. On the other hand the ex-college had developed a more weakly classified integrated curriculum where all teacher education would take place within the closed system of the college and all aspects would be focused on developing knowledge relevant to teachers and be taught by teacher education specialists, excluding academics in the disciplines.

These curricula choices were connected to the prior institutional practices and location. The SETD was located on a general university campus which had a wide range of disciplinary departments that could be drawn in to assist with the teacher education project and was staffed by education academics. The College was situated on an isolated campus relatively far away from a main university campus, had to rely on its own resources and had an institutional history that prioritised relevance and practice and regarded university academics with suspicion. While the basic categories presented in the Shulman model were accepted by all

parties how this was interpreted varied considerably. What contents ought to be selected as appropriate for each category and how these ought to be made available to student teachers was at the heart of heated disagreements and debates.

These local attempts to agree on a design for purposeful ‘Norms and Standards’ (NSE) based initial teacher education qualifications for South African teachers thus rubbed up against arguments over *what* knowledge and practices should be included in the curriculum and *how* these should be organised and delivered to produce the best possible teachers for the transforming context. It became increasingly clear that these issues could not be resolved through the discourse of the everyday world of work, i.e., ‘curriculum workshops’ and ‘committee meetings’. The two views appeared to be based on fundamentally different ideological positions and there appeared to be no easy way of resolving the differences. I became interested in finding out whether it would be possible, based on research, to provide insights into whether and how such decisions could be made on the basis of epistemological and educational arguments, rather than on the ideological stand points of the two sides. One way of doing this would be to explore the field of mathematics teacher education (MTE) as it has been constituted in the South African context. Thus while my local context motivated the study, it is not the focus of the study.

1.2 Focus of the study

The study was conceptualised around the key issue of forms of teacher knowledge and their place in the teacher education curriculum within a context of education reform. In particular I was interested in relating this to the development of initial *specialist mathematics* teachers in and for South Africa and to the design and implementation of curricula for this purpose. In South Africa, specialist school teachers are educated for the Senior Phase of General Education and Training (SPGET), i.e. Grades 7 – 9, and/or for Further Education and Training (FET), Grades 10 - 12. Thus I set out to explore the production of curricula within the reform context for initial specialist MTE in South Africa. I wanted to understand how different forms of knowledge and practices had been selected and organised in curricula across the field of MTE and whether we could learn anything from this for the work of MTE more generally in this country.

2 The design of the study

The study was conceptualised in three parts. The first part began with the aim of describing the teacher education reform context and the policy changes that were taking place in South Africa. I felt it was important to begin here so I could start describing the demands being made on teacher education by the state. The next step would be to survey the various institutions offering teacher education and to analyse the design of their curricula with the view to seeing how these were related to the policy. I realised early on that while this might give me an overview of the intended curricula organisation across the field it would not tell me much about the practices within specific institutional settings. I thus planned for a further phase in the study. On the basis of the survey I would carry out more detailed case studies in selected institutions. The aim was to map out the way in which forms of knowledge and practice were organised, and then to zoom into specific instances to explore how these curricula were being put into practice.

One of the recurring comments in the literature on teacher education research is that the focus of studies has been primarily small scale and conducted on individual courses or seminars by individual teacher educators functioning as participant researchers, often aimed at improving local practice. There are very few longitudinal studies or analyses based on national databases (Adler, 2004a; Adler, Ball, Krainer, Lin, & Novotna, 2005a; Cochran-Smith & Zeichner, 2005, p. 5). While I did not have the resources to undertake a longitudinal study, I hoped that by taking an overview of the system and curricula designed within it as a starting point, and then doing in-depth case studies at selected sites of MTE practice (in which I had no personal involvement), I could contribute to the growth of knowledge in the field. The purpose of the research was not to evaluate these practices or attempt to improve them; rather it was an attempt to understand how MTE is constituted across the field and what we can learn from this to inform the design of our teacher education programmes and pedagogic practices.

It was clear from the beginning that what I was most concerned with were the principles for classification and framing of knowledge and practice operating throughout the teacher education system. This interest was sparked at three levels. Firstly, state policy which frames the regulation of teacher education. Secondly, the design of curricula for MTE qualifications produced by HEIs in response to the policy framework. Thirdly, MTE practices in the institutions that provide initial teacher education qualifications. I thus drew heavily of the

work of Basil Bernstein (Bernstein, 1971, 1977, 1990, 1996, 1999, 2000) to provide a theoretical framework for the study.

2.1 The research questions

As I worked on the theoretical level with Bernstein's concepts and attempted to develop a language of description for the analysis of policy and curriculum practice, I began to realise that I was focusing on the operation of what Bernstein calls the *pedagogic device* within the SA teacher education context, and in particular within the arena of the Recontextualising Field (RF). More specifically, I was looking at curriculum policy being constructed by agents of the state within the Official Recontextualising Field (ORF) and consequently the privileging of particular forms of knowledge for teaching in general, and for mathematics teaching in particular (Official Knowledge). These selections were related to the projection of an Official Pedagogic Identity (OPI) that the state was attempting to institutionalise through their policy reforms. On the second level I was looking at the way different Higher Education (HE) institutions in South Africa recontextualised state policy for their own purposes and therefore the construction of curricula within the Pedagogic Recontextualising Field (PRF). This was focused on the selection of knowledge and practices for teacher education at the institutional level, and hence the projection of institutional pedagogic identities constructed through that selection. Part one of the study therefore became focused on the relationship between the ORF and the PRF, and in particular the pedagogic space opened up in teacher education by the new reform context. The second part would be focussed on the way in which institutions in the PRF positioned themselves with respect to the ORF in the production of their teacher education programmes, and the extent to which their curricula were influenced by the ideology of the ORF within this context.

This work helped me focus the questions I was trying to explore more effectively. The study was essentially broken up into three different parts. In the first part which involved the policy analysis the major questions became:

1. What spaces have opened up to MTE within the context of rapid institutional change and the production of new policies for teacher education and school mathematics?²
2. What concept of a 'good mathematics' teacher and of 'good mathematics teaching' does South African education policy construct? (i.e. What is the Official Pedagogic Identity projected from the policy generated within the ORF) ³

² Some of the findings of this analysis have been published in (Parker & Adler, 2005)

In the second part which involved a survey of initial MTE programmes the major questions became:

3. How have Higher Education Institutions in SA responded to the changes in the teacher education landscape, and, how have they attempted to fill the pedagogic spaces made available for the production of mathematics teachers within this new context?
4. What are the range of MTE programmes available in these institutions, and how has knowledge and practice been organised within them?
5. What knowledge discourses and practices appear to have been made available to mathematics student teachers across these diverse sites?⁴

The focus of the first two phases of the study resulted in my becoming more and more interested in the concept of pedagogic identity and mathematics teacher identity and this lead me to focus in the third phase not only on what was offered in the curricula of the case study institutions but also on the pedagogic identities the novice (student) teachers project after studying at the institution. In order to sharpen this focus, it made sense to look at two HE institutions with different contexts and histories, which would probably project identities with some similarities, but also differences. Thus in the final phase the major questions became:

6. What images of 'good' mathematics teacher and 'good' mathematics teaching are constructed in two contrasting Higher Education Institutions?
7. How do student teachers at each of these institutions project themselves? (What mathematics teacher identities do they project?)
8. How do these identities differ over the two contexts? (What is similar/ different about them?)
9. What can be drawn from this research project to inform the work of MTE within the SA context?

³ This work has also been reported at various conferences (Parker, 2003b, 2004b, 2004c) and published in Parker (2006a; 2006b)

⁴ This aspect of the project has been published in Parker (2006c).

2.2 Scope of the study

The study was driven by my interest and work in teacher education generally and in mathematics teacher education specifically. My need to answer questions that could be of use to my own work, my experience in teacher education, and my theoretical orientation drove me to explore all levels of the system: the policy environment and restructuring of teacher education, the design of mathematics teacher education curricula within this policy context across the field, and the implementation of selected curricula at an institutional level.

To analyse the policy and changing institutional landscape on its own did not seem sufficient, since it could not lead to any understanding of the bases for actual curriculum practices in the field of MTE, which was at the core of my problem. However, ignoring the policy environment and the expected reforms that the state hoped to institutionalise within the system would mean a stunted study. The major challenge in designing and developing a teacher education curriculum within the South African context was related to the dilemmas of having work within the transforming regulatory and policy environment, in an institutional context that had undergone structural change through the incorporation of a College. The study needed to consider the positioning of institutions that offered teacher education within this environment, and attempt to understand the bases for their curriculum designs in relation to their contexts and the policy of the state. In addition, in order to understand how knowledge and practices were being selected into the curricula offered across the system I needed to map the field, and consider the design of MTE curricula at institutions that offered it. However, given that my interest was in understanding the connection between the organisation of knowledge and practice within a curriculum and the specialisation of consciousness and conscience through pedagogic communication, it also seemed necessary to go down to the level of pedagogic practice within institutions.

Once this decision had been made, the scope of the project was set. It was clearly very broad, starting with a system wide analysis and then zooming in to specific cases. I needed more than one case and I needed to select cases that would provide a comparative advantage that could possibly provide me with insights that would be productive for developing knowledge in the field. Once the cases were selected, it was also possible for me to have chosen to focus on one side of the equation – the offerings of the institutions and the opportunities that these presented in relation to specialising secondary mathematics teachers, or the specialisation of the novice teachers themselves, their experiences of the MTE curriculum offered by the institution and

the specialised identities they had constructed during their studies. It seemed to me as I got more involved in the study, that to only focus on the curriculum offered would enable me to explore only half the story, and that without a focus on the teacher identities the study would lose its significance. It was also clear to me that to attempt to focus on the novice teacher identities without considering the curriculum that they had experienced would be meaningless. I therefore made the decision to consider the problem from both sides, and as is the nature of case studies, this involved in-depth analyses in two directions. This decision meant that the study would be a substantive piece of work, at both a theoretical and empirical level.

In retrospect the scope of the study was too wide. However, having set out on this path, having completed the policy analysis, the survey of the system, and then having collected the evidence for the case studies I was bound to see it through. The consequence of working my way systematically through the three phases of the study has been the production of a thesis which has involved both deep theoretical work and extensive empirical work. This has meant that the product is also extensive. It is extensive because it systematically presents all phases of the study as described in the previous section, providing an account that is both thick (to ensure descriptive validity) and theoretically informed. The length of the thesis can only be explained in relation to the width and depth of its scope, as well as the methodological approach adopted in the production of the account.

Perhaps a more sensible approach would have been to stop the study and close it down after the institutional analysis had been completed. However, this would have meant that only half the story would have been presented. I found myself unable to do this and so continued to the logical end. I am now faced with having to explain why I am presenting a thesis that is too 'big'. I know that in today's world a PhD study should be more contained. My only excuse for presenting such a wide ranging study is that I followed the study and was driven to present a comprehensive account that could be defended – and so this PhD is not contained. Its scope is wide and deep and the resulting thesis is long and complex. I have presented it here in two volumes. The first volume contains the first two parts of the thesis and the institutional analyses. The second volume contains the analysis of the student teacher identities and conclusions as well as the appendices, in which some of the data is presented.

2.3 Structure and synopsis of the thesis

Volume 1

Chapter 1: Introduction to the study and research questions.

Chapter 2: Regulation and the problem of teacher education in a context of education reform.

This chapter provides an overview of selected literature from the fields of teacher education, mathematics teacher education and mathematics education relevant to the study, and sets the scene for the remainder of the thesis.

Chapter 3: Reform, regulation and the pedagogic space for teacher education in South Africa post 2000.

This chapter focuses on the context of teacher education reform in South Africa, both in terms of the structural relocation of teacher education and broad changes in policy and curriculum. It develops an internal language of description for theorising teacher education and analysing the pedagogic space within the transforming context. (The focus here is on Question 1)

Chapter 4: Official pedagogic identities and discourses for mathematics teachers and teaching: Projections from South African policy.

This chapter focuses on official pedagogic identities of mathematics teachers projected from teacher education policy and the national school mathematics curriculum statements. (The focus here is on Question 2)

Chapter 5: The construction of teacher education curricula in the PRF: Forms of knowledge and practice.

This chapter reports on the survey of MTE curricula across the field, the organisation of knowledge and practices in their design, and the positioning of institutions relative to the ORF. It concludes with the selection of the case study institutions selected on the basis of the organisation of their curriculum and positioning with respect of the ORF. (The focus of this chapter is on Part 2 of the study, that is, Questions 3, 4 and 5).

Chapter 6: Methodology 1: Researching curriculum, pedagogy and assessment practices within mathematics teacher education.

This chapter focuses on the methodology of interpretation used as a basis for the case studies, and the development of external languages of description for the analysis and interpretation of symbolic message systems for the

transmission of pedagogic communication within the institutional context of each case study. (Chapters 7, 8 and 9, deal with research question 6)

Chapter 7: The case of City University.

This chapter uses the methodological approach outlined in Chapter 6 to provide an in-depth analysis of curriculum, pedagogy and assessment in the context of City University and uses this to provide an account of its intended ‘good’ subjects.

Chapter 8: The case of Rural University

This chapter follows the same pattern as Chapter 7 in the context of Rural University and uses this to provide an account of its intended ‘good’ subjects.

Volume 2

Chapter 9: Methodology 2: Researching an institution’s ‘good’ pedagogic subjects.

This chapter focuses on developing languages of description for the analysis and interpretation of student teachers’ pedagogic identities, that is, accounts of the institution’s ‘good’ pedagogic subjects. (Chapters 10, 11 and 12 deals with research question 7)

Chapter 10: The ‘good’ subjects of City University.

This chapter uses the methodological approach outlined in the previous chapter to provide accounts of City University’s ‘good’ pedagogic subjects.

Chapter 11: The ‘good’ subjects of Rural University.

This chapter uses the methodological approach outlined in the previous chapter to provide accounts of City University’s ‘good’ pedagogic subjects.

Chapter 12: Cross-case analysis.

In this chapter the two cases are contrasted with one another and similarities and differences, absences and presences are highlighted and used to raise issues for the field of mathematics teacher education more broadly. (Chapter 12 deals with questions 8 and 9)

Chapter 13: Conclusion.

This chapter concludes the thesis. It highlights findings of the various chapters and draws the study to a close.

Chapter 2

Regulation and the problem of teacher education in a context of education reform

He who can, does.

He who cannot teaches.

I don't know in what fit of pique George Bernard Shaw wrote that infamous aphorism [...] a calamitous insult to our profession, yet one readily repeated even by teachers. More worrisome, its philosophy often appears to underlie the policies concerning the occupation and activities of teaching. (Shulman, 1986a, p. 189)

We reject Mr. Shaw and his calumny. With Aristotle we declare that the ultimate test of understanding rests on the ability to transform one's knowledge into teaching.

Those who can do.

Those who understand teach. (Ibid., p. 212)

1 Introduction

In the introduction to this thesis I explained that my personal motivation for this research project was rooted in my experiences of attempting to design a new curriculum for initial teachers within the post-apartheid context. At that time it seemed to us that what was happening in South Africa was fairly unique and connected to the particular politics of transformation that were sweeping the country after the demise of apartheid. The closure of the colleges of education and the new policies that were being developed for teacher education were seen as part of attempts by the new state to radically reform the education system and regulate it in a way that would advance the ideals of the newly democratic society. The challenges for teacher educators within this context were coloured by a number of tensions, and these influenced the debates over *what* should be included in the initial teacher education programme and *how* it should be made available to teachers.

Adler (2005) describes mathematics teacher education (MTE) as a complex multi-layered domain of social practice which operates across a range of different institutional sites offering pre-service (preset) and in-service (inset) programmes⁵ for different purposes (e.g. primary and

⁵ Pre-service teacher education (preset) is often referred to as teacher preparation in other parts of the world. In-service teacher education (inset) is referred to as professional development. Lerman (2001) in a review of research perspectives on mathematics teacher education explains that the terms *teacher education*, *teacher development* and *teacher change* are all used in different ways and in different contexts in the literature. He suggests that teacher education is most commonly used in relation to preset programmes and students, while teacher development is mostly used in inset contexts. Teacher change is usually used in the context of research that is focused on development programmes which are aimed at changing teachers' attitudes/ beliefs/ practices towards ideals that are embedded in the programme. In this report my focus is on initial secondary teacher

secondary, rural and urban education). MTE is concerned with the ultimate goal of school pupils' mathematical learning through providing opportunities for teachers' learning, and so is also concerned with how teacher educators foster teacher learning. In the new context, a major concern is to disentangle what it means to know mathematics, to teach mathematics and to develop mathematical and other forms of knowledge and practice for teaching. In other words it is directly concerned with the 'what and how' of pedagogic discourse for mathematics teachers and teaching, and raises questions about access to knowledge discourses and practices that this could be built on, and, in turn, questions about the production of curricula for the specialisation of mathematics teachers.

The local MTE context is marked by the legacy of apartheid education, a general poverty in mathematics education in South African schools, specifically in schools that had served 'black African'⁶ South Africans (see DoE, 2001; Parker, 2004a), and a fragmented schooling and teacher education system characterised by deep inequality (see for example, Adler & Reed, 2002; Chisholm, 2004; Jansen & Christie, 1999; Naidoo, 2005; 2003a; Sayed, 2004; Taylor, Muller, & Vinjevold, 2003; Taylor & Vinjevold, 1999; Welch, 2002). As Adler (2005) puts it, teacher educators

work in a socio-cultural and political context deeply scarred by apartheid education [...] we need to simultaneously work with repair (apartheid did damage), redress (apartheid was constructed by and productive of inequality) and reform (to produce a thriving democracy and supportive curriculum). (p. 163)

Within this context, teacher educators are faced with the challenge of unravelling what it takes to teach in a post-apartheid context, where policy is driven by concerns not only about redressing the ills of the past, but also with moving into a future which is to be profoundly different.

That the past decade has been characterised by major transformations in all aspects of South African society generally and, in particular, by attempts to radically transform the apartheid educational terrain through new policies and regulatory practices in order to construct a different future, is well known. School curriculum changes implemented since 1997 have been described as "unparalleled in the history of curriculum reform" (Harley & Wedekind, 2004, p. 195). These reforms have been explicitly aimed at overturning the unjust distribution of power and control relations that characterised South African society under apartheid. In post-apartheid

education/ preset/ teacher preparation programmes, and I use these terms as seems appropriate within the context I am discussing at the time.

⁶ In the peculiarities of South Africa's apartheid past, the population was divided into different racial and ethnic 'groups'. 'Black' South Africans included the so called 'coloureds', who were of mixed origin, 'Indians' whose origins could be traced to the sub-continent of India, and Africans whose origins were in Africa itself. 'White' South Africans were of European origin. This legacy still structures much of the inequality across the landscape.

South Africa the schooling system, through its transformed curricula, was designed to serve a radically new purpose:

Simply put, if the curriculum had been used to divide races (as well as men and women within their 'own' racial groups), and to prepare different groups for dominant and subordinate positions in social, political and economic life, its new mission would be that of uniting all citizens as equals in a democratic and prosperous South Africa. (*Ibid*)

Much has been written about the gap between the policies that have been developed and implemented to meet ideal visions - of what 'ought to be' - and the reality of South African teachers and schools - 'what is' - especially in the more traditional and rural schools (for example see, Chisholm, 2004; Harley, Barasa, Bertram, Mattson, & Pillay, 2000; Harley & Parker, 2007; Jansen & Christie, 1999; Mattson & Harley, 2003). In South Africa reform demands, exacerbated by the pressure to radically change the apartheid educational order, to move into the 21st Century and the punishing time frames for developing and implementing new curricula representing a new democratic order, produced overwhelming challenges for teacher education and development (Adler and Reed, 2002). However, it is important to note that problems related to the complex demands on teachers made by educational reform initiatives in South Africa, and the paradoxes they produce for teacher education, are a feature of global education reform (as shown in, for example, Hargreaves, 2001) and not simply a local problem.

Before starting out on the research agenda outlined in Chapter 1, I consider the international context of teacher education generally and MTE more specifically. To what extent are the local movements in teacher education, for example the restructuring of the teacher education landscape and regulatory policies of the new state, also concerns in other countries? Was the closure of the colleges of education a local peculiarity, or was this type of structural change happening elsewhere? What were the questions and movements with respect to the design of teacher education curricula in general and mathematics teacher education in particular? In this chapter, I focus on these questions and through a reading of literature⁷ across different contexts, set the scene for the later chapters in which I consider the local context and production of curricula across the field of MTE in South Africa.

In what follows I begin by identifying trends, commonalities and differences in teacher education policies and practices internationally. I show that teacher education reform is a

⁷ This chapter does not represent a traditional literature review of the field. It is more in line with Maxwell's (2006) description of a selection of literature *for* this particular research project. Also, as will be seen, literature is referred to throughout the thesis and thus the full field relevant to this project is not presented in this chapter, but rather is built up as the research project is presented.

complex field in which a number of different trends play out to produce a fairly wide variation of responses across different international contexts. I begin by discussing what has been identified in the literature as a central ‘problem’ of teacher education: the failure of schools to adequately educate the youth. At the same time international moves towards professionalizing teaching and towards the production of well qualified teachers for education systems across the world are recognised, together with two specific trends: firstly increasing moves towards regulating teacher education through the production of government policy, qualification standards and quality assurance processes; and secondly, a trend towards locating the provision of teacher education in higher education institutions. Through drawing on specific international cases I show that these overall trends are not uniform across different context and are happening in very different ways with different effects.

I then focus on issues directly relevant to the design of initial teacher education curricula in general and secondary MTE curricula in particular. I show that while research highlights different aspects of knowledge and practice as important for teachers to learn, there is still much contestation around what should be included in a MTE curriculum and how it should be learnt. I identify a particular focus in the literature which suggests that there is a specificity to the knowledge that mathematics teachers require for teaching (called mathematics for teaching (*MfT*)) that is different from what might be required by a person learning mathematics from a disciplinary⁸ perspective. I argue that while this is an important aspect of any MTE curriculum it would be insufficient on its own and that there is little evidence to support the view that a teacher should not learn mathematics from a disciplinary perspective as well. I argue that the field is complex and that a focus on one dimension in an initial teacher education programme at the expense of another could be dangerous. I link the focus on knowledge and practice to the notion of developing a mathematical identity and mathematics teaching identity, and reorient the focus from what is taught to how it is taught.

2 Teacher education reform: International trends

Bates (2004) contends that teacher education reform is often a consequence of broader redefinitions of power relations within a country and is most visible when there is a change in government which brings about changes in policy. At first it might seem that this was the basis for changes that took place in teacher education in South Africa in the 1990s: the new democratic government instituted reforms at all levels in the education system including teacher education. However, a scan through the literature reveals that during the 1990s

⁸ Here I use ‘disciplinary’ to mean from a perspective of the mathematicians who are the producers (and reproducers) of mathematics as a discipline.

education reform generally became an important focus of international policy discussions and so was clearly not simply a South African phenomenon. In particular, such a review reveals that teacher education has become an increasing focus of reform activity across the globe (see, for example, Avalos, 2000; Bates, 2004; Cochran-Smith & Zeichner, 2005). These authors suggest that the perceived failure of education to, for example, adequately socialise youth or ensure a sufficient supply of qualified labour for the new national and global contexts produced panic – both moral and economic – which drove reform initiatives. This failure of education is clearly expressed in the following quote from the 1998 United Nations Educational, Scientific and Cultural Organisation (UNESCO) *World Education Report: Teachers and teaching in a changing world*:

Education systems it is widely felt are not performing effectively, not doing what they should be doing to ensure the young people passing through them learn well what they are supposed to learn, and are well prepared to assume their future roles and responsibilities in the family, in the workplace, and in the wider community and society. (UNESCO, 1998, p. 48)

Teachers are to blame, they are a major ‘problem’ of education in general – if only they had the right kind of preparation these problems could be solved. This translates into a focus on teacher education which is seen as having clearly failed in its responsibility to society to provide the *kind* of teachers required, and specifically it has translated into policies which attempt to set standards for and regulate teacher education to solve the problem of ‘inadequate’ (incompetent) teachers.

2.1 Teachers as ‘the problem’ of education

Cochran-Smith and Fries (2005), in their comprehensive analysis of research on teacher education in the USA between 1950 and 2003, suggest that seeing teachers as *the problem* of education in general, is not a recent phenomenon and is rooted in the history of teacher education research from the 1950s. Throughout the decades events and reports suggest that:

... schools are in trouble and teachers are failing in some way. Teacher preparation is condemned by both external and internal critics for its lack of intellectual rigor, selectivity standards, structural arrangements, research base and failure to achieve positive results in schools and classrooms. (Ibid. p. 71)

They argue that this apparent failure has been a major driver of teacher education reform and research for decades.

Cochran-Smith and Fries, show that in the USA, the ‘problem’ of teacher education has been constructed in teacher education research differently over three different eras, each one influenced by the particular historical and political context of the time. From the late 1950s to the early 1980s teacher education was seen as a *training problem*. What were needed were

better trained teachers, and teacher education had a responsibility to research, and so develop, ways of training teachers better. From the early 1980s to the early 2000s it became constructed as a *learning problem*. Teachers needed to ‘learn how to learn’ and how to *help* their students ‘learn how to learn’ and teacher education should therefore work towards teachers who were competent in promoting learning and developing self reliant learners. Finally from the mid 1990s to the present it is reconstructed as a *policy problem*. The problem with teacher education is its unaccountability and non-transparency; standards for regulating quality need to be in place to ensure that the *right* kind of teachers required are produced. This policy environment produces further problems and failure for teacher education: governments in constructing their policies to regulate and control the production of teachers, put pressure on teachers and on teacher education to meet policy ideals and visions that are often too far removed from the realities of practice in their classrooms and schools.

The foci revealed by Cochran-Smith and Fries are not only relevant to the USA. They certainly resonate with recent reform initiatives in South Africa (for example, see Jansen, 2001). In particular, they can be traced through a series of UNESCO reports that have been strongly influenced by (and have influenced)⁹ the direction of teacher education reform, teacher education research, as well as government actions and policies in relation to teacher education in different countries. Thus while Cochran-Smith and Fries’ analysis is focussed on research produced in the USA, the trends they identify may be internationally recognised, although within different time scales. A further focus that is not identified by Cochran-Smith and Fries but is identified within UNESCO reports (for example, see UNESCO, 1998) as becoming increasingly important, particularly by governments, is research on monitoring and evaluating the provision of education and teacher education.

The publication of the ILO¹⁰/ UNESCO 1966 *Recommendation concerning the status of teachers* (Recommendation, UNESCO, 1966), and the subsequent setting up of the UNESCO *Joint Committee of Experts on the Recommendations Concerning the Status of Teaching Personnel* (CEART), was influential in putting teacher education on the international agenda, encouraging governments to take increasing responsibility for teacher education and putting forward teacher education, as a *problem of training*, at the centre of research activity. In particular principles 11 to 13 of the Recommendation, quoted below, signalled that

⁹ Influenced by (and reflections of) the movements that have taken place in industrialized/ developed nations and influencing the developments taking place in the developing nations, as will be shown in the chapter.

¹⁰ The International Labour Organisation.

governments have a responsibility to fund teacher education and ensure their teachers are properly trained.

- Principle 11: Policy governing entry into preparation for teaching should rest on the need to provide society with an adequate supply of teachers who possess the necessary moral, intellectual and physical qualities and who have the required professional knowledge and skills
- Principle 12: To meet this need, educational authorities should provide adequate inducements to prepare for teaching and sufficient places in appropriate institutions.
- Principle 13: Completion of an approved course in an appropriate teacher education institution should be required of all persons entering the profession. (UNESCO, 1966, p. 5)

The *Recommendation* signalled the importance of providing society with teachers who would have the necessary “moral, intellectual and physical qualities” to socialise its youth and the “professional knowledge and skills” to do it. Teachers are to be upstanding members of the community who will uphold the mores of society¹¹. Teaching should be recognised as a profession and not simply as a vocation/ occupation and this requires properly trained teachers. The need for regulation of teacher education by governments is prefigured in the *Recommendation* however, at this stage the state’s role is described in terms of the responsibility to recruit, fund and employ new teachers. Teacher education and the training of teachers it is suggested should be through ‘approved’ courses, and approval appears to be related to the ‘appropriateness’ of the institution that offers the course.

Principle 21(1) of the *Recommendation* describes appropriate institutions in the following way:

All teachers should be prepared in general, special and pedagogical subjects *in universities* or in an *institution on a level comparable to universities*, or else in special institutions for the preparation of teachers (Ibid. p. 6, emphasis added).

This signals an important change in teacher education internationally: the suggestion that *all* teacher education should take place in universities (or other *higher* education institutions).

The *Recommendation* also provides guidelines for what contents should be selected into a teacher preparation programme (principles 19-24) and what the responsibilities of teacher preparation institutions should be (principles 25-30). It specifically points to their duty to *research* teaching and teacher education and *use* this research in-and-for developing teacher preparation programmes (see principle 26 below). There is an implication here that teacher education should be based on research which would keep it up to date and relevant to society.

- Principle 26: Research and experimentation in education and the teaching of particular subjects should be promoted through the provision of research faculties in teacher-preparation institutions and research work by their staff and students. All staff concerned with

¹¹ I note there is an implied commonality in these principles – for example, it is not suggested that different societies may have different values etc. These values are everyone’s values: a universal humanity.

teacher education should be aware of the findings of research in the field with which they are concerned and pass on its results to students.

To summarise, the *Recommendation* emphasised the responsibility of governments to take control of funding and ensure that teachers they employ in their system are adequately qualified through ‘appropriate’ teacher education institutions. It also underlined the responsibility of these institutions to develop a research-base for their work of training teachers¹². While these recommendations were not a formal policy, they formed the background of subsequent UNESCO and CEART work on teacher education. This work influenced governments across the world to take responsibility for developing teacher education policy and to become involved in the regulation of teacher education through standard setting and quality assurance in their local contexts. The move from trusting institutions to provide the right kind of teachers for society to a focus on regulating the production of their qualifications could be explained in part as a response to the perceived failure of institutions to produce the kind of teachers required. I will return to discuss the issue of trust and its connection to the increasing regulation of teacher education a little later in the chapter.

Another UNESCO report, which is illustrative of the second era identified by Cochran-Smith and Fries (2005) and has influenced policy makers across the world (Avalos, 2000), is the 1996 UNESCO report of the International Commission on Education for the 21st Century, *Education: The Treasure Within* (Delors, 1996). In the report it is suggested that:

Our vision of the coming century is one in which the pursuit of learning is valued by individuals and authorities all over the world not only as a means to an end, but also as an end in itself. Each person will be encouraged and enabled to take up learning opportunities throughout life. Hence, much will be expected, and much will be demanded, of teachers, for it largely depends on them whether this vision can come true. Teachers have crucial roles to play in preparing young people not only to face the future with confidence but to build it with purpose and responsibility [...] the importance of the role of the teacher as an agent of change, promoting understanding and tolerance, has never been more obvious than today [...] The need for change from narrow nationalism to universalism, from ethnic and cultural prejudice to tolerance, understanding and pluralism, from autocracy to democracy in its various manifestations, and from a technologically divided world where high technology is the privilege of the few to a technologically united world, places enormous responsibilities on teachers who participate in the moulding of the characters and minds of the new generation. (Delors, 1996, pp. 141 - 142)

This indicates a move in the focus from teaching to learning and promoted the concept of lifelong learning, which became a hallmark of education reform across the world in the 1990s, as well as in South Africa. It also emphasises the diversity of societies that teachers are expected to work in and so highlights the increased responsibility for teachers to play a role in

¹² It is important to stress that while the 1966 *Recommendation* set these ideals in place, it later became clear that they would be differentially taken up in different countries with different resources, and that the aim of highly educated appropriately qualified teachers would not be possible in all contexts (UNESCO, 1998).

‘moulding’ citizens who will be open and ‘tolerant’, and able to work with others whose fundamental belief systems are different. The assumption underlying this is of a world in which (certain) universal norms and values are taken for granted as the ‘good’ that education should instil in all. Thus the teachers’ role is expanded from teaching specific knowledge and developing identities related to that discipline/ subject and instilling values appropriate to their local social and cultural contexts, to teaching their learners ‘how to be’ citizens for this changed world. At the same time there is also a clear acknowledgement that there is a differentiated distribution of knowledge and technology to different social groups, and that teachers must play a significant role in creating the conditions of access *for all* groups.

The publication of the Delors’ report (Ibid.) was followed by the 45th International Conference on Education hosted by UNESCO in 1996 whose theme was: “Professionalism: strengthening the role of the teacher in a changing world”. This preceded the publication of a further significant UNESCO report: *Teachers and Teaching in a Changing world* (UNESCO, 1998), which refers to the Delors report to support its advocacy for teachers to be prepared, in their training, for a much wider spread of demands than ever before. Teachers should not only to be able to implement change but also to foresee its need and be imaginative and skilful in providing solutions to problems in society. It signals a shift in focus from teaching, to learning as knowledge production, which is considered as a key human resource and necessary for economic development in the global context.

The young generation is entering a world which is changing in all spheres: scientific and technological, political, economic and cultural. The outlines of the ‘knowledge-based’ society of the future are forming. The status of education is changing: once seen as a factor of unity and integration within society, it is increasingly becoming a source of such differences and distinctions between societies in a global economy which rewards those who possess more advanced skills and limits the opportunities of those who do not. (UNESCO, 1998, p. 16)

Thus it is important for governments across the world to reform education (through development of policy) and teacher education to spread opportunities for access to the new ‘goods’ of global society, so as to develop self managing citizens capable of learning and improving their lives and of working co-operatively and productively.

‘The focus of basic education’ the World Conference on Education for All declared ‘must ... be on actual learning acquisition and outcome, rather than exclusively upon enrolment, continuing participation in organized programmes and completion of certification requirements’ [...] Yet if learning is to improve [...] the quality of teaching and therefore of teachers cannot be overemphasised. (UNESCO, 1998, p. 48)

What is illustrated in these UNESCO documents is a key shift in international educational policy: governments are now to be encouraged to develop policy that not only focuses on

getting children into schools and retaining them¹³, but also ensures that their learning is pertinent and useful for an increasingly complex society.

Avalos (2000) suggests that the 1998 UNESCO report promoted the development of government policy throughout the developing world to focus on the provision of universal access to the codes of modern society through a focus on high-level cognitive abilities which would enable people, as promoted in the Delors (1996) report, to learn how to learn and produce knowledge (to learn how to do) and to learn to live with others and respect diversity (to learn how to be). That is the policies would be developed on ideals based in the international arena of the globalising world. That these reform ideals have been influential in the South African context is well documented (see for example, various chapters in Chisholm, 2004; Jansen & Christie, 1999).

The various UNESCO reports and the work of CEART, arguably driven by research produced in developed contexts and by the changes in society within industrialised (Western) nations have over the decades encouraged all governments to take increasing control over the regulation and governance of teacher education, in particular, the responsibility to ensure that teacher education produces the right *kind* of teachers for a changing world (globalising world): teachers who could rise to the challenges of the increased roles as described above¹⁴.

Hargreaves (2001) argues that these demands of educational reform, which are being increasingly felt across the globe, produce paradoxes for teachers and serious challenges for teacher education. Adler, Slonimsky and Reed (2002) describe the demands being put on teachers internationally in the following way:

Teachers are expected to teach new knowledge in new ways, and so engage in ongoing learning in relation to their professional expertise. They are expected to produce learners with high level skills and

¹³ It is important to note that the focus of this shift does not imply that all children *are* in schools. Getting all children into primary schools still remains an aim of 'Education for All'. The World Conference on Education for All (EFA) in Jomtien, Thailand, in 1990 pledged in the *World Declaration on Education for All* and the *Framework for Action for Meeting Basic Learning Needs*, to provide primary education for all children and to massively reduce adult illiteracy by the end of the decade. Ten years later the World Education Forum Conference held in Dakar, Senegal in 2000 reviewed the progress made towards EFA and 164 countries (including SA), committed themselves to specific goals and targets towards EFA (DoE, 2002). However, the shifts identified here give a clear signal of the location of power in UNESCO, and shows that its goals for the world are driven by the values of developed countries where these educational aims reflect aspects of society that might be taken-for-granted. That this 'need' for a shift is placed on all countries is significant – it signals the expectation that poor countries of the world *ought to be* part of a common complex global culture. There is an expectation that all societies ought to become modern (and government policy should be used to reform education to enable this, and so tend to be based on 'visions' for a new world that are often far removed from the practices that exist – that is, from *what is*). They should replace traditional authority and values with those of the 'changing world'.

¹⁴ It is illuminating to see the similarities between what is advocated here and the roles described in the NSE, and the aims of the National Curriculum Statements in SA. These are discussed in some detail in Chapter 4.

integrated and flexible knowledge so that they may take their rightful place as informed and active citizens in their new knowledge societies. Teachers are also expected to play a significant role in eradicating the social ills and inequalities that their learners bring to their classrooms. (p. 150)

As will be shown in Chapters 3 and 4, these are very similar to the demands being made on teachers in South Africa. Adler et al. (Ibid.) stress that if this is felt as a challenge for teacher education in industrialised/ developed countries, the demands in the South African context where we deal with the legacy of apartheid are felt even more acutely.

The discussion so far highlights the point that the work of teachers, and in the context of my project, secondary teachers, has been re-conceptualised (globally) from one in which they systematically teach specific texts and ensure their learners can adequately work with and reproduce these, to one in which teachers must become lifelong learners engaged in self improvement and be responsible for socialising their learners into becoming the kind of citizens required by the global economy. In addition teachers are expected to respond to the crises of society linked to, for example: the AIDS epidemic; socio-linguistic diversity of their learners; poverty, hunger, violence, drug abuse and other social ills. They must also be in a position to respond to challenges presented by changing youth culture brought on by the demise of traditional authority, the explosion of the new knowledge economy, influences of international (Americanised) media and the expansion of technology. These demands put teachers and teacher educators in what has been described as an ‘impossible position’ (see, for example, Ben-Peretz, 2001; Hargreaves, 1994). They are set up for failure.

An assumption that teachers are the central problem of education and that the way they have been trained/ prepared/ educated for teaching has been inadequate has lead to policies across the world increasingly focusing on quality of teacher education (for example, see Avalos, 2000; Bates, 2004; Cochran-Smith & Zeichner, 2005; UNESCO, 1998). This supposed inadequacy of teachers however, has to be seen against a backdrop of massive change in global culture and the expectation that it is education’s role to ensure that *all* citizens (of the world) have access to the ‘goods’ of this culture. This recognition of failure (that is, teachers do not meet up to these ‘visions’ of the world) has, through the influence of organisations such as UNESCO, led governments to increasingly see the need for regulation of teacher education (and the development of standards against which it can be quality assured). Hence there has also been an increased focus in teacher education research on these policy directions themselves.

2.2 Accountability and autonomy in teacher education

The increasing focus of governments across the world on regulating teacher education is illustrated by numerous publications since the 1990s focusing on the regulation of teacher education and the development of standards for teacher education qualifications. For example, Ginsburg and Lindsay's (1995) edited book which reports on this process across a variety of countries, both industrialised¹⁵ and developing, and many other more recent reports focussing on teacher education reform and issues of regulation and autonomy. Some examples are: in the USA (e.g. Beyer, 2002; Bullough, 2002; Bullough, Clark, & Patterson, 2003; Newby, 2003), in Brazil (e.g. Flores & Shiroma, 2003; Ludke & Moreira, 1999), in South Africa (e.g. Parker & Adler, 2005; Robinson, 2003; Sayed, 2004; Shalem & Slonimsky, 1999), Australia (e.g. Bates, 2002; Sachs & Smith, 1999; Sullivan, 2002), Guinea (e.g. Schwille, Dembele, & Bah, 1999), Mexico (e.g. Totto, 1999), China (e.g. Zhou & Reed, 2005), Ghana (e.g. Amedeker, 2005), the UK (e.g. Furlong, Barton, Miles, & Whitty, 2000; Gilroy, 2002), and so on¹⁶.

Standards for quality in teacher education are appearing all over the place, and as Bates (2004 p. 119) puts it, "(t)he avowed purpose of all this policy, all this regulation, is the improvement of student performance through the improvement of teachers via the improvement of teacher education". Bates suggests that in almost all cases this 'improvement' takes place through the mechanism of accountability. Since significant amounts of government money are to be spent on education, institutions that spend the money should be held accountable for the quality of their performance. Thus standards are developed and curricula specifications set down.

Accountability mechanisms in teacher education, particularly in contexts such as in England and Wales where there has been strong government led regulation and prescription of practice-based standards over the last twenty years or so (for example see Furlong et al., 2000; Lambert & Totterdell, 1995; Tulasiewicz, 1996), have been described in terms of the logic of global capitalism driven by the development of a 'knowledge economy' where everything must be comparable, measurable and transparent. Ball (2003) suggests that the technologies through which such accountability in teacher education is imposed, the market, managerialism and performativity, significantly redefine the nature of teaching and impose a direct intervention into the lives and identities of teachers. For Ball the effect is that "(k)nowledge and knowledge relations, including the relationship between learners, are de-socialised" (Ibid. p. 226).

¹⁵ In the literature countries are generally referred to as either industrialised/ developed or developing.

¹⁶ It would be impossible to review or even list all of them. However, in my search for literature in this area I came across an overwhelming variety of papers.

However, Harley and Parker (2007) show that the move towards the regulation and quality assurance of teacher education should be seen in the context of broader moves to regulate and quality assure higher education and education in general. They describe the argument that regulatory frameworks and quality assurance are technologies of managerialism and performativity related to the spread of global capitalism as a “superficial charge” (Ibid., p. 870). They argue that the need for such frameworks should rather be explained in terms of changes in divisions of labour in society. They draw on Durkheim to argue that the need for regulation and quality assurance can be understood as linked to an inevitable change in authority relationships in social contexts where we can no longer take for granted the values that bind the fabric of society.

Harley and Parker link the need for regulation to Durkheim’s theory on different forms of social solidarity: *mechanical solidarity* and *organic solidarity*. Individuals in societies with undifferentiated forms of labour share certain commonalities which provide the glue for social cohesion. Within such societies, there is a common faith and traditional positional authority relations are taken-for-granted, there is an unquestioning acceptance of one’s place in the world. This form of solidarity is called mechanical solidarity “because it is an unreflexive, unquestioning form of solidarity” (Ibid.). However, as society becomes more complex, and labour increasingly differentiated and specialised, the similarities amongst individuals diminish and solidarity becomes more unstable. At the same time occupational interdependence becomes more pronounced and the ties that lead to solidarity now depend on mutual recognition and co-operation rather than on faith and trust in positional authority. This form of solidarity, called organic solidarity by Durkheim, depends on a morality of co-operation. Organic solidarity however, cannot be taken for granted; it is not powerful enough for society to *trust* everybody to act in the way they ought to in order to retain cohesion, to keep its fabric from falling apart. Continued co-operation must be ensured by other means.

To sustain solidarity, *contract* has to replace *covenant*. Contract is juridical expression of co-operation. When ‘mechanical’ faith and trust disappear, our interdependence is sustained by law, and by transparent forms of regulation. (Ibid.)

Harley and Parker show that while in earlier times HE institutions operated comfortably within the legitimacy provided by mechanical solidarity, in present times this is no longer the case. Then there was a common understanding, culture and faith:

Higher education used to be a community with shared norms. When European scholars came to South America, they did not bring with them only their knowledge of science or philosophy. They brought with them customs and symbols, a complete ethos that pervaded traditional higher education. And the

same happened in all countries. Higher education shared a common set of norms, and therefore could be trusted, within and across countries (Lemaitre, 2005, quoted in Harley & Parker, 2007, p. 870)

Now, with the increased complexity in the division of labour and the consequent loss in the legitimacy of traditional authority, the faith, trust, and covenant that bound societies in a mechanical solidarity and assured society that HE would operate for the public good, disappear. The change in nature of solidarity together with the growth of the knowledge economy and a belief in human capital theory put HE (and teacher education) under the spotlight: society can no longer take for granted its appropriateness, quality and effectiveness. HE can no longer be left up to its own devices and (behind closed doors) act with impunity. It needs to prove itself as trustworthy to provide the public good (to develop human capital appropriately), and this requires accountability to the public through some form of transparent demonstration against agreed upon criteria. This is seen to require regulation (a social contract). With the change from mechanical to organic solidarity, from covenant to contract, transparent regulatory frameworks and the development of standards to ensure quality become a requirement¹⁷.

A key point in all of this is that the need for regulation is political, not educational, and is brought about by changes in the forms of social cohesion and authority structures of late capitalist society. Government cannot simply leave HEIs to their own devices and assume they will act in the interests of the public 'good'. However, what these interests are, how quality is defined and what criteria are put in place to regulate the system, are not a foregone conclusion. The diversity within society itself implies there are competing interests and therefore political contestation over what comes to be accepted as an adequate and acceptable regulatory framework.

In her editorial for the 'millennium' issue of the *Journal of Teacher Education* Cochran-Smith (2000) points to this when she emphasises that

teaching and teacher education are unavoidably political enterprises and are, in that sense, value-laden and socially constructed. Over time, they both influence and are influenced by the histories, economies, and cultures of the societies, in which they exist, particularly by competing views of the purpose of schools and schooling. Like it or not, more of us in teacher education and in the policy communities will

¹⁷ It is noted here that in Harley and Parker's argument they point to the South African context to show that in that case the move from mechanical to organic solidarity was legislative rather than a 'natural' or inevitable change within society as Durkheim had theorised. Under apartheid, society was socially engineered to ensure that certain members of the population remained under traditional authority. In the new democratic order, there is also an attempt to legislate a new form of solidarity – policy and regulation pushes education in the direction of what 'ought to be' in a modern society rather than working with what is (traditional authority based on mechanical solidarity). It attempts to use new regulation to create organic solidarity. Later in the thesis this will be discussed in relation to the problems of policy and the issue of social meliorism (Mattson & Harley, 2003) in the South African context, and explored in relation to changes in orientation to knowledge within teacher education generally and MTE specifically.

need to engage in these public and political debates if we are to have a real voice in framing the questions that matter for the future of teaching education. (p. 165)

The charge of managerialism and the logic of performativity with which we began this subsection, cannot explain the move towards the need for accountability and regulation. ‘Performativity’ is better recognised as *one* of the possible effects of the move towards the need for social contracts under new forms of solidarity. The ‘logic of performativity’ is produced in specific contexts where the ‘transparent’ criteria (or indicators) for demonstrating compliance with the contract, are linked into performance indicators that are directly and punitively connected into the economics of the system (which, as will be shown below, has been the case in the UK).

The need for a social contract for governing the provision of quality teacher education (however quality is defined within a particular society) can be more coherently explained by changes in the social relations that bind societies to a common purpose. The ‘common’ purpose is not so common anymore and so HEIs cannot be left to their own devices to make the decisions on the basis of their own biases, however, as Crochan- Smith points out, their voice is not necessarily completely quashed – if they are positioned to engage in the processes there is a possibility of having a ‘real voice’ in framing what really matters in teacher education¹⁸.

2.3 Accountability and relevance in teacher education

In the discussion so far, I have argued that the move to regulate teacher education is linked to a number of factors including: the perceived failure of education to adequately educate youth for contemporary society and therefore of teacher education to prepare teachers for this complex role; a change in social solidarity and the loss of trust in teacher education institutions to produce the kind of teachers that contemporary society requires without some form of contractual accountability; and pressure for the status of teachers and teaching to be elevated into a profession¹⁹ and pressure to develop teacher professionalism²⁰.

Within this new context, teacher education must be *accountable* and *relevant*, and across the world attempts are being made to ensure that this happens through various forms of regulation. Teacher education must be accountable to the public for what it does, and to ensure this

¹⁸ This will be theorised in more detail in relation to my research project in Chapter 3

¹⁹ To be professionalized all teachers should be adequately qualified through a formal HE qualification.

²⁰ Professionalism refers to the work of teachers. Improved professionalism refers to teachers flexibly to meet certain academic and/or professional standards that will be relevant for their context and to the globalising world.

accountability, systems for quality assurance of teacher education need to be developed and implemented. Teacher education must be *relevant* and *purposeful*. It must be relevant for schooling in general and to the schools in which teachers will practice when they are qualified; it must be relevant to the economy, civil society and the state. And on top of this, it must be relevant for the globalising context. These requirements lead to the development of descriptions of ‘standards’ and ‘competences’ which attempt to define what relevance means within a particular country context, and to provide criteria against which it can be quality assured.

However, the issue of what makes quality teacher education is littered with diverse and conflicting views (Hoban, 2005): these range from views which see teacher education as out of touch with schools and advocate school-based apprentice type education for initial teachers, to views which see schools as generally conservative, promoting poor practice and in need of major change and therefore advocate more focused academic curriculum that will encourage teachers to be critical of taken-for-granted school practices. These different views are reflected in the attempts to regulate teacher education in different contexts across the world. How regulatory policies are developed, who has control over the definitions of how quality is defined within policy, and whether/ how the regulations are implemented and quality assurance takes place, varies considerably across contexts. An international perspective shows that the form regulation takes, and its effects on teacher educators to make curriculum decisions, varies across different contexts.

2.4 Three international movements within teacher education

In considering the discussion thus far, three specific movements in teacher education since the 1960s can be recognised. The first is the move to *professionalize teaching*: to establish teaching as a profession and to raise its status and ensure that all teachers are well trained. That is, the social and political project involving aspirations for recognition of teaching as a profession (see for example, Flores & Shiroma, 2003). In particular, if all teachers are qualified through initial teacher education programmes which adhere to the basic standards laid out in the *Recommendations* (UNESCO, 1966), the status of teachers will be enhanced, teaching will be seen as a profession, and teachers will be properly trained to take up the challenges of their work. This would be enhanced through further educational opportunities, specifically, “in service education designed to secure a systematic improvement of the quality and content of education and of teaching techniques” (Principle 31, Ibid., p. 6) . With these

moves, teachers are also expected to become more professional in their work and outlook – that is teacher professionalism comes under the spotlight.

The second movement is connected to the first, and this involves *the move of teacher education* for all levels (primary and secondary) *into the Higher Education sector*: in the ‘ideal’ world teacher education is to become a graduate profession. This has increasingly been implemented over the decades and by the turn of the century, in most developed countries teacher education is located in higher education institutions, while in developing countries there is a clear trend towards this as the status quo (Avalos, 2000; Vonk, 1995; Zhou & Reed, 2005).

The third move is towards *increased regulation and quality assurance of teacher education* qualifications, which became very visible in the literature from the 1990s. This is connected to changing forms of social solidarity and to the need to develop social contracts, or policies to regulate and quality assure teacher education, to ensure that teacher education institutions are accountable and their programmes are relevant.

2.5 Variations in teacher education practices across different contexts

A reading of the literature²¹ shows that the way these three movements have played out across different contexts has varied. In particular there are differences between developed and developing countries, with the former being further along the way towards all three movements than the latter. These variations seem to be connected to a number of key factors. Variations in the *location* of teacher education are mostly visible in the differences between developed and developing countries. Variations in the *type of regulation* (for example whether regulation policies result in strong prescriptions and attempt to produce homogeneous teacher preparation programmes, or enable teacher education institutions to have some autonomy over generating their own curricula and influencing the agenda for teacher education) seem to depend on the local economic and political situation. In particular this is influenced by: the varying participation of different agents and agencies in the production of the regulations (including the state, professional teachers’ organisations, unions and academics); administrative capacity of the state and institutions; and, funding for teacher education and

²¹ See Appendix A for a detailed discussion of the literature with examples to support the argument presented here. It is felt that since the argument presented here feeds into the overall thesis, it should be supported by evidence from the literature and therefore it should be presented somewhere in the thesis. This discussion has therefore been placed in an appendix in the interest of making the discussion here more focused.

research. These variations are complicated by different understandings of: research and its role in decision making over teacher education; the role of institutional-based learning and work-based learning; and the relationship between these.

In Appendix A I discuss examples from across developed and developing contexts to show that variations in the nature of regulations and policies are related to how key foci identified in the previous paragraph (that is: institutional location; agents and agencies involved in producing the regulations; what is seen as relevant for the school, economy and polity; understanding of research; and understanding of the relationship between institutional and work-based learning), play out within particular contexts. These variations produce different possibilities for teacher education. In particular, I show that while it appears that all regulation policies claim in some way or another to be based on ‘research’, some policies are highly *prescriptive* and lead to decreased autonomy for teacher educators to make decisions over their work, whereas others are more *generative* and lead to the possibility of teacher educators having a significant influence and relative autonomy to make decisions over and lead developments in teacher education.

The move to regulate teacher education through policy has generally gone hand in hand with its movement into higher education. In many developed nations, the movement has led to what is termed the ‘universitisation’ of teacher education (Arreman, 2005; Flores & Shiroma, 2003; Vonk, 1995; Zhou & Reed, 2005), where comprehensive universities have increasingly become involved in initial teacher education programmes for all levels of schooling. Within many of these contexts, the focus has been on developing a research-base and a strong academic focus for initial teacher education, with varying degrees of attention paid to the professional and work-based aspects across different contexts. In other cases, mostly in developing countries, single purpose institutions in higher education (sometimes new institutions and in other cases converted/ incorporated colleges of education or normal schools), take the responsibility for teacher education, and here more often the focus is on the professional (or pedagogic) aspects of teacher education (Flores & Shiroma, 2003; Zhou & Reed, 2005). The nature and focus of the research and the connection to practice within the teacher education programmes produced in these contexts varies from institution to institution and country to country (Arreman, 2005; Hoban, 2005).

The literature suggests that the regulations are in some cases designed and implemented by the government (and their agencies) in order to impose a specific (prescribed and audited) order,

as was the case in the UK (see for example Furlong et al., 2000; Gilroy, 2002; Tulasiewicz, 1996). This was a pattern across many of the commonwealth countries. It was also attempted in Brazil (see Flores & Shiroma, 2003) and other Latin American countries (see Avalos, 2000). In other cases it appears that the move to regulate teacher education, while also led by governments wanting to set up systems of accountability, are negotiated in conjunction with other agents (for example academics/ and or teachers through the involvement of universities/ professional associations/ unions etc) (Tulasiewicz, 1996). In some of these cases the regulations are used to encourage teacher education to become more research-based and to develop a professional body of knowledge for teaching and school improvement, as is reported to be the case in Sweden, Canada (see Arreman, 2005) and other Western European countries (see Vonk, 1995). In other countries professional bodies have taken the lead in developing such standards and assuring quality in teacher education and governments have not had direct involvement. This has been the case, for example, in parts of the USA (see Bullough et al., 2003) and Australia (see Bates, 2002; Sullivan, 2002).

In Appendix A I provide a discussion of examples from developed contexts where the three movements are most advanced and a discussion of examples from developing contexts where they are visible but less advanced. These cases are used to highlight the international trends, commonalities and differences in teacher education policies and practices. Later, in chapter 3, the ways these movements have played out in the South African context will be explored.

2.6 Some final comments on international movements in teacher education

I have argued that the need for regulation is linked to changes in forms of solidarity in contemporary society, and in particular to changes brought about through the globalisation of capitalism. However what has also become visible from the limited discussion of the international cases in Appendix A is that while regulation, standard setting and quality assurance is becoming more and more common, there is a wide variation in what is advocated as the basis for these teacher education reforms across different countries (e.g. England compared to Sweden; Brazil in comparison to China) and even within some countries (e.g. USA). Differences in understanding of what constitutes quality in a teacher education programme lead to different frameworks for regulation – some generative and some prescriptive.

While in most countries new demands are being made of teacher education, there are differences in the way in which teacher education institutions are able to respond to these attempts. There are also major differences in the way in which ‘research’ is used. On the one hand teacher education is seen to have failed because it was too theoretical and irrelevant to the real focus which should be on the practical aspects of teaching which should be more focussed on a training process in the site of practice – the school. In such cases, practice based standards are *prescribed* for teacher education and the teacher education curriculum is more or less controlled by the state through funding. On the other hand there is a view of teacher education as a knowledge-based activity grounded in research with an academic focus on developing a theory of teaching, and more time is spent in the academic institution during initial education programmes. There are also many variations between these extremes. What occurs in a specific context depends largely on which agents and agencies are positioned to influence and develop the policies in a particular context, and on the administration and funding made available to enable the policies to be implemented and supported.

One of the recurring themes in the discussion so far is the balance within teacher education programmes between academic and professional aspects – between theory and practice. This is a dilemma for all teacher education programmes and relates to issues over the design of programmes and the relationships between knowledge and identity. I now turn to this issue in the sections that follow.

3 The design of initial teacher education programmes

In this section I consider research in the field of teacher education on the design of teacher education programmes and in particular on issues related to knowledge(s) and practices for mathematics teachers and teaching and the organisation of these in initial teacher education curricula. Issues related to two major aspects to be developed within initial teacher education programmes, that is, the academic and professional aspects that constitute *formal learning* (i.e., institution-based learning) and those aspects related to *learning in-and-from practice* (i.e., work-based learning), and the relationship between these, are brought into focus.

3.1 Research on the elements included in initial teacher education programmes

Cochran- Smith and Zeichner (2005, p. 11) in their AERA survey of research on teacher education suggest:

For many years, collegiate teacher preparation programmes and now many alternative route programmes have been organised around several key components of preparation, including preparation in the subject

matter, general arts and sciences, the foundations of education, pedagogy and teaching methods and classroom teaching.

Zeichner and Conklin (2005) found that there are significant variations within teacher education institutions and state policy contexts, and that studies attempting to compare the effectiveness of different types of programmes (e.g. traditional versus alternative, or 4-year versus 5-year, integrated offerings versus separated offerings) provide conflicting findings. They suggested that research studies into these aspects of different programmes are limited, self focussed, methodologies are vague and conclusions not always warranted. However, there were two significant and consistent research findings that are of importance for my study:

- regardless of the type of teacher education programme completed, in the case of secondary teacher education, the *subject matter specialisation of teachers matters* in terms of teacher retention and teacher success;
- during the first year of teaching teachers with little or no prior PRESET professional preparation perform at a lower level of competence than teachers who have completed programmes with significant professional preparation, however findings also suggest that this difference does not persist and that the former group tends to catch up by the end of the first year of teaching.

These two aspects, subject matter knowledge and professional preparation (particularly length of practice) are often hotly contested, and as was visible in the discussion on policy regulations (see Appendix A), the suggestion that teachers who have too little practice in their initial teaching are poorly prepared for teaching is often used to justify positions advocating moves towards practice orientated, school-based teacher training. This illustrates the point that ‘evidence-based’ policy decisions are often not made on the basis of substantive research that is directly related to studies of teacher education curricula, but rather on the basis of inferences from raw data collected for other purposes. These inferences are themselves often based upon specific ideological positions. As Cochran-Smith and Zeichner (2005, pp. 2-3, emphasis added) suggest,

Education and teacher education are social institutions that pose moral, ethical, social, philosophical and ideological questions. Although questions of value and ideology underlie many of the most contentious disagreements about teacher education, these arguments are often mistakenly treated as if they were *value-neutral and ideology free*.

Teacher preparation is complex and a large number of variables intersect that could have different effects on the outcomes of any particular programme. It is conducted in local communities and institutions where programme components and structures interact with one

another as well as with the different experiences and abilities prospective teachers bring with them. It is also affected by local and state political decisions, which create their own accountability demands and other constraints and possibilities. Also, the outcome of a teacher education programme always depends in part on the “participants’ interactions with one another and how they make sense of their experiences” (Ibid. p.3). Relationships that develop between participants (teacher educators, learner teachers) and the various elements of the curriculum (knowledge and practices) are a significant aspect of the success or failure of a programme. This is surely true of teacher education in other parts of the world as well – whether in contexts where the curricula are highly prescribed by government, or where they are not.

For this reason, Cochran-Smith and Zeichner suggest it is not very productive to attempt to try and compare programmes to find the ‘magic pill’ that will cure all teacher education’s problems. Sometimes, they suggest, the ingredient that makes a particular programme work is elusive, a result of individual passion, local combinations of personalities, as much as what it is that is learnt or how it is learnt. However, they do suggest that it would be useful to undertake in-depth case studies of teacher education programmes to illuminate what prospective teachers learn from the opportunities they are provided with. This is a major focus of my research and, as indicated in Chapter 1, I undertake two in-depth case studies from very differing contexts which I hope will illuminate important issues for MTE within South Africa.

Research on effective teacher education programmes indicates that a wide variety of organisational structures just as easily lead to success as to failure. A question that does arise then is: what makes the difference? There are a number of suggestions. One that seems to have some merit in relation to mathematics teacher education is tentatively put forward by Lerman (2001, p. 49) who suggests that,

In those mathematics teacher education projects which are successful ... it seems to me that we can talk of teachers having developed their identities as teachers. The goals of the course have become their goals, either through their own desire to progress in their career, feel better about their teaching or improve the learning of their students, or because they have taken on the values of the project and the researchers or tutors running the project.

How does an initial teacher education programme achieve this development of the teacher’s identity? Initial teacher education is a complex project involving many different elements. How these are linked may be important (as suggested by Hoban, 2005), just as much as local variables such as what personalities are involved and how they relate to each other (e.g. lecturers and particular combinations of student teachers) (see, Cochran-Smith & Zeichner,

2005). As Lerman (2001) indicates some situations may be particularly fruitful for the development of productive elements of teachers' identities, whereas others are not successful and do not lead to any significant impact. I will pick up on the link between knowledge for teachers and teaching and teacher identity later in this chapter, in Chapter 3, and at other stages in the thesis. Subject and pedagogic identity are to become central themes in this thesis.

Floden and Meniketti (2005) in a survey of research on the impact of content courses on teacher's knowledge as revealed through coursework in the arts and sciences within teacher education programmes, identified three types of studies, two of which I mention here. Significantly for my project, they found that the strongest field in this area of research was within mathematics teacher education. The first type of study focuses on correlations between the amount of teachers' subject matter study and either ratings of teacher performances or the performance of the learners they teach. These studies consistently confirmed positive associations between teachers' undergraduate college studies in mathematics, and the mathematics achievement of their secondary school pupils. Specifically studies found that secondary teachers who studied mathematics as a major in their undergraduate degrees (usually three years of university level mathematics) consistently have better results in their high school students' achievements than teachers who have a more limited initial mathematical education²². The correlation however does taper off as increasingly higher mathematics courses are taken. For example, while three years of mathematics will result in a positive correlation, additional higher mathematics courses taken seem to have little additional positive effect. This supports Begel's (1979)²³ earlier analysis of the number of courses teachers take in more advanced²⁴ mathematics. Begel found that teachers taking advanced mathematics courses in inset programmes produced positive effects on their school student's achievements in only 10% of cases, while producing negative effects in 8% of cases.

The research reported here could suggest that in the initial education of secondary teachers, an undergraduate degree in mathematics should be a basic requirement, while in teacher development programmes, additional studies in mathematics (in-and-for itself) may not be appropriate, and a focus on mathematics in-and-for teaching would have more significance.

²² Other studies also suggest that such teachers are more likely to learn from inset mathematics teacher development programmes than teachers who do not have this disciplinary grounding (see, for example Irwin & Britt, 1999)

²³ Begel's work is interestingly used to support a different conclusion from the one presented here: that mathematics learnt from a disciplinary perspective may not be the right kind of mathematics for teachers to study (and may even be damaging) (in particular, see Ball, Bass, & Hill, 2004, p. 53)

²⁴ Advanced mathematics courses would be those that would normally be taken in an honours or master's level programme and would go into levels of abstraction past the normal undergraduate calculus courses)

However, Floden and Meniketti (2005) warn that although this research does produce evidence of a positive association between the study of mathematics and pupil achievement, these studies cannot be used without caution. The greater effectiveness of teachers who have undergraduate mathematics majors may be due to other factors. For example, these teachers enjoy mathematics and that's why they chose to major in mathematics, and this may be rooted in experiences with past mathematics teachers who taught them both to love maths and approaches to learning (and by implication teaching) for which formal studies in post-school mathematics and in their professional teacher preparation programme, is not the source. What these studies do point to however, is that a strong *mathematics subject identity* is important for successful secondary school mathematics teaching, where success is measured by school learner success. The importance of subject specialisation for *secondary school mathematics teachers* is thus confirmed by these studies. However *what* selection of mathematics prospective students should study is not clarified and Floden and Meniketti suggest this needs further exploration. Whether a degree in mathematics is better than a degree in mathematics education remains disputable - no studies (in their extensive review) address questions about the focus of, or different combinations of, college mathematics courses.

The second type of studies Floden and Meniketti describe are focussed on mathematics teacher's subject matter knowledge at various stages in their studies towards their initial qualification. These studies are not as conclusive as those mentioned above. However, one consistent result is that "a significant number of prospective students have only a "mechanical" understanding of the subject they will teach. They know the rule to follow but cannot explain the rationale behind that rule. Some evoke inaccurate "rules" " (Ibid., p. 283). This finding is specifically related to studies on prospective secondary mathematics teachers²⁵. Floden and Meniketti found studies of other subject areas and of mathematics teachers' knowledge at lower levels in the system inconclusive.

The research discussed in the previous paragraphs, while it confirms that it is important for secondary mathematics teachers to learn substantial mathematics in their undergraduate degrees, also seems to support the contention that novice teachers come into the profession without a deep understanding of the mathematics they have learnt. The claim that teachers need to know the subject matter they teach has strong intuitive appeal, but exactly what they need to know to teach at various levels, and how they need to know this are still debated and

²⁵ I note here that these studies include all secondary mathematics teachers and not only those with majors in mathematics in their undergraduate programme; whether such a finding would apply to this latter group cannot be inferred.

remain topics for further research. In particular the issue of teachers' understanding is seen as critical, and reminds us of the infamous George Bernard Shaw quote with which this chapter opened: *he who can does, he who can't teaches*; and Shulman's (1986a) retort: *those who can do, and those who understand teach*. The significance of teachers' understanding for the design of teacher education curricula and the selection of contents into the programme is related to what teachers need to know and how they need to know it to teach well. This is the focus of the next section of this chapter.

3.2 Knowledge and practices for teachers and teaching within (mathematics) teacher education programmes.

In a review of literature focussing on subject knowledge in teacher education, Kennedy (1998) identifies a shift in focus from a previous preoccupation on the amount of time within the curriculum that should be allocated to subject knowledge and pedagogic practice, to a recognition that *what* is learnt in any pedagogic context is deeply connected to *how* it is taught, and this in turn is connected to how it is understood. This shift is seen in moves towards attempts to integrate subject matter and pedagogical knowledge in teacher education. This shift was highlighted in Shulman's (1986a; 1987a) work which stressed that knowledge for teaching involves *more* than teachers' knowing and understanding their subject (disciplinary knowledge).

Shulman's work on teacher knowledge has different facets, one of which focussed on an attempt to understand how knowledge gets transformed by teachers in teaching into a form that learners can comprehend and understand. Shulman recognised seven different categories of teacher knowledge - knowledge of: content; pedagogic content; curriculum; general pedagogy; learners and learning; contexts of schooling; and educational philosophies, goals and objectives. Shulman saw *all* of these, which spanned the academic and professional aspects, as important in the education and preparation of teachers. Of significance for my project, he distinguished between three distinct types of *specialist knowledge* for teaching a particular subject: *subject content knowledge* (SCK) or *subject matter knowledge* (SMK), which refers to knowledge about the subject (e.g. the discipline of mathematics), its structure and syntax²⁶; *pedagogic content knowledge* (PCK), which includes,

the ways of representing and formulating the subject that make it comprehensible to others [and] an understanding of what makes learning the topics easy or difficult; the concepts and perceptions that students of different ages and backgrounds bring with them...(Shulman, 1986a, p. 203)

²⁶ This implies that a teacher "must not only have depth of understanding with respect to the particular subjects taught, but also a broad liberal education that serves as a framework for old learning, and as a facilitator for new understanding" (Shulman, 1987a, p. 229).

[PCK] represents the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organised, represented and adapted to the diverse interests and ability of learners, and presented for instruction (Shulman, 1987a, p. 228);

and, *curriculum knowledge*, which refers to the scope and sequence of a subject and materials used in teaching.

Shulman's work shifted the field of research on teaching to focus on the underlying *knowledge base* that informs teacher's plans and decisions in teaching, and formed a basis for a number of "models of teacher knowledge ... generated by researchers in the field" (Grossman, 1990, pp. 4 - 5). These models could be used as a basis for designing and organising a less fragmented teacher education curriculum. Grossman lists a number of models produced in the field (including Elbaz (1983), Leinhart and Smith (1985), Shulman (1986; 1987) and Wilson, Shulman and Richart (1987)), concluding,

While researchers differ in their definitions of various components, four general areas of teacher knowledge can be seen as the cornerstones of the emerging work on professional knowledge for teaching: general pedagogical knowledge; subject matter knowledge; pedagogical content knowledge; and knowledge of context. (Ibid.)

Grossman's interpretation of these four areas are summarised in diagrammatic form in Figure 1 below.

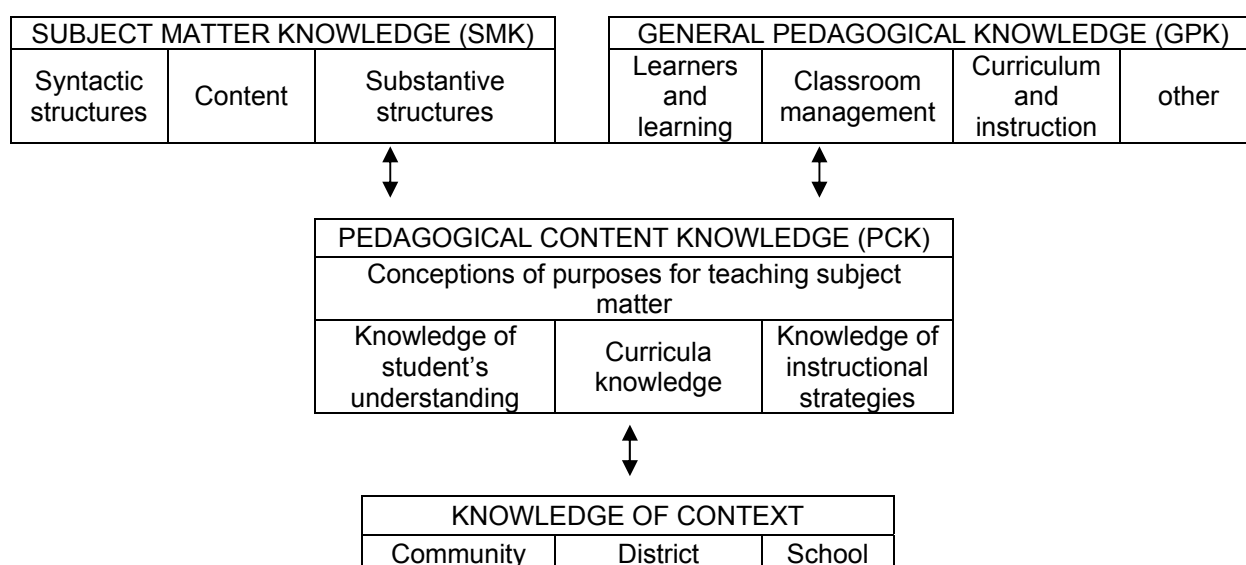


Figure 1: Model of Teacher Knowledge Structures (after Grossman, 1990, p. 5)²⁷

²⁷ We see here that disciplinary knowledge in education, for example, studies "of the main elements of philosophy, psychology, sociology as applied to education, the theory and history of education, and comparative education" (UNESCO, 1966, p. 6) which were prominent in the 1966 *Recommendation* are subsumed under and integrated into new categories such as 'learners and learning' and 'other'. This illustrates a further trend in education, a move from studying the foundations of education to Education as a multidisciplinary, integrated field.

The various models of teacher knowledge produced through such research are mostly descriptive²⁸, providing detailed images of various aspects of teacher knowledge. Implicit in the models is that these various forms of knowledge are interconnected and thus “learning in one domain is necessary for, and can result in, learning in the other” (Lerman, 2001, p. 41). The models underline the importance of a specialised knowledge base for teaching. However, how and where these different forms are best learnt and coordinated in a teacher education programme and how they are connected to the work of teaching produce challenges that remain unresolved and are contested.

Orton (1993) raises two problems with the idea of a knowledge base for teaching: the tacit problem (that teacher knowledge appears to be primarily a form of knowing *how*) and the situated problem (that teacher knowledge is “deeply dependent on particular times, places, and contexts, and lacks the general character of knowledge in mathematics, physics, or even psychology” (Ibid., p. 1).) The tacit problem is linked to the idea that much of the ‘know-how’ knowledge that effective/successful teachers hold cannot be discursively described, and therefore cannot be stated and transferred in formal teacher education programmes (*knowledge how* cannot be reduced to *knowledge that*). If the knowledge that teachers know (and need to know) cannot be stated, how can it form part of a knowledge base for their teaching? The situated problem, arises from the argument that knowledge for teaching is specific and not generalisable, and therefore “turns on a ‘matter of taste’” (Ibid.).

Ennis (1993) in a response to Orton, argues that *there is* propositional knowledge that lies behind any specific instance of knowledge how. He suggests this can be recognised when a situation is set up where “a probe is called for, seeing how the person responds to the probe, and asking the person why she or he responded in that way” (Ibid., p. 2). While there is no direct translation between knowledge how and knowledge that, and the former cannot be reduced to the latter, Ennis argues that this should “not prevent us from including such knowledge in our teacher education curricula, and it does not prevent us from evaluating teachers for possession of this knowledge” (Ibid.) From this point of view, there is much propositional knowledge²⁹ that is related to knowledge how, that contributes to a knowledge

²⁸ I do not elaborate here on the specific contents of the various elements of the model. See Shulman (1986a; 1987a) and Grossman (1990), for example, for detailed descriptions.

²⁹ For example, general and subject specific pedagogic knowledge which provide generalised principles for teaching. An example in mathematics teaching would be Reys, Suydam, and Lindquist’s (1992) discussion of ten principles underlying mathematics teaching/learning (see pages 50 – 57). While these cannot be translated directly into practice, they provide a discursive basis for discussing a specialist practice and instances of observed practice based in, and elaborations of, more abstract theories of learning (both cognitively and socially orientated

base for teaching and its functions. Ennis also suggests that Orton's so called situated problem is not a problem at all. He contends that there are common generalisations in teaching that go beyond specific situations and therefore are not simply a matter of taste. This evokes Shulman's (1986a) discussion on forms of teacher knowledge: propositional knowledge, case study knowledge and strategic knowledge.

Shulman described *propositional knowledge* as constituted by principles derived from empirical research, maxims not confirmed by research, but distilled from accumulated practice and are taken as given in the field; and norms which are values, moral and ethical knowledge. *Case knowledge* is contextual and situated, and is constituted by prototypes which exemplify theoretical principles, precedents which communicate principles of practice or maxims, and parables which convey norms and values; and, *strategic knowledge* described in terms of professional judgement, evaluation and decision making. This latter knowledge comes "into play as the teacher confronts particular situations or problems, whether theoretical, practical, or moral, where principles collide and no single simple solution is possible" (Shulman, 1986a, p. 211), that is, when confronted by a dilemma, where two principles conflict or two cases yield contradictory interpretations³⁰.

For Shulman, it is when strategic understanding is brought into the examination of specific principles and cases that professional judgement, which he refers to as "the hallmark of any learned profession" (Ibid.), is called on to make decisions in-and-for practice. He suggests that what distinguishes "mere craft from profession is the indeterminacy of rules when applied to particular cases" (Ibid.) The professional is someone who not only holds knowledge how and can demonstrate the capacity for skilled and masterful performances, but also knows what (the content which underpins the performance) and why (the rationale or explanation for why something is an *appropriate* thing to do in a particular context)³¹. In teaching, and teacher education, knowledge should guarantee "the flexibility to judge, to weight alternatives, to reason about both ends and means, and then to act ... (it) ... guarantees

theories). Another example is Kilpatrick, Swafford, and Findell's (2001) description of the strands of mathematical proficiency.

³⁰ Shulman gives an example: some research suggests wait time is important for high levels of cognitive processing, while other research suggests if the pace of learning is slowed down, a teacher may experience discipline problems.

³¹ This, as will be seen in Chapters 3 and 4, resonates deeply with the notion of 'competent teacher' described in the Norms and Standards for Educators (DoE, 2000b), the symbolic and regulatory policy governing teacher education in South Africa. This is linked to the notion of applied competence as comprised of foundational competence (knowing that), practical competence (knowing how) and reflexive competence (knowing why), integrated so that a teacher knows what to do, how to do it, why it is appropriate and can carry it out in the moment of practice.

only grounded unpredictability, the exercise of reasoned judgement rather than the display of correct behaviour” (Ibid.)

What is signalled in this discussion is just how complex it is to try and unpack the various types of knowledge for teaching. There are no guarantees that any particular selection into a teacher education programme would lead to the kind of professional judgement that Shulman is advocating. While this work opened up the field in teacher education to the development of models of teacher knowledge on which to base curricula design, the taxonomy of different types of teacher knowledge described is, as Mason (1998) points out, “daunting in the extreme, and the many interconnections between types mean that the taxonomy is rather unstable in practice. The trouble with such a list is that it comes across as factual knowledge, knowing that, and as rigid and discrete” (cited in Lerman, 2001, p. 41). Knowing *that* about all these types of knowledge may not assist in knowing *how* to make them available to teachers through teacher education programmes.

Returning to the earlier debate between Orton and Ennis, I would argue that both are putting forward positions which have merit. Orton’s important contribution here is not that aspects of such knowledge cannot be directly described, but rather that describing this does not give full access to these forms of knowledge. What is it that teachers have to know, understand and be able to do that will enable ‘good’ teaching in a specific subject in a specific context? How can this knowledge be structured into and co-ordinated in a teacher education programme to guarantee the development of strategic knowledge? Shulman (1987a) highlights this difficulty in his discussion of the ‘wisdom of practice’ as a base for developing teacher knowledge, which he recognises is the “least codified of all” (p. 232). He suggests that it is necessary for research to attempt to “lay a foundation for a scholarly literature that records the details and rationales for specific practice” (Ibid.), which could form the basis for case studies that might be used in teacher education.

One of the frustrations of teaching as an occupation and profession is its extensive individual and collective amnesia, the consistency with which the best creations of its practitioners are lost to both contemporary and future peers. Unlike fields such as architecture (which preserves its creations in both plans and edifices), law (which builds case literature of opinions and interpretations), medicine (with its records and case studies), and even unlike chess, bridge or ballet (with their traditions of preserving both memorable games and choreographed performances through inventive forms of notation and recording), teaching is conducted without an audience of peers. It is devoid of a history of practice (Ibid.)

Shulman thus suggests that while practice is deeply contextual, there are aspects that can and should be codified, to form a knowledge base for teacher learning *from* the wisdom of practice.

Ensor (2003) highlights this difficulty in her discussion of different modalities of teacher education practice. She argues that there is a tacit or craft dimension to teacher's knowledge, and to teacher educator's knowledge. Her study seems to point to two forms of this knowledge – the first form, although not immediately available to teachers or teacher educators can be retrieved linguistically if appropriately evoked, say, through interviewing or viewing and discussing video recordings of lessons. This would be akin to Ennis's (1993) notion of a probe mentioned earlier. A second form is also not available immediately, but is different from the first in that it *cannot be grasped discursively through language*. She thus argues that professional teacher education discourse is hybrid – it incorporates explicit aspects that can be expressed in language, and implicit (invisible) aspects that cannot. Ensor suggests that in relation to both these aspects (the yet-to-be-articulated, and the truly tacit) a context is required which evokes the first (provides discursively for its recognition) and allows the second to be modelled, in the context provided by the school classroom. So for Ensor the rules of selection, internal sequencing and evaluation which constitute 'best' teaching practice can be expressed in a teacher education discourse by using what she calls a "professional argot", but only partially since there is always some aspect that is truly tacit, either unable to be grasped in language or not immediately available and which requires presentation through demonstration and modelling in the site of practice. This latter aspect requires the novice teacher to be apprenticed alongside a master teacher who has access to the desired practice.

How such a professional argot, or specialised language for teacher's professional knowledge-in-practice, can be made available for acquisition in the teacher education programme and how this links to the various other forms of knowledge (e.g. aspects of the formal knowledge base, in particular SMK/ SCK and PCK described by Shulman and others) is elusive and remains a point of contention in the design of curricula for educating and training teachers. As was pointed out earlier research on the 'success' of teacher education programmes has not been linked to any particular organisation or selection of knowledge, and may just as easily be a result of the interaction of particular personalities in the process of learning to teach (Cochran-Smith, 2004; Cochran-Smith & Zeichner, 2005).

The issue of the what and how of knowledge(s) and practice(s) for teachers and teaching is far from resolved and the literature reveals an astonishing variety of 'research' perspectives on the issue (for example, see amongst others, Beck & Kosnik, 2002; Borko & Peressini, 2000; Davis, 1999; Ensor, 2000; Ernest, 1999; Even & Tirosh, 1995; Goulding, Hatch, & Rodd, 2003; Graeber, 1999; Grover & Connor, 2000; Hiebert, Gallimore, & Stigler, 2002; Jaworski

& Gellert, 2001; Kahan, Cooper, & Bethea, 2003; Kennedy, 1997; LaTurner, 2002; Short, 2002; Steinbring, 1998; Stephens, 2001; Stotsky, 2006). These perspectives vary from those which argue that new teachers mainly learn to teach by teaching (both in their practice teaching experiences in their initial teacher education programme, and then once they are out in practice) and that the time spent on taking education courses (whether specialised or general) should be reduced, to those that claim that while it may need some improvement, university-based learning is of major importance and should be strengthened and lengthened. There are also a wide variety of views within this about who should be responsible for teaching different aspects of the teacher education programme, in particular in relation to SMK, that is, knowledge to form the basis for the prospective secondary teacher's understanding of the subject or discipline he or she will teach.

Whatever the arguments are for these various types of knowledge and practice(s) in the design of teacher education programmes, the wide variety of differences seen in examples across international cases emphasises the development of teacher education programmes as situated within specific historical, socio-economic and cultural contexts and having to balance tensions between epistemological, political, economic and organisational issues (see Stuart & Tatto, 2000, for a discussion of examples from the 'north' and the 'south').

3.3 Mathematical knowledge and mathematics for teaching

Adler (2002) confirms that while almost everyone agrees that to teach well teachers need to know their subject matter well *and* know how to present it clearly to learners, what this means and how teachers ought to learn these different aspects is contentious. For Adler, Shulman's work on SCK or SMK, and PCK influenced the move from thinking that what is required to improve teachers' knowledge in *inset* programmes were more studies within the subject area under consideration to think about other possibilities. However, as she indicates, being able to name and describe these aspects of teacher knowledge as important does not lead to agreement over how to organise teacher learning with respect to the development of knowledge for the specialised work of mathematics teachers; mathematics teaching. The issue over the *nature of knowledge* related to the specialisation within an initial (preset) or continuing (inset) teacher education programme is by no means resolved, nor as previously indicated, is any particular view point adequately supported by research studies.

Brodie (2001) argues that, although personal mathematical competence and understanding is important, this is not sufficient to improve mathematics teaching and reports on research that

strongly indicates that while teaching methods, SCK and PCK are all necessary, none are sufficient on their own. Teaching and learning are, she suggests, complex acts that should be understood as an “interaction of various kinds of knowledge resources and practices” (Ibid., p. 86). She suggests that Shulman’s ideas highlight the need for teacher educators to develop the ability of teachers to transform SMK “into knowledge and practices that provide resources for learning” (Ibid., p. 87). Teachers should be able to develop, select and sequence texts and tasks in order for particular learners to learn particular mathematical concepts. Brodie finds it useful to think of PCK as knowledge of subject, students, and pedagogy which come together to form a unique kind of teacher knowledge, deeply situated in all three but moving beyond them in practice.

Adler, Slonimsky and Reed (2002) take these ideas further emphasising the major challenge in teacher education around developing teachers’ *conceptual knowledge for teaching* within their area of specialisation, particularly in the South African context and in the context of inset programmes designed to ‘upgrade’ teachers. They point out a general epistemological assumption underlying the emphasis on this aspect of teacher knowledge, that is, knowledge of subject matter for teaching is of primary importance – without this teachers would be unable to engage learners in high-level thinking. However, they suggest that

there is increasing support for the position that disciplinary knowledge for teaching is a *special kind of knowing* about the subject, and that this knowledge is substantively different from the kind of knowing and knowledge held by an expert in the discipline, for example a mathematician. (Ibid. p. 136, my emphasis)

This disciplinary knowledge for teaching is referred to by Adler et al. as teachers’ conceptual-knowledge-in-practice or TCK.

Adler et al. (2002, p. 139) describe TCK as the coordination of four analytically distinct characteristics of what constitutes ‘more’ in relation to teachers’ conceptual knowledge base, and suggest that a key challenge for teacher education, particularly in South Africa, is to extend what is understood as teachers’ subject knowledge to include these elements. These four aspects are:

1. Teachers must hold a relatively *broad and deep knowledge of the subject* they are teaching.
2. Disciplinary knowledge in-and-of itself is not sufficient for teaching – it needs to be transformed in moments of teaching and in teaching programmes, into sequenced, graded and developmental/ progressive tasks for learners, learning and assessment. Thus pedagogical knowledge and specifically *knowledge of curriculum in their subject area* is a key component of TCK.

3. Teachers' ability to transform their disciplinary knowledge into curricula is inextricably connected with knowledge of how children learn, not only in general, but specifically in relation to the subject: *Teachers need to know how learners come to know their specific subject.*
4. Teachers need to understand how *the teaching and learning of their subject comes to shape and be shaped by their specific contextual conditions* – their coming to know is never isolated from the context in which teaching and learning take place – for example in SA the reality of poverty, HIV/AIDS, situations of conflict and violence, multilingual classes and second language (and in deep rural areas foreign language) learners and so on.

These four elements bring together and extend many of the characteristics of forms of knowledge described by Shulman, Grossman and others, discussed in the previous section of this chapter. Specifically SMK and PCK are brought together and situated within context, not just in general terms, but specifically related to the subject specialisation and the social, political and economic context in which teaching and learning must take place.

It is important to note that Adler et al. developed this notion of TCK specifically in relation to inset programmes for practising mathematics (and science and language) teachers who had limited prior mathematical education³². While almost everyone will agree that mathematics learned from a disciplinary perspective is *insufficient* for teaching, and that teachers require more than this (as indicated in points 2 to 4 above), the importance of developing subject content knowledge or subject matter knowledge (point 1 above) as a basis for this development is not disputed. However the nature of this 'basic' subject knowledge is disputed, particularly in relation to initial teacher education programmes: what is a relatively 'broad and deep' knowledge of the subject and how should this be made available to initial teachers, particularly in four-year teacher education programmes?

Whether or not *some* mathematics learnt from a disciplinary perspective is necessary for *secondary* school teachers as part of their undergraduate programme is contested, with some authors arguing for a *special* mathematics curriculum for teachers in which disciplinary knowledge and instructional knowledge are integrated (for example, see Davis & Simmt, 2006; Kessel, Epstein, & Keynes, 2001) and others seeing value in teachers being inducted into the discipline as the basis for further mathematics learning (see Beck & Kosnik, 2002).

³² This is perhaps a specific challenge in the South African context (and possibly other developing country contexts) which is different from more developed contexts where assumptions can be made about the prior mathematical knowledge base of teachers who enter secondary inset programmes.

Nevertheless there appears to be growing support in the mathematics education and teacher education community for the position that there exists *disciplinary knowledge for teaching* that is a special kind of knowing about the subject, and that this knowledge is substantively different from the kind of knowing and knowledge held by an expert in the discipline, i.e. a mathematician (see in particular, Ball, 2000; Ball & Bass, 2000; Ball et al., 2004; Cohen, 1998; Doerr & Wood, 2004). More recently this is being described as the ‘mathematical work of teaching’ or ‘mathematics for teaching’ (*MfT*) (for example see, Adler & Davis, 2006; Adler, Davis, Kazima, Parker, & Webb, 2005b; Ball et al., 2004; Davis & Simmt, 2006).

One of the research findings, discussed earlier in this chapter, which is specifically used to support the view that secondary teachers require a different kind of mathematics to mathematicians, is the finding that teachers near the end of their initial teacher education programme do not have a sound understanding of the mathematics that they will need to teach (see, for example, Doerr & Wood, 2004; Even, 1990; Floden & Meniketti, 2005), even though they may produce good results in their secondary school leavers. The issue of teachers’ personal understanding of mathematics is seen as important because it is linked to the requirements of reform curricula in school mathematics education where conceptual understanding developed through discussion is increasingly emphasised and practising procedures to become fluent is de-emphasised. Lampert and Ball (1998) describe this kind of teaching for understanding in the following way:

Teachers are to help students delve more deeply into the underlying meanings of the mathematics, engage their classes in discussion of problems and ideas, reasoning and understanding, rather than merely emphasizing performance. This kind of teaching creates challenges by opening up the classroom discourse as well as the ways in which knowledge is treated and by demanding a finer and more ongoing discernment of students’ knowledge. (p. 32)

For Lampert and Ball teaching for understanding depends on acknowledging several aspects of uncertainty in teaching: the inherently incomplete nature of the knowledge with which teachers work; teachers’ commitment to be responsive to diverse students and students’ unpredictable responses; and, possible conflicts between a commitment to teach for understanding and the other educational commitments teachers have, including the need to produce performances to meet standards. When teachers teach for understanding, evidence of learning may be elusive and may not provide what is generally considered sound and valid knowledge about students. Teachers’ plans predict and prescribe teaching in a certain sense, but students’ unpredictable responses create an ever-changing context for teaching that is not fully predictable or "prescribe-able".

The requirement to teach for understanding implies that teachers not only are able to provide the pedagogical context in which learners can learn in this way, but also that teachers understand the mathematics they are to teach in ways that will support the kind of mathematical problem solving that teachers need to carry out in this type of practice. Ball and Bass (2000) argue that pedagogy in a mathematics classroom is fundamentally *mathematical* and that teacher education needs to develop mathematical practices for teaching which support the work of mathematics teaching. They see an important distinction between knowing and practising mathematics as a discipline, and knowing it in ways that enable its use in classroom practice. It is therefore not just what mathematics teachers know that is important but also *how* they know it and what they are able to mobilise mathematically in the course of their teaching. Ball and Bass suggest that teachers need to be able to *decompress* or ‘unpack’ mature and compressed ways of knowing mathematics back to the roots of that knowledge. Teachers “need to work with content for students in its growing, not finished, state, they must be able to do something perverse: work backwards from mature and compressed understanding of the contents to unpack its constitutive elements” (Ibid., 2000, p. 98)

Ball et al. (2004) argue that “mathematical knowledge for teaching is rooted in the mathematical demands of teaching itself” (p. 54). They reframe the problem of the knowledge base for teaching, expressed in the question, “what do teachers need to know to teach mathematics well?” by asking the question, “what mathematical work do teachers have to do to teach well?” (Ibid., emphasis in original). This reframes the question from *what* needs to be known to *how* it should be known for productive teaching and learning *in* practice. By asking the questions in this way, Ball et al. refocused the research on teacher knowledge from an obsession with giving more and more detailed descriptions of the forms of knowledge teachers needed and developing models of teachers knowledge structures, to research which could be used to develop a “*practice-based theory of mathematical knowledge for teaching*” (Ibid., p. 55, emphasis in original)³³. Their work, while focusing on elementary teaching, opened up new possibilities in the field³⁴, particularly in relation to the practice related and professional

³³ This is precisely what Shulman (1987a; 1987b) called for when he suggested that there was a need for teacher education research to codify knowledge of practice so that in teacher education we could begin to create opportunities for teachers to learn *from* practice (and then later in practice). Shulman, in particular suggested that records of practice be collected and studied (as was the case with Ball’s teaching of the grade 3 classes) to distil and codify this ‘wisdom of practice’ so that it could be used in teacher education.

³⁴ Of particular significance to the research reported in this thesis is the QUANTUM research project led by Professor Jill Adler, which has focused on how mathematics for teaching is constituted in secondary inset teacher education programmes in South Africa. This work is productively connected to the research on MTE practice reported in this thesis, as will become clear in later chapters. (See, for example Adler, 2004b; Adler & Davis, 2005, 2006; Adler et al., 2005b; Davis, Adler, & Parker, 2007; Davis, Adler, Parker, & Long, 2003; Parker, Davis, & Adler, 2005)

aspects of teacher learning. Their studies showed that substantial *mathematical work* was required in mathematics teaching, and they were able to identify specific “mathematics that teachers have to do in their course of their work”, each of which involve mathematical problem solving. These are:

- Design mathematically accurate explanations that are comprehensive and useful for students;
- Use mathematically appropriate and comprehensible definitions;
- Represent ideas carefully, mapping between physical or graphical model, symbolic notation, and the operation or process;
- Interpret and make pedagogical judgements about students’ questions, solutions, problems, and insights (both predictable and unusual);
- Be able to respond productively to students mathematical quality of instructional materials and modify as necessary;
- be able to pose good mathematical questions and problems that are productive for students’ learning;
- Assess students’ mathematical learning and take next steps. (Ball et al., 2004, p. 59)

Linking this to the previous discussion on Ensor’s (2003) ideas of aspects of ‘best’ practice that could be got at linguistically and those that are truly tacit, and to Shulman’s (1987a; 1987b) call for codifying the wisdom of practice, it seems clear that these descriptions of mathematical work from practice are important, and together with records of practice (videos, case study descriptions and examples) could be used to orientate teachers discursively towards productive forms of practice, that is knowledge *from* practice. However, they would still need to get access to the truly tacit forms of this knowledge *in* practice, through practising.

What becomes increasingly clear as one reads the literature in the field is that teacher education is an incredibly complex field and that there are no easy answers. Many of the proposals for what ought to be in a secondary mathematics teacher education programme, which appear to be ‘research- based’, draw on research which was produced in different contexts. For example, Ball et al’s research on elementary school mathematics teaching is used to support recommendations for the mathematical education of secondary school teachers, and in particular to support the proposition that secondary mathematics teachers should focus on mathematics for teaching *rather than* mathematics in-and-for itself (i.e., rather than a disciplinary perspective). Or, research which focuses on professional initial teacher education programmes designed for students who have already completed an undergraduate degree or general liberal education used to support a specific design in an undergraduate degree programme which must include academic and professional aspects (as in the case of the four year Bachelor of Education (B.Ed) in SA). Within this body of literature there appears to be a growing belief that mathematics teachers will do better to learn their mathematical content differently from those learning mathematics for other purposes, and with this is an implication that they should not learn it from a disciplinary perspective (in disciplinary departments taught

by mathematicians) but rather from a mathematics teaching perspective. Research in the field is however not conclusive, and it is not clear what evidence would support the contention that learning mathematics from a disciplinary perspective is not a necessary component of a secondary teacher's education. That is, while it may not be sufficient it may be necessary.

To summarise, I have shown that there is a growing research field focusing on notions of teacher knowledge structures and selection of knowledge and practice for the purpose of mathematics teaching (for example, Adler, 2003; Ball, 2000; Ball et al., 2004; Brodie, 2001; Bullough, 2001; Davis & Simmt, 2006; Even, 1990; Even & Lappan, 1994; Grossman, 1990; Long, 2003; Ma, 1999; Mason & Spence, 1999; Shulman, 1987a; 1997, and many more). I have argued that this research does not produce conclusive evidence around the best structure for initial teacher education. Nevertheless there are strong suggestions that mathematics teachers *should be* apprenticed into a different *kind* of mathematics to someone learning it from a disciplinary perspective, that is, *MfT*. I have argued that for secondary teachers a focus on mathematics from a disciplinary perspective may also be important. It seems that research in this field has most often focused on what prospective teachers should learn rather than on the critical issues of *how* this learning takes place. As Grossman (2005) puts it “in teacher education attention to pedagogy is critical; *how* one teaches is part and parcel of *what* one teaches [...]. In the professional preparation of teachers the medium *is* the message” (italic in original, Ibid., p. 425). Grossman feels that too little attention is paid to this crucial aspect of the teacher education curriculum by researchers. A focus on what is selected into a teacher education curriculum is insufficient. As Shulman (1990, p. 401) puts it, “the content of the cannon must be understood in deliberations about *what* is taught but, equally important, with *how* it is organized, taught and evaluated”.

3.4 Pedagogic discourse, knowledge and identity

Bernstein (1990; 1996; 2000) sees pedagogic discourses as constructed through both ‘the what’ and ‘the how’ and as inextricably linked to the relations between and within knowledge(s) and practice(s) selected into and communicated through (teacher) education contexts. He emphasises that the mode of pedagogic communication constituted within a specific context is productive of orientations to knowledge (consciousness) and ways of being (conscience) and thus to the developing pedagogic identity³⁵ of the teacher learner. Any reform initiative, theoretically, will involve a change in these knowledge/practice relations and

³⁵ I simply signal these theoretical underpinnings here. Bernstein's notions of pedagogic identity and its links to knowledge and practice will be discussed and theorized in some detail in Chapter 3.

attempt to change the pedagogic identity of a teacher so that he/she will be in a position to internalise the ideology of the reform, whatever that may be. This signals that in relation to theorising the organisation of knowledge within the initial teacher education programme, the question of identity cannot be ignored.

Earlier I had indicated that Lerman (2001) suggested that the perceived success or failure of a teacher education programme was connected to whether and how particular learner teachers bought into the programme – that is the extent to which they internalised the values of the programme so that these become their own values. How they come to know and be as learner teachers is intimately caught up with their relationship to knowledge and practices within the programme and with other individuals taking part in the learning community, and involves questions of identity and identification. The key shift here is from concerns over knowledge as reified cannon, to orientations to knowledge and knowing.

Boaler's (2002) and Boaler and Greeno's (2000) work within mathematics education illustrates this point. Their discussions of the different mathematical identities produced by two different pedagogic modes (didactic teaching and discussion-based conceptual teaching) and orientations to meaning (received knowing and connected knowing) is an example of this in operation. In their study the positioning of the learner as the 'receiver' and the teacher as the 'source' of all knowledge in the didactic classroom, produces particular identities in relation to what is constituted as legitimate mathematics, and how it should be practised. While this practice produces many successful mathematics students, it also alienates some students of high ability. On the other hand, a different pedagogic mode and way of knowing in the discussion based classroom is also effective – here there is a different positioning of the learner, as actively connecting knowledge, and the teacher as providing the discursive basis for the connections to take place. This type of classroom produces different understandings about the nature of mathematics and how it is practised. These studies are useful because they help us see how pedagogic identity is produced differently through different pedagogic modes and how these develop different orientations to meaning.

Boaler and Greeno (2000) point to an important issue. While both sets of students in their study are successful at mathematical tasks, many in the didactic group want to give up mathematics because their identity as 'received knowers' in relation to mathematics does not fit with their sense of self in other aspects of their life-worlds. However students who are positioned as 'connected knowers' engaged in what Boaler and Greeno call the 'dance of

agency'³⁶, don't want to give up mathematics and see it as useful and meaningful in their lives; it is relevant to them. This is important for understanding what it means to learn mathematics so that: access to powerful mathematical knowledge (the discipline) is achieved; that mathematical learning is experienced as meaningful; and, a wide cross section of learners are motivated to continue studying mathematics and see it as relevant in their lives.

The notion of relevance produced in these discussion-based classes is not about integrating everyday experiences into mathematics, or about contextual examples and applications being 'close' to their experienced understandings, but rather produced through a pedagogy that allows learners to develop and use their own voice in ways which are legitimate in terms of the discipline itself. In this way disciplinary knowledge is achieved, a mathematical gaze is acquired and the learner has developed a disposition for doing mathematics as a meaningful activity in their lives. This has to do with control relations in the classroom that enables a pedagogy which produces a *productive disposition* (Kilpatrick et al., 2001) towards mathematical knowledge and practices, and that invites the learner into a discursive relationship with the knowledge. That is, the form of regulation operating in the classroom is specifically focused on developing social codes for mathematics learning – mathematical conduct and habits of mind (rather than a general regulation of behaviour). An orientation to meaning is developed which gives entry into the discipline and is not just 'watered down', non-principled, segmental knowledge based on low level everyday examples³⁷. A *mathematical gaze* (Dowling, 1998) is acquired, the majority of learners are not alienated from mathematics and they learn important practices that mathematicians would recognise as not only skilful, but also imaginative and creative.

Boaler (2002) shows how, in the discussion-based classrooms in her study, the formation of identity as a becoming 'mathematician', a learner of a discipline, is not simply about agency and having reform classrooms based on group discussion – it *matters* what goes on in the classroom. It is not simply about learners having more agency and authority to make decisions – where there is the possibility that they are left to wander in different unproductive directions constructing 'fuzzy mathematics'. Here there is a focus on the '*nature of agency*'. In the dance of agency mathematics (as a discipline) has agency - its 'voice' is determined by the 'strong

³⁶ The 'dance of agency' refers to Pickering's (1995) description of 'conceptual practice' produced through an analysis of agency in mathematical and scientific work. As he puts it "conceptual practice ... has ... the familiar from of a dance of agency, in which the partners are alternatively the classic human agent and disciplinary agency." (Ibid. p. 116)

³⁷ This can be related to Bernstein's (1999) discussion of vertical and horizontal discourses and their grammar (weak or strong). This will be discussed in detail in Chapter 3 of the thesis.

grammar’ of mathematics (Bernstein, 1999) and there are times when the voice of mathematics must necessarily be in the foreground. But this is not the only voice. There is also human agency – the voices – where other resources are recruited. In the ‘dance of agency’ there are times when the learner submits to the discipline and other times where they bring the self into the discipline. Thus relationships develop – a community of speaking mathematics, doing mathematics and using mathematics develops. This is an example of the ‘voice-message’³⁸ system at work. A crucial point here is that for such a pedagogic practice to be workable, it must be related to the discipline of mathematics and the practices of mathematicians in important ways. It is not just any discussion/ discursive classroom that will do – it is specialised to the work of mathematics learning.

What is emphasised in Boaler’s work is that it is not only important *what* is learnt but also *how* it is learnt. It is the *how* that makes a difference to the way individuals create meaning for themselves, which in turn, is related to their increased commitment to mathematical orientations and the constitution of their mathematical identities. This points us to important aspects about learning mathematics, and by implication, about teaching mathematics. *What* and *how* do teachers need to know and be able to do to develop these productive mathematical identities in their learners? What kind of identities do teacher educators need to develop in their students (becoming mathematics teachers), and how can this be related to orientations to mathematics, mathematics education and education more generally in the teacher education classroom? In other words the quality of MTE may be connected as much to how mathematics (as a discipline in-and-for itself) is learnt by prospective teachers (i.e. SMK), as to how *MfT* (as disciplinary knowledge in-and-from practice) is acquired.

Brodie (2004) argues while we need to consider the kind of knowledge that teachers need for practice, we also need to understand that the kind of *practices* that teachers engage in constitute and constrain what counts as mathematical knowledge. She argues that what is important is finding ways to enable learners to make meaning. She sees enabling meaning making as the key to good practice. Although she doesn’t say it, this meaning making is a question of identity. She believes that a clear distinction should be made between form and substance – a teacher engaging in a particular form associated with learner centred practice (e.g. group-work) does not necessarily promote genuine mathematical engagement and thinking amongst her learners. At the same time, it is quite possible that in a teacher-led

³⁸ This is specifically related to Bernstein’s (1990; 1996; 2000) theory and will be elaborated in detail in Chapter 3.

classroom learners are engaged in meaning and interaction with mathematics, and so although the form looks like its not learner-centred it is! For Brodie, learner-centred teaching does not require particular methods (forms) - it requires an orientation to meaning.

Brodie suggests a key question about teachers' knowledge is: "what kinds of knowledge do teachers need in order to work with learners' meaning in the classroom?" (Ibid., p. 70). She explores the ideas of *thinking practices* for learning mathematics (what it means to do mathematics and mathematical thinking). She suggests that,

(t)he notion of mathematics practices suggests that learning mathematics is not only about learning particular knowledge and skills, but also about developing particular habits of mind, tools for thinking and dispositions to think and act in particular ways that we call mathematical. (p. 76)

Brodie argues teachers' mathematical knowledge and mathematics teaching practices are mutually constitutive: each one shapes, creates and constrains the other while remaining distinct analytical objects. What is important is for teachers to develop productive mathematical orientations for teaching.

The idea of mathematical practices that Brodie invokes is related to developments in mathematics education in the USA, and in particular the work done by the RAND Mathematics Study Panel (2002) which focused on the notion of mathematical proficiency, which was seen as being connected though mathematical practices. The Rand Study suggests that:

A major part of the knowledge teachers need for teaching concerns mathematical proficiency and how it can be developed in their students. If teachers hold a restricted view of proficiency and are not themselves proficient in mathematics, as well as teaching, they cannot bring their students very far towards current goals for school mathematics ... A second critical priority, if teachers are to help all students attain mathematical proficiency, is the identification, analysis and development of mathematical practices (Ibid. p. 9)

The RAND study drew on Kilpatrick et al's (2001) idea of mathematical proficiency. Mathematical proficiency is described as consisting of five intertwined strands, which are seen as critical for school learners (and teacher learners) to develop in order to gain access to powerful mathematical ideas. The strands are summarised as: *Conceptual understanding* – comprehension of mathematics concepts, operations and relations; *Procedural fluency* – skill in carrying out procedures flexibly, accurately efficiently and appropriately; *Strategic competence* – ability to formulate, represent and solve mathematical problems; *Adaptive reasoning* – capacity for logical thought, reflection, explanation and justification; *Productive disposition* – habitual inclination to see mathematics as sensible, useful and worthwhile,

coupled with a belief in diligence and one's own efficacy. I will not elaborate on these aspects here³⁹.

Kilpatrick et al. argue that these strands are interdependent and need to be developed simultaneously. Each one relies on the other for its development. They present an integrated and coherent view of mathematical knowledge and practice and show that proficiency in conceptual knowledge without developing procedural knowledge is not possible (and procedural knowledge without conceptual knowledge is usually incorrect). They emphasise there is *more* to mathematical practice than knowing and understanding concepts and how to carry out procedures fluently. These strands of mathematical proficiency point to an understanding that mathematics is not just a body of knowledge, but that it is fundamentally about engaging in particular kinds of practices. The notion of mathematics practices suggests that learning mathematics is not only about learning particular knowledge and skills, but also about developing particular habits of mind, tools for thinking and dispositions to think and act in particular ways that we call mathematical. From this point of view teaching mathematics is a practice which is focussed on helping learners engage in mathematical practices, and in doing so, to internalise mathematical knowledge and skills related to the selections in the school curriculum, in ways that will be meaningful and provide access to all learners.

This work suggests an important distinction between knowing and practising mathematics as a discipline, and knowing it in ways that enable its use in classroom practice. It is thus *how* teachers know and *what* they are able to mobilise mathematically in the course of their teaching that becomes a key. As discussed earlier, Ball and Bass (2000) suggest that it is most important that teachers are able to decompress or unpack mature and compressed ways of knowing mathematics back to the roots of that knowledge, and that this is used to suggest the teachers need something different from a disciplinary perspective. However, I would argue that this 'unpacking' is possible only when the teacher is in a position to read the compressed forms – if the teacher is not in a position to read the compressed forms then it will be impossible to unpack them.

What does this say about the kind of knowledge a teacher needs and how she needs to hold it? While knowledge-in-practice is clearly crucial for teaching, and therefore a focus on the mathematical work that teachers need to do to teach well is important, it makes no sense without the practice of the knowledge form in-and-for-itself. This brings us full circle back to

³⁹ For a full discussion of the strands and their significance in teaching, see Kilpatrick et al. (2001).

Shulman's insights and recognition of the need to co-ordinate different types of knowledge(s) and practice(s) important for teacher learning, in the teacher education curriculum. A focus on PCK, knowledge-in-practice, or on teaching for understanding obscures a necessary focus on SMK. This is akin to an aspect of Adler et al's (2002) notion that teachers need to hold a relatively broad and wide knowledge of their subject. As Shulman describes it:

We expect that the subject matter content understanding of the teacher be at least equal to that of his or her lay colleague, the mere subject matter major. The teacher need not only understand *that* something is so; the teacher must further understand *why* it is so, on what grounds its warrant can be asserted, and under what circumstances our belief in its justification can be weakened and even denied. Moreover, we expect the teacher to understand why a given topic is particularly central to a discipline whereas another may be somewhat peripheral. This will be important in subsequent pedagogical judgements regarding relative curricula emphasis. (Shulman, 1986a, p. 202, emphasis in the original)

4 Conclusion

I began the chapter with an examination of the international context of teacher education reform and showed that there are three common international trends: a move to professionalize teaching, and hence a focus on developing teacher professionalism; a move towards locating teacher education in HE institutions, either in general comprehensive universities (universitisation), or in single purpose teacher education institutions; and, increasing regulation of teacher education through policies, standards setting, and quality assurance mechanisms to ensure accountability and relevance of teacher education provision. I argued that the need for regulation was rooted in the changing forms of social solidarity in contemporary global societies emerging from the increasing differentiation of labour. This is seen in the loss of trust in HEIs to produce the kind of teachers required by (a globalising) society, and the need for social contracts (regulation policies) to ensure they carry out their work for the 'good' of society. I showed the nature of movements in teacher education across different countries was not uniform. Differences are related to a number of factors, including, the agencies and agents who are included (excluded) from decision making over regulatory policies, funding for teacher education research and administrative capacity of the state, as well as different understandings of (orientations to) research as a basis for decision making, and the role of institution-based (disciplinary/ academic and professional learning from the wisdom of practice) and work-based learning (in practice).

I moved from a focus on these general trends in teacher education to consider research into the design of initial secondary teacher education curricula, with a specific focus on mathematics teaching. I found little literature related to the education of secondary teachers through four-year degree programmes which attempt to co-ordinate the disciplinary, professional and occupational aspects of learning to teach (the kind of MTE programmes in focus in my study).

While there was no conclusive research within the field to support a particular view, some suggestions for what ought to be selected into a secondary MTE curriculum are being put forward, specifically, the belief that mathematics teachers need to know mathematics differently from someone learning it as a discipline in-and-for itself. I argued, however, that teachers need to know and understand mathematics from a disciplinary perspective *and* learn mathematics from-and-in teaching. A crucial issue would be connected to *how* these different aspects are learnt and the relationships produced with mathematics and teaching, and hence, the mathematics and mathematics teaching identities developed through the teacher education programme.

It is clear that the field is very complex. It is unlikely that any simple connection exists between what is covered in the teacher education curriculum and a teacher's ability to teach well. The discussion points to many possibilities both theoretically and practically in relation to the regulation, location, design and delivery of teacher education programmes, and raises numerous questions about what happens in MTE in South Africa. In the chapters that follow I focus on the South African context and consider how the international trends identified in this chapter, have played out. In Chapters 3, I consider the nature of the regulatory environment and the location of teacher education in South Africa and consider what pedagogic spaces have been opened or closed for teacher education and raise issues related to the design of teacher education curricula within this context.

Chapter 3

Reform, Regulation and the Pedagogic Space for Teacher Education in South Africa Post 2000

How a society selects, classifies, distributes, transmits and evaluates the educational knowledge it considers to be public, reflects both the distribution of power and principles of social control. (Bernstein, 1977b, p. 85)

1 Introduction

In Chapter 2 we saw that teacher education reform in South Africa cannot easily be divorced from the international and global context of teacher education and development. Reform in teacher education is a global phenomenon driven by the perceived failure of teachers to produce the kind of citizens required by society. The particular shape that reform takes varies from context to context, but in the majority of cases it is driven by a need to regulate teacher education and to set standards for teacher education that will ensure a supply of the ‘right’ *type* of teacher for that context. What type of teacher is required and what becomes defined as ‘good’ teacher education are by no means uncontested notions. How the policies relating to these standards are generated across the globe therefore differs, with different agents (e.g. university based academics, professional teachers bodies, government appointed education officials, etc.) having varying power to influence and make decisions about what quality in teacher education means. The extent to which the professionalism of teachers within a particular country becomes defined in terms of, for example, a practice oriented or research-based discourse will be influenced by these decisions. The way in which regulation in teacher education is implemented across different contexts appears to be related to the way in which power is distributed in that society more generally and this influences the relative autonomy that teacher education institutions can exercise in making decisions over *what* knowledge and practices are selected and privileged for inclusion in the curriculum and *how* these are made available to student teachers.

Internationally there has been a move to professionalize teaching and this is connected to the move to firmly situate teacher education in the higher education (HE) sector, although the nature of this also varies across different countries. Most often in industrialised nations this is connected to the move of teacher education into the comprehensive university sector with

single purpose teacher education institutions being closed in favour of the incorporation into a general university. This has been referred to as the ‘universitisation’ of teacher education in the literature. In developing countries the trend is not as well advanced. We do see a movement towards all teacher education being incorporated into the HE sector, although with varying degrees of ‘universitisation’ taking place. In many developing world contexts teacher education is to be found in single purpose higher education institutions (HEIs), and in some cases, secondary education schools.

In this chapter I explore the reform context of teacher education in South Africa, giving a description of the way in which the institutional landscape of teacher education has been transformed since the 1990s, the nature and scope of recent teacher education policy initiatives and an analysis of the regulative environment of teacher education. I theorise the pedagogic space for teacher education that is made possible within this context. I draw mainly on theoretical resources derived from Bernstein’s sociology of pedagogy to produce this analysis and I introduce the notion of pedagogic identity as a focus in this research project. This chapter concentrates on the nature of the regulative environment and the position of teacher education academics in relation to control over teacher education curricula and the selection of knowledge and practices for teachers and teaching raised in the previous chapter. I use this to set the scene for exploring what is referred to as the *official pedagogic identity* of mathematics teachers projected from the SA policy context, which will be the focus of the next chapter.

In the sections that follow, I begin by briefly discussing the teacher education landscape in South Africa. I give an overview of the changing institutional and policy context that has occurred since the 1990s. Following this I discuss some theoretical concepts from Bernstein’s theory that I will use in analysing teacher education reform in SA. I draw on these concepts to argue that teacher educators have been repositioned as academics in the new order, and that this repositioning has opened a space for them to profoundly influence the education of teachers, particularly an opportunity to insert research as a basis for teacher education and to organise their curricula to provide access to principled knowledge for teachers and teaching. However, it is noted that this space may not be well recognised and therefore the full opportunities that it presents may not be realised.

2 The changing teacher education context in South Africa

From 1994 – 2003, public⁴⁰ teacher education underwent a rapid transformation that included a de-location and re-location of pedagogic practices from colleges of education regulated and controlled by the provincial⁴¹ education departments of the state, to relatively autonomous Universities and Technikons located in the HE sector. In this section I describe this movement and later in the chapter argue that it created a pedagogic space, not previously available, for mathematics teacher educators, education researchers and mathematicians⁴² to play a major reform role by designing curricula for the development of new mathematics teacher identities.

2.1 The teacher education landscape prior to transformation

Prior to 1995 there were about 140 state funded institutions providing teacher education to approximately 200 000 pre-service and in-service students (Parker, 2003a)⁴³. These institutions included 32 partially autonomous universities and technikons and around 110⁴⁴ colleges of education. Teacher Education operated under 19 different apartheid education governance systems and offered a variety of types of qualifications of varying quality. While the ‘provincial’ authorities had the responsibility for primary teacher training, the universities and technikons provided secondary teacher education.

The colleges operated in much the same way as high schools with full teaching timetables, little space for independent study, and little expectation that staff become engaged in research activity or that they be experts in the disciplinary field underpinning the school subject they

⁴⁰ In this research project my focus is on public (state funded) teacher education. While there were/ are private providers and non-governmental organisations involved in various forms of teacher education, the focus here is on the public system, and specifically on initial teacher education qualifications for secondary teachers (Grades 8 – 12).

⁴¹ After 1994 the various apartheid education authorities were consolidated under the nine new provinces. Prior to this the situation was very complex since under the apartheid order colleges of education were variously governed for different race groups. White teachers were educated through colleges governed by the four provinces; coloured teachers through colleges governed by the Department of Education and Culture of the House of Representatives; Indian teachers through colleges governed by the Department of Education and Culture of the House of Delegates, and black African teachers through colleges governed by the Department of Education and Training (previously the Department of Bantu Education), and in the various homelands colleges, governed by the different homeland Departments of Education and Culture. The proliferation of colleges of education (of approximately 110 at its peak in 1994) reflects an aspect of apartheid: the building of colleges for every (ethnic) ‘group’ so that they would train their ‘own’ teachers and preserve their own culture. In what follows I will refer to the state, or, ‘provincial’ authority to include all these various departments.

⁴² Clearly this space is wider than mathematics teacher education; it includes all forms of teacher education.

⁴³ For a comprehensive and insightful analysis of the teacher education landscape in South Africa see: Parker, B. (2003a). Roles and responsibilities, institutional landscapes and curriculum mindscapes: a partial view of teacher education policy in South Africa: 1990-2000. In K. Lewin, M. Samuel & Y. Sayed (Eds.), *Changing patterns of teacher education in South Africa: policy, practice and prospects* (pp. 16-44). Sandown: Heinemann.

⁴⁴ This number appears to vary between 102 and 120 according to different sources (see Parker, 2003a; Sayed, 2004; Vinjevold, 2000; Welch, 2002).

were educating teachers to teach. Most teacher educators were qualified to teach their subjects at secondary level and had practical experience of teaching in schools. The teaching (lecturing) posts in colleges were ‘promotion’ posts equivalent to the level of head of department in a school, and all teacher educators in these positions were employed by and governed by the ‘provincial’ education authorities.

In general the teacher education curricula (for diploma qualifications run through the colleges) were externally controlled by the ‘provincial’ authority. In most of the colleges, externally set examinations were written and the curricula focused almost entirely on school curriculum knowledge. It was in the relatively few ‘white’ and ‘Indian’ colleges of education that teacher educators had some autonomy and set their own examinations, however even in these institutions teacher education was relatively strongly framed by the provincial/state regulations and were staffed by teachers rather than academics.

In universities the main qualification for secondary teachers was the post graduate Higher Diploma in Education, and secondary teachers qualifying through this route all had initial general degrees. Within the university education departments there were varying practices with the more progressive English speaking universities educating teachers within a general framework provided by the state, but providing a strong resistance culture to fundamental pedagogics⁴⁵, the dominant educational discourse of the time. In general, secondary teacher education was governed by the national department of education and the universities were expected to construct curricula to meet the general requirements of the state. However, they were relatively autonomous with their own acts and the academic freedom to position themselves outside the influence of the various ‘provincial’ education departments.

There was, therefore, a ‘dual’ teacher education system in South Africa, one for secondary teachers which was ‘universitised’ and one for primary teachers that was separate and operated under the various provincial/ homeland apartheid education departments. The quality of provision within this dual system was very variable and dependent on the department under which the institution operated and the resources made available within the Apartheid state. Sayed (2004) describes the teacher education system under apartheid “as a ‘system of systems’, with different systems for different racial and ethnic groups [... which...]

⁴⁵ This philosophy supported an authoritarian education system in which children were to be lead into adulthood through a system of indoctrination into specific cultural and religious norms which supported the apartheid ideology of separation and division into ethnic/ cultural/ religious/ languages ‘groups’. Specifically, fundamental pedagogics underpinned the approach to mathematics education in SA during the apartheid era (see Khuzwayo, 2005).

determined whether individuals were trained, how they were trained and where they were posted”. (p. 247)

This ‘system of systems’ exhibited many anomalies, for example, in the case of what became known as ‘scarce subjects’, mathematics, the sciences and commercial school subjects, many secondary teachers were educated in colleges. Due to the problem of access to mathematics and science in universities and the relatively few teachers who were produced through that system, many junior secondary (Std 6 – 8⁴⁶) mathematics and science teachers were trained through colleges of education, and de facto went on to teach to matric level (Std 10/Grade 12), particularly in Department of Education and Culture (DEC) and Department of Education and Training (DET) schools⁴⁷. Colleges which trained junior secondary mathematics teachers generally had a relationship with a university through which these qualifications were accredited. For example, in what was to become KwaZulu-Natal after 1994 Edgewood College of Education provided secondary teachers diplomas and higher diplomas for white teachers that were accredited by the University of Natal (Durban). A similar relationship existed between Springfield College of Education and the University of Durban Westville for Indian teachers, and Eshowe College of Education and the University of Zululand for black African teachers. In addition there were a large number of teaching schools operating under the DET that produced black African primary school teachers for rural areas. Secondary school students entered these teaching schools/ colleges after completing Standard 7 (Grade 9), and obtained a Primary Teachers Certificate (PTC). Many of the under-qualified primary teachers currently within the system were trained in this manner.

In his analysis of the teacher education landscape in South Africa, Parker (2003a) explains that the origins of this dual (provincial primary/ national secondary) teacher education system lie in a political compromise reached in 1910 with the negotiations over the Constitution for the Union of South Africa. Specifically, the Natal colony was reluctant to enter the new Union and one of the sticking points was control over teacher education. The English speaking colony wanted to keep cultural control of their schooling system and therefore the training of the teachers who would be employed by it. A carrot that was used to get them to join the Union of South Africa was control over the governance of teacher education for primary schools. Interestingly, the move to take control of primary teacher education out of provincial hands, also finds its origins in a political compromise. In 1994 there was also contestation over the

⁴⁶ Grade 8 – 10 in the new lexicon.

⁴⁷ These were the schools for black African students. The various DEC schools were under control of the different ‘homeland’ authorities while the DET were governed nationally.

location of control over teacher education during the negotiations for the interim Constitution of a post-apartheid South Africa. The tension was between parties who argued for decentralisation of power to the provinces and those who argued for centralisation at a national level. As Parker puts it, agreement was “reached ‘at the last minute’ by an important compromise: colleges became a national competence in exchange for permitting private-sector provision of higher education” (Ibid. p. 20)

After the elections in 1994 all colleges of teacher education were consolidated under the nine new provinces, but the 1910 constitutional division between provincial and national governance of teacher education remained in place for the interim. After the adoption of the new Constitution of South Africa in 1996, which made all tertiary education a national competence, and the promulgation of the Higher Education Act of 1997, in which all teacher education was declared to be part of the tertiary education system (in Section 21 of the Act), the competence for teacher education was removed from the various provincial authorities to the National Department of Education. This marked the beginning of radical structural transformation of the teacher education system which led to the provincial rationalisation of most colleges of education and culminated in the incorporation⁴⁸ of the remaining colleges into universities and technikons in 2001⁴⁹.

2.2 The rationalisation of colleges of education

The decision to close colleges of education as independent institutions was highly contested⁵⁰ and the result of the culmination of a number of processes⁵¹. The 1993 National Education

⁴⁸ The Government Gazette *Declaration of Colleges of Education as subdivisions of Universities and Technikons* (DoE, 2000b), an addition to the Higher Education Act of 1997, gives details of the incorporations. The institutional landscape of teacher education has been changed again since this gazette was published. There have been further institutional mergers in HE, for example the University of Natal and the University of Durban Westville have merged to form the University of KwaZulu-Natal. Technikons have been merged with universities to become comprehensive universities, or with other Technikons and colleges to become Universities of Technology. For example the Rand Afrikaans University has merged with the Witwatersrand Technikon to become the University of Johannesburg, and the Cape Peninsula University of Technology is the result of a merger of two Technikons and a number of Colleges of Education. These merges took place after the initial collection of survey data for this research project. The work reported here refers to the situation before the more recent mergers.

⁴⁹ It is noted that in the Mpumalanga and Northern Cape provinces there were no HEIs. In these provinces, National Institutes for Higher Education were set up to offer qualifications under the auspices of a university or other HEI.

⁵⁰ I will not deal with the nature and scope of this contestation here. While it would be interesting, in the context of this research it is not possible to unravel all the aspects of the processes and contests involved in the closure of the colleges. However, there was particularly strong resistance from within the college sector, represented by the Committee of College of Education Rectors of South Africa (CCERSA). The resistance was particularly strong amongst the ex-white colleges who saw themselves as ‘centres of excellence’ in teacher education.

⁵¹ In addition to the processes described here, a further significant factor was the cost of teacher education through the colleges which were funded through provincial budgets. In 2000, the cost to the state for funding teacher education through the colleges was approximately R40 000 per student. On the other hand, Higher

Policy Investigation (NEPI) report on teacher education made recommendations about the teacher education landscape that did not include a closing down of colleges but rather proposed possible models⁵² for their continued existence (NEPI, 1993). The NEPI process led to the African National Congress's (ANC) *Policy Framework for Education and Training* and *The Implementation Plan for Education and Training*, which both considered the issue of teacher education. However there were no specific recommendations made for the structural location of teacher education.

In 1995 the *White Paper on Education and Training* recommended an investigation into teacher education, which led to the commissioning of the National Teacher Education Audit (Hofmeyr & Hall, 1995). The purpose of the audit was to investigate

teacher demand, supply and utilisation as a basis for the development of models for projecting future needs [...and...], evaluate teacher education institutions and programmes, formal and non-formal, in terms of their capacity to provide pre-service and/or in-service teacher training, the quality of the programmes offered and governance structures (Ibid. p. 1)

The audit revealed a wide variability across the system. While the audit recognised some centres of excellence (generally the well funded ex-white colleges and universities), the overall picture was dismal. The system was characterised by a general lack of quality in provision, differentiation in curricula, an over enrolment of primary teachers and too few secondary teachers, a proliferation of under-utilised colleges in the homelands⁵³, and widespread inefficiency in the system. While the audit did not focus on the structural location of teacher education, there was a general assumption that single purpose colleges would remain part of the HE system when teacher education became a national competence. I will not go into the details of the audit here, however, it was clear that drastic measures needed to be taken not only to deal with the problem of creating appropriate curricula for teachers in the

Education worked through a system of subsidies, and so the cost to the state for funding a teacher education student through a university at that time was around R 10 000 (Parker, 2003a). What this hid of course was that university fees for the students at universities were much higher than at colleges of education and so that the individual costs for student teachers would be greater. Also since colleges of education were previously run through the provinces, the budgets for running them were in the provincial coffers. With the national DoE taking over the responsibility for primary teacher education, if the colleges of education were to be kept open, they would have to be governed and financed through the DoE on a different system from the one in place for higher education in general. The Act specifically demanded a single HE system with programme based funding. (Also see Crouch & Lewin, 2003).

⁵² This included three possibilities: the development of a collegiate (consisting of a cluster of colleges in a particular geographical area); Institutes of Education (single regional institution bringing together the resources of a number of colleges); education development centres.

⁵³ New colleges were being built on a regular basis. The continued expansion of new colleges appeared to be based on a system of patronage and a need to enhance the status of the homeland leaders through visibly showing their commitment to post-secondary education. An example of the waste and inefficiency that was incurred was the case of Lebowa. The audit revealed that in 1990 four brand new colleges of education were built even though there were already eight colleges in the homeland which still had capacity and room for expansion (Jaff, Rice, Hofmeyer, & Hall, 1996).

new order, but also to deal with the wastage and inefficiency of the inherited apartheid college system.

There were also other significant processes underway at the time, in particular the formulation of new policies for the HE system that set out to transform and reshape the apartheid system; the aim was to “preserve what is valuable and to address what is defective and requires transformation” (Nelson Mandela quoted in NCHE, 1996, p. 1). The National Commission on Higher Education (NCHE) was one of the first steps in this process. Its report recommended that all teacher education be fully incorporated into existing HEIs to create a public HE system of thirty to forty multi-campus institutions. This recommendation was carried through to the 1997 *White Paper 3: A Programme for the Transformation of Higher Education* which suggested a full review of the college sector⁵⁴ in order to create “a single system of higher education regulated through programme-based funding and rigorous quality assurance of providers and programmes”(Parker, 2003a, p. 33).

The acceptance of these recommendations and the promulgation of the Higher Education Act of 1997 gave the national Minister of Education the power to declare the incorporation of a college of education into the national public HE system. While at this stage there was still the possibility that some colleges could be declared autonomous HEIs⁵⁵ this set in process the provincial rationalisation of colleges between 1998 and 2000. I will not go into the details of this process here, however, by the end of 2000 there were only 25 colleges of education (23 full-time contact colleges with residences and 2 distance colleges) still in operation. These had been earmarked by the national DoE for incorporation into the various universities in 2001.

In summary, by 2001, the state had restructured the teacher education landscape⁵⁶, the college sector had been absorbed into the HE system (universities and technikons) and there remained 23 public institutions that offered teacher education programmes. This restructuring not only radically reduced the number of institutions providing teacher education qualifications, but

⁵⁴ This was not only with respect to teacher education, but all colleges including agricultural and nursing colleges.

⁵⁵ In terms of the HE Act, the Minister appointed a task team in 1997 to investigate how the college sector could be incorporated into HE. The report, *A Framework for the Incorporation of Colleges of Education into the Higher Education Sector*, was presented in 1998 (DoE, 1998b). It left open the possibility of some Colleges becoming autonomous institutions if they had sufficient numbers of students (set at 2000 full-time student) and the capacity (infrastructure and resources) to be self-governing.

⁵⁶ There is much more that can be said about the unintended effects of the closure of colleges and the opening up of HE to private providers, in particular related to the lack of funding for teacher education, the consequent problems with the supply of new teachers, etc., as well as the early proliferation of public-private and private provision of dubious quality. I will not go into this here as it is not significant to this research project. For more information see Crouch and Lewin (2003), Parker (2003a), Sayed (2004) and Welch (2002).

also repositioned them as agencies with the major responsibility for generating (researching, developing and implementing) purposeful curricula for teacher education qualifications, for all phases of the public school curriculum (grade R through to Grade 12).

2.3 Movements towards rationalising, transforming and regulating teacher education curricula

The radical transformation in the institutional landscape was accompanied by major changes in the teacher education curricula. The National Education Policy Act (Act No. 27 of 1996, subsection 3 (4) (f) (1)) gave the Minister of Education the responsibility to determine national policy for the professional education and accreditation of educators (teachers), for establishing a curriculum framework for teacher education and for setting the requirements for employment in public education. The Committee on Teacher Education Policy (COTEP), a sub-committee of the Heads of Education Committee (HEDCOM) was tasked with developing norms and standards for teacher education, to accredit teacher education programmes and qualifications and to advise the Minister on all teacher education matters. COTEP was comprised of members from all provincial departments of education, teacher unions, student unions, the South African Council for Educators (SACE), colleges of education, universities and relevant directorates from the national DoE.

The publication of the COTEP Norms and Standards for Teacher Education (NSTE) in 1996 marked the beginning of years of curriculum development processes in the colleges and universities, as institutions were asked to revise their teacher education curricula to meet the new national requirements and to submit them to COTEP for approval. The NSTE created the first national core curriculum for teacher education qualifications. This was supplemented by the publication of criteria for the recognition and evaluation of qualifications (which came to be known as the ‘green book’). Together the NSTE and the criteria set in place a process for regulating the provision of public teacher education and of making public teacher education providers accountable to the Minister for the quality of their programmes.

The COTEP NSTE was a prescriptive and complex document, which many colleges who had formally worked with syllabuses provided by their governing authority found difficult to use⁵⁷. However, it precipitated a process of curriculum transformation in teacher education to

⁵⁷ I was employed in a College of Education at the time. The document attempted to move teacher education into line with the post-apartheid system changes being introduced in education more widely. It introduced the notion of developing teacher competences. It included long and detailed prescriptions of what (contents) ought to be in the initial teacher education curriculum and appeared to us to be rooted in a design based on what was already being offered in colleges such as ours (white, privileged). At the time I was chairperson of the Association of

meet the needs of the post-apartheid education system, and attempted to bring some uniformity in quality of qualifications across the system. Nevertheless there were still numerous types of different qualifications (certificates, diplomas, higher diplomas and degrees) for initial teachers that had proliferated in the past and these needed to be streamlined to create some coherence and quality in the system.

In 1997 the national DoE set up a technical committee to revise the NSTE, with the purpose of bringing teacher education into line with other policy, in particular the South African Qualifications Authority (SAQA) Act of 1995 which laid the foundation for the development of the National Qualifications Framework (NQF), a programme-based approach to the regulation of education and training (HE Act of 1997), and the implementation of the new outcomes based school curriculum, Curriculum 2005 (C2005). This would lead to a new Norms and Standards for Educators in Schooling (NSE, published in February 2000) together with a new set of Criteria for the Recognition and Evaluation of Qualifications for Employment in Education (Criteria, published in September 2000). The number and type of qualifications that would be accepted by the DoE for employment in education would be streamlined. Most significantly, the NSE would provide a generative framework for public HE ‘providers’ to take the responsibility to research and design *new* HE qualifications for teachers.

Under these new regulations teaching was to become a graduate profession. All future teachers were to be educated in universities through a new four-year degree programme (Bachelor of Education – B.Ed), or a general three year degree followed by a Post Graduate Certificate in Education (PGCE). The old diplomas and certificates in education were to be discontinued. New in-service qualifications (such as the Advanced Certificated in Education (ACE)), which enabled teachers who had been educated under the old system to upgrade their qualifications and gain access to further studies in education leading to honour’s and master’s level qualifications, were introduced.

Mathematics Teacher Educators in KwaZulu-Natal (AMTEK) an organization which brought together university-based and college-based mathematics teacher educators from all TE institutions in the province. The requirements for the revision of curricula were complex and the organization became more widely involved in the curriculum development process as many of its members were unfamiliar with making curriculum decisions and with interpreting such a document. They also had been steeped in the ideology of fundamental pedagogics and were not familiar with the idea that they could be responsible for developing their own curricula, setting their own examinations, and organizing for these to be moderated.

The NSE (DoE, 2000c) describes what it means to be a competent professional educator in South Africa. It provides a vision of a professional teacher who is able to integrate a complex set of seven teacher roles⁵⁸ with social, economic and moral responsibility. The NSE describes in generic terms the *applied and integrated competences* that constitute the roles. These are: foundational competence (knowing that/what); practical competence (knowing how); reflexive competence (knowing why), applied and integrated so that teachers know *what* to do, *why* it should be done, *when* to do it, and *how* to do it in the moment of practice. The Criteria (DoE, 2000a) compliments the NSE. The NSE has a largely symbolic function presenting a holistic picture/ image of an ideal teacher towards which teacher education curricula should aim. The Criteria plays a largely regulative function making it mandatory for higher education institutions involved in teacher education to design curricula in line with the NSE⁵⁹. From the perspective of the Department of Education (DoE), these norms, standards and criteria indicate to all providers (public and private) the kinds of teacher qualifications and learning programmes that the DoE would consider for employment in education. And for the public providers, the kinds of programmes and qualifications the DoE would consider for funding (Parker, 2003). Inherent within the NSE is a general regulative discourse (GRD) that is underpinned by the values and logic of the wider education reform that swept the country in the second half of the 1990s.

At this point we need to move the discussion from describing the context to analysing the extent to which the restructuring of teacher education in SA has lead to the full integration of teacher education into the HE system. How much control over teacher education has the state retained through its new regulatory policies, particularly the NSE and Criteria, and what pedagogic spaces have been opened/ closed in this new context for university based teacher educators and academics to act within this context? Before doing this however, some theoretical referents need to be introduced.

⁵⁸ The roles include being: mediators of learning; interpreters and designers of learning programmes and materials; leaders, administrators and managers; scholars, researchers and lifelong learners; community members, citizens and pastors; assessors; and subject specialists. These roles will be considered in more detail in the following chapter of this thesis.

⁵⁹ The distinction between symbolic policy, regulative policy is based on De Clercq's (1997) analysis of types of policy generated within the in the transforming SA context. She identified a number of types of policies: *substantive policy* – reflect what government should do; *procedural policy*: spell out who should act (who is responsible for doing specific things) and how (what mechanisms they should use to carry out the actions they are responsible for); *material policy* – provide real resources to specific interest groups; *symbolic policy* – rhetoric about needed changes and vision; *regulatory policy* – limit the actions and behaviour of groups and individuals; *redistributive policy* - shift the allocation of resources or rights among social groups.

3 Theorising (mathematics) teacher education

Having partially described the transformation of the teacher education landscape within the South African context, the next step is to analyse policies produced to regulate teacher education within this context and to consider how various HEIs earmarked to take on the responsibility for teacher education responded to these. To do this I first need to theorise the production of policy and curricula for teacher education in general and for mathematics teacher education in particular. In this section I present and discuss a theoretical basis for this work drawing on the work of Basil Bernstein (Bernstein, 1996, 1999, 2000).

3.1 Forms of knowledge and the specialisation of consciousness

Bernstein understood that all pedagogy is concerned with the shaping of consciousness and conscience and that this is connected to the transmission and acquisition of knowledge and practice(s) within social contexts. Consciousness is related to access to knowledge discourses and their practices and conscience to values and social conduct. For Bernstein these two work hand in hand and cannot be empirically separated. Clearly, in educating mathematics teachers we are principally concerned with the acquisition of knowledge and practices for mathematics teaching, and curricula designed for teacher education are concerned with providing access to certain privileged selections of these. The basis for these selections, what is selected and how these selections are made accessible to pedagogic subjects (student teachers) within the MTE context, are central concerns of this research project. Bernstein's work provides productive concepts for theorising the production of curricula and for analysing what is found in the field.

Bernstein was concerned with “general questions of pedagogic communication as a crucial medium of symbolic control” and “understanding the social processes whereby consciousness and desire are given specific forms, evaluated, distributed, challenged and changed” (1996, p. 12) This is also connected to the question of identity, “to know whose voice is speaking is the beginning of one's own voice” (Ibid).

In particular, Bernstein was interested in describing how forms of knowledge are transformed into pedagogic communication (i.e., pedagogized) and the principles that regulate its transformation. Different forms of knowledge, whether intellectual (academic/ disciplinary), practical (craft), expressive (art), official (state generated/ legal) and local (everyday/ cultural) can be made available for acquisition by the pedagogic subject (e.g. student teacher) through pedagogic communication, and if acquired, shape their consciousness and conscience. The

knowledge forms themselves, theoretically, have different structures and internal organisations and different currency within particular social contexts. The way they are transmitted (communicated) to and acquired (learned) by pedagogic subjects will vary across different contexts and through different modalities of pedagogic practice. This variation would be influenced by who is teaching (the transmitter and the access they have to the knowledge forms) as well as the specifics of the context in which the communication takes place (for example, the resources available, time over which it takes place, and the learning spaces in which it happens).

Specialising the consciousness of mathematics teachers through a teacher education programme, for example, would be related to the teachers' acquisition of specialised knowledge forms made available through pedagogic modalities operating within a specific curriculum context (e.g. a particular university teacher education programme), as well as other social contexts in which teachers find themselves and in which teacher learning takes place, for example while out practicing in schools. Questions of *what* knowledge forms (selection) should be made available to mathematics teachers and *how* these should be made available (organised and delivered in the curriculum) are central to the quality of any teacher education programme, and are directly related to the "type" of teacher the programme hopes to produce. Some issues related to questions of teacher knowledge were raised in the previous chapter which resonate here.

It is recognised that education is a field of study rather than a discipline. Shulman suggests it is
a locus containing phenomena, events, institutions, persons and processes that themselves constitute the raw material for inquiries of many kinds. The perspectives and procedures of many disciplines can be brought to bear on the questions arising from and inherent in education as a field of study. (1997, p. 279)

Teacher education is a field of study that not only draws on other disciplines, but also on the field of education itself, as well as on a variety of sources of practical knowledge (which in teaching may also include various forms of practical wisdom, craft knowledge) and possibly expressive knowledge (teaching as an art including aspects of drama) as well as localised experiences. In the education of teachers, particularly in initial teacher education (preparation) programmes such as the four-year B.Ed., which focuses on both the academic and professional aspects of becoming a teacher, a wide range of different types/ forms of knowledge are therefore brought together from different disciplines, fields and practices.

That pedagogic communication is a central concern of all teaching, including teacher education is clear. In the next subsection I introduce Bernstein's notion of the *pedagogic*

device and discuss its significance for research in teacher education as a model for analysing the distribution, communication and evaluation of knowledge in relation to the specialisation of consciousness and conscience. Later I will return to discuss issues for teacher education that are implicit in the proposition, mentioned above, that different knowledge forms have different internal organisations and structures and raise some theoretical questions related to the question of *what* forms could be selected into the initial teacher education programme and *how* these forms could be made available to student teachers in the context of MTE.

3.2 The Pedagogic device

Bernstein's *pedagogic device* provides a way of describing the principles of the internal construction of any pedagogic communication of knowledge through three hierarchical and inter-related sets of rules: *distributive, recontextualising, and evaluative rules*. The distributive rules regulate access of different social groups to different forms of knowledge: "access to the 'unthinkable', that is to the possibility of new knowledge, and access to the 'thinkable', that is to official knowledge" (Bernstein, 1996, p. 117). Recontextualising rules construct official knowledge, that is, they construct the 'what and how' of pedagogic discourse, or the 'thinkable'. It is through the recontextualising rules that forms of knowledge are 'pedagogized'. Evaluative rules construct pedagogic practice, the criteria to be transmitted and acquired.

These rules operate over three fields or arenas in the system, *production, recontextualisation* and *reproduction*. Production is the arena in which *new* knowledge discourses - whether intellectual (e.g. mathematics), expressive (e.g. art), practical (e.g. craft) or official (e.g. law) - are generated in agencies of symbolic control, for example, in research institutions and agencies of HE, or through the legal system. Recontextualisation: is the arena in which knowledge discourses are recontextualised, i.e., selectively appropriated from the field of production, simplified and transformed into a new pedagogic discourse - for use in another context, for example for educating mathematics teachers. This is the arena in which curricula for teacher education or for the schooling system are produced. Reproduction is where recontextualised discourses are transformed a second time for transmission and acquisition in a site of practice through evaluative criteria. For example, recontextualised by teachers for learners in schools so that they are socialised into what is considered 'worthwhile' school knowledge and social practices; and by teacher educators for student teachers so they are socialised into what are considered 'best' practices for teaching and learning. Figure 2 gives an overview of the pedagogic device.

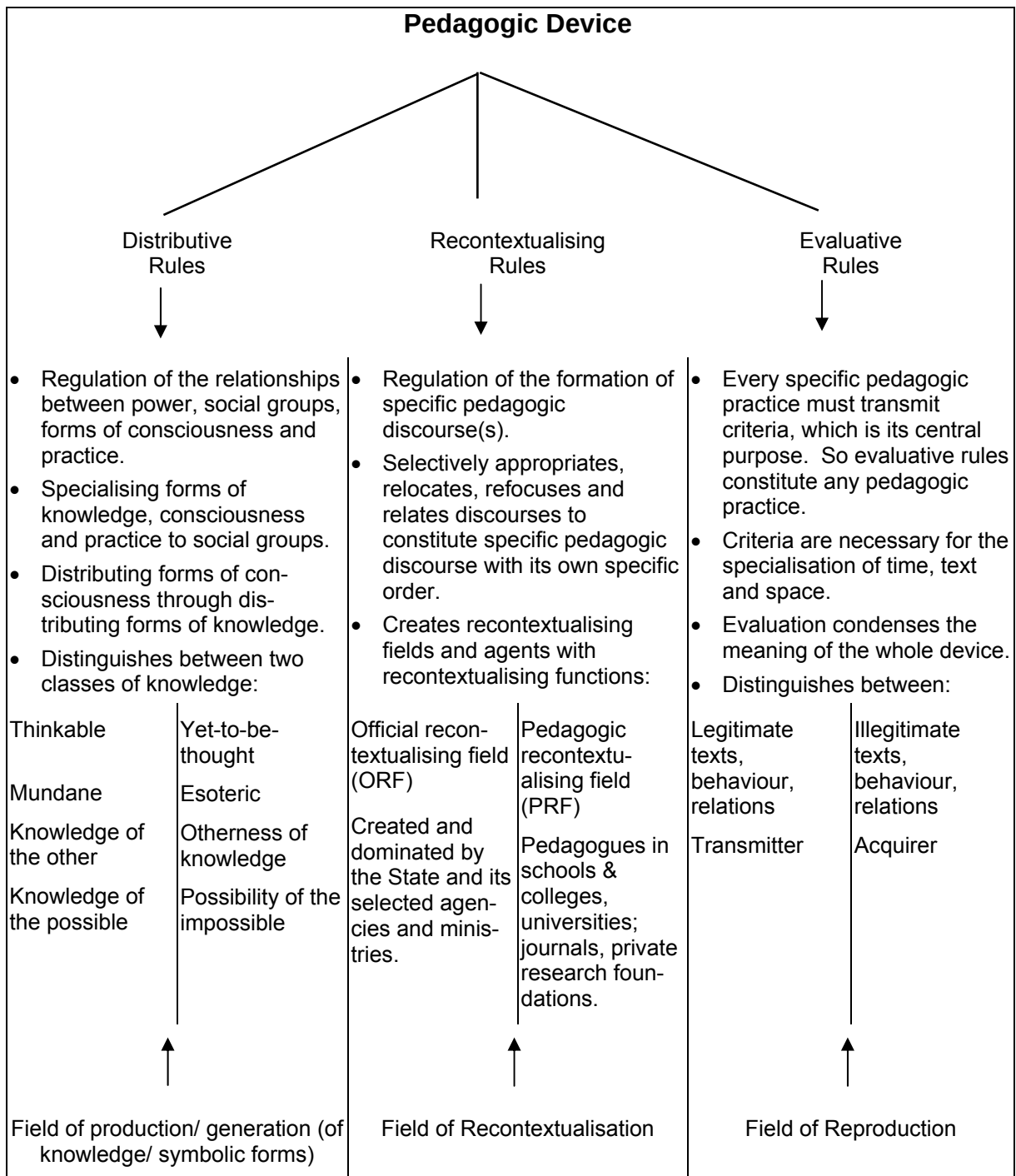
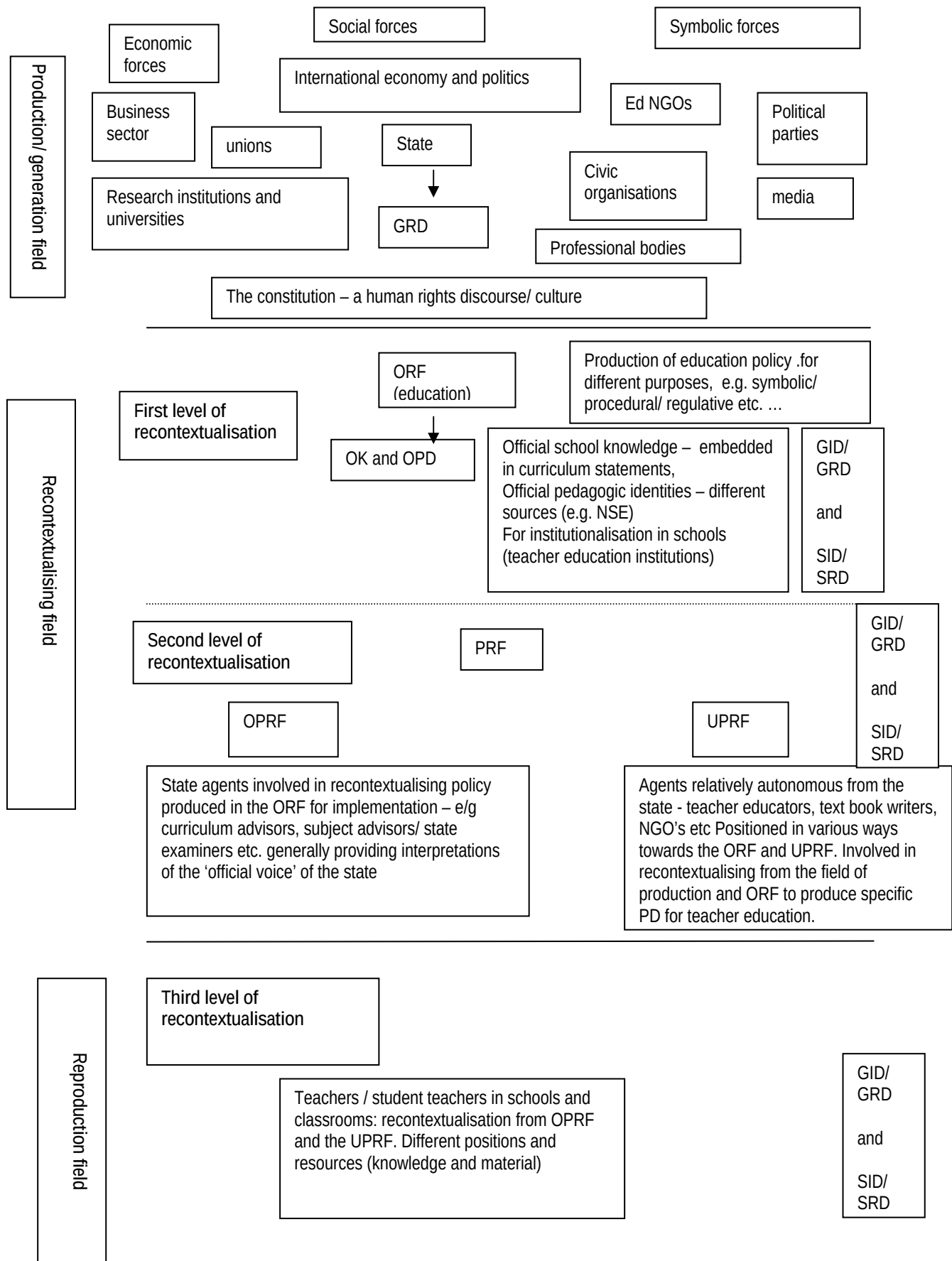


Figure 2: The pedagogic device (adapted from Davis et al., 2003, p. 27)

In each arena ideological struggles take place as different agents and agencies attempt to dominate the distribution, recontextualisation and evaluation of pedagogic discourse at different levels within the system. Figure 3 gives a diagrammatic view of the three fields and shows the complex nature of the different groups, agents and agencies that are involved in producing/ recontextualising/ reproducing knowledge at each level.

Figure 3: Agents and agencies operating across the fields of the Pedagogic Device (All acronyms in this diagram are elaborated in the text that follows and can be found in the list at the beginning of the thesis)



My interest is in teacher education and therefore the empirical field for this research is within the second level of the system – the field of recontextualisation. And yet this field cannot be seen in isolation from the first and third fields. It is linked to the first since knowledge generated in the field of production (whether from research institutions or bureaucratic/ state organisations, civil organisations or the media) is selected for recontextualisation into the teacher education programme. It is connected to the third, since teachers who are the students in any teacher education programme are being prepared to work within the third layer of the system, i.e. they are required to recontextualise knowledge for the purpose of teaching their learners. In addition experience gained in the third level feeds back up to the second level in the form of practical knowledge related to the craft/ art of teaching, to forms of practical wisdom for teaching and various localised pedagogic experiences, and has the possibility of influencing the education of teachers.

What is different about teacher education when compared to teaching in discipline-based academic departments in a university? Theoretically academics in HEIs would select knowledge from their specialised research-based field of knowledge production for recontextualisation, specifically knowledge produced through research would be recontextualised for the purpose of creating access to the field in-and-for-itself, access to its disciplinary foundations and access to the unthinkable/ yet to be thought. However teacher education would not necessarily be concerned with recontextualising knowledge for the purpose of providing access to a disciplinary field and opening up possibilities of research, but rather for other purposes (e.g. for reproducing knowledge in a school, for learning to educate others). In teacher education (and possibly other professional qualifications), there is in addition to the possibility of recontextualising such disciplinary selections, more than likely a recontextualisation of practical/ expressive and/or experiential knowledge from the field of reproduction, and official curriculum knowledge from within the recontextualising field itself. For example, it is quite conceivable that in ‘maths methods’ courses teachers could be taught a selection of ‘tips’ selected as appropriate for learning the practice of mathematics teaching. These ‘tips’ may be selections from the idiosyncratic experience of the mathematics teacher educator or other teachers. Of course there could equally be cases where the selections are from research in the field of *mathematics education* or the practice of *mathematics teaching*, in which case the recontextualisation is of research-based knowledge from the field of production. This latter knowledge would be congruent with what Shulman (1990) referred to as codified knowledge from the wisdom of practice, as discussed in the previous chapter.

In the next section I will describe the recontextualising field in more detail and discuss its significance for considering the production of curricula for initial teacher education. Before doing that however, I want to emphasise Bernstein's position that the pedagogic device is

a symbolic ruler, ruling consciousness, in the sense of having power over it, and ruling in the sense of measuring the legitimacy of the realisations of consciousness. The question becomes whose ruler what consciousness? (1996, p. 117)

Here I will raise some questions that this quote provokes. These are simply signalled here but will be returned to later in the thesis:

Who has control of the pedagogic device in teacher education?

If the device acts as the symbolic regulator of consciousness, who is the regulator, what consciousness is being (re)produced and for what purposes?

Does the state control the device (through the policy it generates and the regulations it puts in place – e.g. the Criteria, NSE, National Curriculum Statements for Mathematics (NCSM, the new FET school mathematics curriculum)), or to the various institutions that provide the qualifications for teachers?

What is the relationship between the state and the providers (how are they positioned)?

Who are the recontextualisers and what are the principles operating for the selection and transformation of knowledge for mathematics teaching and mathematics learning across the HEIs made responsible for teacher education?

3.3 The recontextualising field

Teacher education is an act of recontextualisation and its agents and agencies operate within the field of recontextualisation. Theoretically Bernstein describes two recontextualising fields: the official recontextualising field (ORF) and the pedagogic recontextualising field (PRF). The ORF is created and dominated by agents of the state who select and transform knowledge from a variety of dominant discourses (e.g. political or educational) and disciplines (e.g. mathematics) generated in the field of production into *official knowledge* (OK) reflecting the state's 'bias and focus' (e.g. embedded in policy such as the NSE and the NCSM). The PRF consists of pedagogues (located in, for example, teacher education institutions, state departments of education, specialised journals, professional organisation etc) who are involved in a *second* type of transformation, where official and/or academic and/or practical and/or expressive knowledge undergoes a recontextualisation into pedagogic discourses and practices for teaching. What knowledge is selected for transformation will depend on the positioning of

particular agents involved in the teacher education process with respect to the ORF, the field of production and the field of reproduction.

This means that within the PRF itself pedagogic discourses for teaching will be produced unevenly – not all agents and agencies in the educational field are positioned in the same way in relation to the official discourse produced within the ORF, to academic knowledge produced in the field of production, or to practical knowledge developed in the field of reproduction.

Morgan, Tsatsaroni and Lerman (2002) suggest that the PRF can be thought of as being constituted by two recontextualising fields, the official pedagogic recontextualising field (OPRF) and the unofficial pedagogic recontextualising field (UPRF). These are named to reflect the positioning of pedagogues operating in the PRF with respect to official knowledge produced within the ORF of the state. It is conceivable that in some cases teacher educators would be positioned closely to the OPRF, teaching official knowledge/ discourse as scripture, while others may position themselves in opposition in the UPRF (as was the case with the progressive universities during apartheid times), or even the schizoid position of some who position themselves in both (as is the case with those who move into the ORF to produce policy, promote it through the OPRF and then criticize it from the UPRF).

We can now see that the restructuring of the teacher education landscape in the South African context has created the possibility for teacher educators to reposition themselves within the UPRF. In addition the move has created the possibility that they join other academics in the field of production. In other words the structural changes in the teacher education landscape have changed the relationship between those responsible for teacher education and the state – whereas before they were direct employees of the state working within the field of reproduction and located in the OPRF and therefore had little autonomy⁶⁰, they are now simultaneously positioned within the UPRF and the field of production. This creates possibilities in teacher education that did not exist before.

Thus in the new context teacher educators are positioned as knowledge producers themselves operating out of institutions in the relatively autonomous HE sector (theoretically, located in

⁶⁰ Although, as all teachers do, they did have relative autonomy within the context of their own classrooms.

the field of production). I say theoretically, because there may be some HEIs whose research productivity records in education are severely limited by structural and economic factors. Thus while all universities may claim to be research organisations, on the ground there are likely to be major differences between the positioning of different HEIs in relation to the production of new knowledge in education (in Bernstein's terms, who has access to the unthinkable?). Simultaneously, however, teacher educators are potentially re-positioned within the PRF. This positioning in the UPRF (theoretically) enables them to exercise more power over the selection of knowledge and pedagogic discourses for teachers and teaching than was possible before. They certainly are more powerfully positioned than other agents in the PRF, for example, the curriculum advisors employed by the state and tasked with training teachers for new curriculum implementation, or school textbook writers who need their products purchased by the state. This repositioning creates the possibility for teacher educators (as academics) to question the basis of official knowledge and to enable access to forms of principled knowledge and therefore provide a counter to the tendency of state agents to fall into the trap of reproducing 'mythological truth' (Harley & Wedekind, 2003)⁶¹. I will return to this issue a little later in the analysis of the regulative environment which follows.

3.4 Teacher education and pedagogic discourse

Recontextualising rules regulate the work of all teacher educators who construct the 'what and how' of pedagogic discourse for teachers and teaching, i.e., selections of subjects, contents and practices (what) and a theory of instruction (how). In this sense pedagogic discourse is

a principle for appropriating discourses from the field of production, and subordinating them to a different principle of organisation and relation. In this process the original discourse passes through ideological screens as it becomes its new form, pedagogic discourse (Bernstein, 1996, p. 117)

The ideological screen that operates in the transformation of the selected knowledge (i.e. the what) creates the basis for its regulation. Pedagogic discourses involve two embedded discourses: the *instructional discourse* (ID - which transmits a selection of various kinds of knowledge and skills *and* their relation to one another) and a *regulative discourse* (RD - which creates order, relations and identity). Any pedagogic practice can be described in terms of the ID/RD.

⁶¹ Education academics located in the UPRF have contested the terrain, and have influenced the curriculum process leading to a review of the first C2005 and hence to changes in official knowledge (DoE, 2000d; Taylor et al., 2003).

Bernstein stressed the point that the symbol ID/RD is used to emphasise the embedded nature of the two discourses and that:

Pedagogic discourse is the rule which leads to the embedding of one discourse in another, to create one text, *one* discourse (Ibid: 46, *Italic* in original)

This is important, because it signals that any knowledge discourse (contents, skills and the relationships between them) is only acquired within a particular regulative order that creates productive⁶² relationships and identities within and between the acquirers (learners), transmitters (teachers) and with knowledge itself. This social order is not just an expression of the general values of society or behavioural norms of the classroom, it also has elements that are specific to the knowledge discourse to be acquired. That is, ways of behaving and habits of mind that set up a relationship between the acquirer and what is to be acquired through a modality of acquisition. It therefore also has elements specific to the underlying theory of instruction, which contains within it a model of the learner and the teacher, which can never be ideologically free. From this perspective the regulative discourse is dominant and it operates at a number of levels: at one level it creates the rules of social order of the educational institution (classroom) – the general moral conduct, who has the right to speak, when and how they can speak, what they can do etc. (the general regulative discourse, GRD). At another it produces the order in the instructional discourse, irrespective of the internal logic of the knowledge itself, expressed in, for example, the principles of selection, relation, sequence and pace and in the dispositions it creates with respect to the knowledge discourse itself (specific regulative discourse, SRD). Finally it produces an image of what counts as good teaching and learning and therefore is instrumental in the construction of pedagogic identities in teachers and learners.

This is related to the issues already discussed in Chapter 2 in relation to different mathematics identities produced through different pedagogic practices in discussion-based as opposed to didactic teaching (Boaler, 2002a, 2002b; Boaler & Greeno, 2000). It is important to note here that to say that pedagogic discourse always has an ideological basis, does not suggest that any particular ideology is ‘better’ than another or that there is anything evaluative about recognising such an ideology. That is, *every* pedagogic practice has an ideological basis (whether it is consciously acknowledged and recognised or not) and one of the aims of analysing such practices is to reveal its ideological basis.

⁶² In cases where unproductive relationships are created, the possibility of access (acquisition of the specialized consciousness) diminishes. In such cases it is still possible that the learners do acquire a specialized conscience, that is, the regulative discourse works to develop social norms and general behaviours/ dispositions. The likelihood is that in such cases it will be social groups who are educationally/socially disadvantaged that will be excluded from acquiring the instructional discourses.

In general teacher educators are required to recontextualise knowledge for teachers that will provide a knowledge base so that they can learn to teach. Note that knowledge *for teachers* and knowledge *for teaching* are not necessarily the same thing as these could be considered to have different purposes – the one is focussed on individual acquisition of knowledge (for the self) and the other on creating the possibility for others to acquire knowledge (for others).

In relation to the new four-year B.Ed degree programme in SA, teacher educators are faced with a complex challenge. They must provide access to various knowledge discourses for teachers and teaching, including disciplinary knowledge in the subject/ specialisation they will later teach, educational knowledge (both specific to the specialisation and more generally), as well as practical (wisdom from practice and in practice) and expressive (craft/ art) knowledge. Thus the pedagogic discourses (there may be more than one) of the teacher education curriculum can never be the *same* pedagogic discourses that will operate in the school. Each will have its own ID/RD that will operate to create relationships between and within different contents, spaces and agents (e.g. mathematics and mathematics education, the lecture theatre and the classroom, teacher educators and student teachers).

This is important because it emphasises that any particular pedagogic discourse in teacher education may be set up to teach a different pedagogic discourse (e.g. principles for the transmission of school mathematics), rather than simply to recontextualise a form of knowledge to be (re)produced in-and-for-itself. This is complicated because the site of acquiring such a discourse (in the teacher education classroom/ lecture) is not the same as the site of practice (in the school classroom where it will be used and transformed). It is also the case that the site of practice where the teacher needs to learn the craft/ art of teaching mathematics may be isolated from the teacher education context, and therefore create the possibility for contradictory practices to be adopted. The difficulty with this is caught up in the relationship between what is taught in the teacher education classroom and what happens when the student teacher goes out into the school where a different principle of regulation operates. This is often talked about as a vision-reality or theory-practice⁶³ gap. This means identities constructed in the teacher education classroom may not survive out in practice in a real classroom, and that the past forms learnt during their own schooling may be re-established

⁶³ This is also referred to as the gap between the ‘real and ideal’ in the context of teacher education policy in SA. (See Harley et al., 2000)

once the student teacher is qualified and goes out into the field to practice. It is now necessary to consider the notion of pedagogic identity before returning to the question of selection of knowledge for teachers and teaching.

3.5 Pedagogic identity

In Bernstein's terms, pedagogic identities are 'forms of consciousness'. Any particular reform represents an *approach to regulating and managing change*, moral cultural and economic, which is expected to become the lived experiences of teachers and students, through the *shaping of consciousness* (Bernstein, 2000). For Bernstein, the power (classification) and control (framing) relations of any pedagogic practice regulate the acquisition of pedagogic identity.

Classification and framing are key concepts for Bernstein. In broad terms classification refers to the degree of boundary strength between the contents in the curriculum. It does not simply refer to *what* is to be learnt but also to the *relations* between them. "Classification refers to the nature of the differentiation between contents. Where classification is strong, contents are well insulated from one another by strong boundaries. Where classification is weak, there is reduced insulation between contents, for the boundaries between contents are weak or blurred" (Bernstein, 1977b, p. 88). However, classification strength does not only refer to the modalities of curriculum organisation (integrated/ collection codes), it is theoretically "the means by which power relations are transformed into specialised discourse" (Bernstein, 1996, p. 3). Power distributes privileged knowledge and control regulates its acquisition and change. Classification is a product of power and framing of control. Thus classification "provides us with our voice and the means of its recognition" and framing is "the means of acquiring the legitimate message" (Bernstein, 1996, p. 26).

The hidden power relations within the principle of classification leads to teachers developing loyalty to what they believe are the 'natural order' of things.

The arbitrary nature of these power relations is disguised, hidden by the principle of the classification ... (which) ... comes to have the force of the natural order and the identities that it constructs are taken as real, as authentic, as integral, as the source of integrity, of coherence of the individual" (Ibid.: p. 21).

So classification can be seen as having two functions, one external to the individual facing outwards to social order, and one that faces inwards to order within the individual. When the outwardly facing classificatory principle is changed (for example when a new curriculum is

introduced), order in society is disrupted, and “contradictions, cleavages and dilemmas, which necessarily inhere in the principle” (Ibid. p. 21) and were previously suppressed by its insulation (e.g. strong boundaries) appear. However the inward order developed under the past principle of classification, “becomes a system of psychic defence”, and changing the internal principle requires more than just a curriculum statement (e.g. NCSM) or new descriptions of the roles and competencies of a professional teacher (NSE)).

The (student) teachers’ internal ‘voice’ constructed under the old forms during their own educational career cannot simply accept and internalise the new forms without major cleavages, contradictions and dilemmas appearing within their internal psychic order – without changing their system of orientation to meaning. However, as Bernstein points out “psychic defences are rarely wholly effective and so the unthinkable, the yet to be voiced is also rarely silenced” (Ibid. p. 21). This means that it is possible to change orientations to meaning– but only if the new principle can set up new relations of internal order, that this new text can be accepted as legitimate, and that time and commitment are invested in the re-education process.

It is through the evaluative rules (rules of recognition and realisation) that specific pedagogic knowledge and practices are constituted as legitimate in practice and orientations to meaning are acquired. Briefly, *recognition rules* are the criteria (special relationships) for making distinctions, for distinguishing the speciality of a thing/ a practice/ a specialisation/ a context, what makes it what it is. They are principles for recognising the ‘legitimate text’, the voice to be acquired, and are determined by the classification principle at work (relations between different knowledge discourses and practices). *Realisation rules* are the means for creating and producing the special relationships internal to what is recognised as the ‘legitimate text’ i.e. the means for (re)producing/ creating the speciality in practice. These are connected to the framing principle, the *relations within* the specialised practice and hence the production of messages. Thus evaluative rules are concerned with recognising what counts as valid acquisition of instructional (curricular content and practices) and regulative (social conduct, character and manner) texts and for realising this (being able to (re)produce them in practice). It is through principles of evaluation that the ‘legitimate text’ is recognised and realised – the meaning of the pedagogic device is therefore condensed in the evaluative rules (Ibid. p. 50).

The selections of knowledge(s), performances and practices and their evaluation rules relay a particular social order and way (mode) of knowing and being, whether explicitly or tacitly. The acquisition of the specialised consciousness produces particular *orientations to meaning* –

ways of recognising and realising what is constituted as the 'legitimate text'. Educational reforms require changes in these orientations and in the recognition and realisation rules of the pedagogic practice and therefore can be seen as "the outcome of the struggle to produce and institutionalise particular identities" (Bernstein, 2000, p. 66)

For Bernstein (Ibid.) local identities are social identities – constructed through social location – and these vary with age, gender, social class, occupational field and economic and symbolic control. They are not necessarily stable positions and shifts can be expected in the discursive and economic base of the identity. This fits with Castells' (1997, p. 8) concept of identity: "no identity can be an essence, and no identity has, per se, progressive or regressive value outside its historical context". For Castells identity is a source of individual meaning and experience that should be distinguished from social 'roles'. Roles are defined by norms structured by the institutions and organisations of society, whereas identities are sources of meaning for the actor, constructed through a process of individualisation. Identities organise meaning while roles organise functions. Meaning is the symbolic identification by social actors of the purpose of their actions.

In the context of teacher education research related to the roles described in the NSE, Harley et al. (2000), observed a selection of successful teachers to see how examples of their 'best practice' fitted with the roles described in policy. They suggest, following Hoyle, that the NSE provides an image of teachers as 'extended professionals'⁶⁴, whereas in practice, even 'good' teachers are observed as only engaging in a form of 'restricted professionalism'. In terms of the NSE, they found that the 'good' teachers had strong foundational and practical competences, but that their reflexive competences were more weakly developed. In considering the 'ideal' images of teachers projected from NSE policy through the roles as compared with the 'real' contexts of teachers working in schools, they recognised that 'good' teachers had "something extra" (Ibid. p. 74). They relate this to Bernstein's notion of 'achieved status' based on interpersonal control relationships rather than 'ascribed status' based on positional control. From this perspective, it would be impossible to imagine that every teacher could 'perform' every role, that interpersonal control relationships could be disaggregated into criteria-based descriptions of discrete roles. While the roles described in

⁶⁴ According to Hoyle (1980) extended professionals locate their work in a broader context, collaborating with other teachers and comparing their own work against the work of others. They systematically evaluate their teaching and work and commit themselves to improvement on the basis of research and self-evaluation. On the other hand, restricted professionals focus more narrowly on classroom-based work. Their thinking is rooted in experience rather than theory and research. They value their classroom privacy and are reluctant to compare their work or collaborate with others, and their sense of responsibility is restricted to the academic curriculum.

policy may provide a symbolic image of an ideal, this ideal cannot be ascribed to individual teachers, and would possibly include all the functions of a school, rather than those of an individual teacher. This evokes Castells' (1997) argument that roles are functions of an organisation or institution and not individual attributes. From this point of view, the roles of a teacher described in the NSE can be thought of in terms of the functions of a school that different teachers carry out to a greater or lesser extent depending on their position and occupational function in the school.

This helps point to the difference between an *official* pedagogic identity and a *local* pedagogic identity of a teacher. The official pedagogic identity is constructed through descriptions of what 'ought to be' based on particular projections (or images) by institutions of the roles, knowledge codes and social modes individuals ought to take up (official knowledge). Local pedagogic identity is constructed socially in local educational and historical contexts. Thus while official teacher identities can be designed on the basis of 'teacher roles', local teacher identities cannot. As Graven (2002b) suggests, teacher identities emerge, enabled or constrained, within the pedagogic context. In times of change, teachers are required to acquire the recognition and realisation rules that will support the specialisation of their local identity in these new images. That is, to be socialised into the new identities – to integrate the new roles into their social contexts of knowing and doing, of practice and being.

Bernstein (1996: 73) explains that teacher identity emerges from the

dynamic interface between individual careers and the social or collective base ... [I]dentity arises out of a particular social order, through relations which the identity enters into with other identities of reciprocal recognition, support, mutual legitimisation and finally through negotiated collective purpose.

In this case, the career of a student teacher is a "knowledge career, a moral career and a locational career" (Bernstein, 2000:66). From this point of view, identity is embedded in the social practices of a community. In this understanding local pedagogic identities are not simply individual (psychological or cognitive) attributes, neither are they merely constructed politically or as a result of a curriculum prescription, they are constructed through an interplay of the 'voice-message' system (Bernstein, 1996), an interplay between official and local knowledge and practices within an educational community. Thus in teacher education, 'legitimate' texts (e.g. what are accepted as 'good' mathematics practices or as 'good' mathematics teaching practices) are constructed through a relay between transmitters (specialists in the field of teacher education/ education who already hold the criteria) and acquirers (novice teachers) within an educational, social, economic and historical context.

Individual pedagogic identities are constructed both inwardly and outwardly. The introjected identity faces inwardly and is most often related to the acquisition of stable inner loyalties related to esoteric forms of thinking and doing, for example, working in principled ways with disciplinary knowledge, or developing a therapeutic identity related to notions of child development and internal, or sacred, religious and cultural values. The projected identity faces outwardly and is most often related to external demands from the state and the market for producing particular kinds of citizens, and for regulating and controlling them.

The challenge for teacher educators is to design programmes that enable the construction of introjected identities leading to ‘good’ mathematics and ‘good’ mathematics teaching practices. That this occurs within economic constraints and a competitive environment of the HE sector is clearly one limiting factor in any specific choice. A further factor would be the need to balance this with projected identities that meet (at least some) of the transformational ideals of the state. In our context this includes an imperative to provide access to ‘powerful’ mathematics to a wider range of South African students. However, what is meant by ‘good’ and ‘powerful’ will always be relative to the ideology structuring the context, and thus we could find variations across the field of MTE practice. To recognise that there is an ideological bias that is inevitable within this construction and to consciously choose it is a challenge for teacher educators and academics involved. It requires teacher educators’ own reflexive competence to be highly developed and to have access to the field of knowledge production which underpins their work.

To summarise, in this research project I am interested in the pedagogic identity of initial **mathematics** teachers: here the ‘roles’ are the norms identified in the NSE or implied in the NCSM – they are descriptions of functions and the expectations of ‘ideal’ teachers in fulfilling these functions. These descriptions, officially projected, are expected to become the basis for internal pedagogic identity construction of mathematics teachers. Official pedagogic identities projected from policy produced within the ORF are underpinned by the ‘bias and focus’ the post-apartheid state. HEIs providing teacher education may be expected to institutionalise these identities. However in the field of teacher education in SA, where the HEIs have the responsibility to design the specific curricula for the acquisition of these pedagogic identities, state projections may not be uniformly taken up. These institutions will themselves project ‘institutional pedagogic identities’ that may or may not be in line with what is projected by the state, and in the new global economy, may be more determined by economic principles than

esoteric or therapeutic principles. This is particularly so in the context of local and global competition for funding for both students and research in the networked society and the new knowledge economy.

3.6 Vertical and horizontal knowledge discourses

Earlier, in Section 3.1 it was suggested that teachers require access to a number of different forms of knowledge and practices (e.g., academic/principled knowledge, professional and official knowledge, and practical wisdom and craft knowledge). In Chapter 2 the issue of teacher knowledge was also raised and we saw how in different work attempts were made to name different types of specialist knowledge (e.g. subject content knowledge, pedagogic content knowledge, conceptual-knowledge-in-practice, mathematics for teaching, etc.). One of the central problems for teacher education in SA, and elsewhere, is what to select into a teacher education programme and how to make it accessible so that it makes a difference to the work of teaching (see for example, Adler & Reed, 2002; Ensor, 2000, 2001, 2003; Graven, 2005). Bernstein's discussion of the internal organisation of different knowledge discourses is useful for theorising this issue.

While Bernstein's major focus was on pedagogic communication and the structure of pedagogic discourse that could determine who (which social groups) get access to different forms of knowledge within an educational context, in his later work he also became interested in the knowledge forms themselves. He acknowledged that sociological investigation traditionally would not concern itself with the contents of a specific field and would rather focus on the activity of the field, and that a focus on the internal specialised structure of the discourse could be described in Bourdieu's terms as "an incorrigible proposition". He quotes Bourdieu to summarise this view:

Symbolic power does not reside in symbolic systems in the form of an 'illocutionary' force but that it is defined in and by a determinate relationship between those who exercise this power and those who undergo it, that is to say, in the very structure of the field in which belief is produced and reproduced. What makes the power of words to command and order the world is the belief in the legitimacy of the words and of him (*sic*) who utters them, a belief which words themselves cannot produce. (Bourdieu, 1977 p. 177, quoted in Bernstein, 1996, p. 170)

In his earlier work, Bernstein had focussed on the pedagogic transformation of various discourses without concern for the internal structure of the discourses themselves. However he became concerned that the *forms* of the discourse, that is their internal principles and construction and their social basis, were taken for granted in his work and were not analysed sufficiently (Bernstein, 1999). That is, there was no analysis of the discourses that were subject to pedagogic transformation. He wondered if it was always appropriate to dispense

with the ‘symbolic system’ as Bourdieu suggested, and whether the internal structure of such systems always had “no structuring significance” (Bernstein, 1996, p. 170). In particular he was concerned with the differences between everyday local knowledge (horizontal discourses) and academic knowledge (vertical discourses), which he argued display very different structural features and forms of organisation. This concern was related to contemporary ‘progressive’ moves in pedagogy where everyday knowledge (local knowledge) was being recruited into school teaching (particularly in mathematics) in order to provide wider access to all. Bernstein warned,

[a]s part of the move to make specialised knowledges more accessible to the young, segments of horizontal discourse are recontextualised and inserted in the contents of school mathematics. However, such recontextualisation does not necessarily lead to more effective acquisition [...] A segmental competence, or segmental literacy, acquired through horizontal discourse, may not activate in its official recontextualising as part of a vertical discourse, for space, time, disposition and social relevance have all changed. (1999, p. 169)

Bernstein (1999) acknowledged that these two discourses are spoken about in different ways in the literature. For example, Durkhiem speaks of the sacred and profane (or the esoteric and mundane), Bourdieu speaks of symbolic and practical mastery; Habbermas of instrumental rationality and life-worlds (individual), and Giddens speaks of expert-systems (disembedded from the local) and the local experiential world. In each case these dichotomies set up pairs of oppositions which take up stereotypical forms (e.g. school(ed) knowledge as opposed to everyday common sense knowledge, or, official knowledge as opposed to local knowledge). Bernstein coins the terms vertical and horizontal discourses to signal that his interest is in distinguishing something about their internal structure, where other authors do not consider this. Also, Bernstein’s model provides a greater range of possibilities and so while it seems that he is creating a dichotomy, his theory creates the possibility of different distinctions. A summary of the two discourses as discussed by Bernstein is given in Figure 4 below. While this work was left incomplete, it sparked debates about the problem of ‘voice discourses’ and ‘knowledge’ as a category in its own right, in the curriculum (for example, Maton, 2000; Moore & Muller, 1999; Moore & Young, 2001; Young, 2000). It also generated much debate in the South African context, particularly in relation to the implementation of Curriculum 2005 which attempted to implement a radical integration of everyday and school knowledge in order to make specialised knowledge relevant and more accessible to all. It was argued that this had the possibility of undermining access to school knowledge, particularly if teachers did not have a sensitivity to the differences between these forms (Taylor, 1999). The review of Curriculum 2005 (DoE, 2000d) drew on Bernstein’s distinction to argue that it privileged horizontal sense making at the expense of vertical progression and thus disrupted access to

specialised academic knowledge. The revised national curriculum statements which replaced C 2005 attempted to rectify this problem.

	Horizontal discourses	Vertical discourses
Description	Everyday (common sense) knowledge	Coherent, explicit and systematically principled structure, hierarchically organised (as in science) or Specialised languages (as in the social sciences)
Characteristics of discourses	Oral, local, context dependent, specific, tacit, multi-layered, contradictory across contexts (e.g. different practice and knowledge about the same thing), but not contradictory within contexts, and segmentally organised.	Expert, official, principled, explicit, recontextualisation in different contexts, and either hierarchically or horizontally organised
Organisation	Little systematic organising principles	Systematic and principled
Circulation	Social practices	Explicit recontextualisation on evaluation
Evaluation	Spontaneous evaluation	Contrived
Recontextualising principles	Tacit	Explicit
Distributive rules	Status/ position/ social relations and practices/ contexts	Strong distributive procedures based on objective epistemology
Pedagogic control	Segmented	Institutional

Figure 4: A comparison of Vertical and Horizontal discourses following Bernstein (1999)

What is signalled in Figure 4 is that these two discourses are very different in origin and form. Some authors argue that they are incommensurable (e.g. Ensor & Galant, 2005; Muller, 2000). Nevertheless, as Davis (2005) points out, there is a persistent belief that integrating the everyday and the academic is productive for making knowledge accessible and relevant, particularly in the field of mathematics education and MTE. I will not rehearse these arguments here, but what is suggested by Davis' work and that of some others (e.g. Dowling, 1998) is that if forms of local knowledge are incorporated into the academic, it is generally "a sham: either a host of strategies enabling teachers (and authors of curriculum materials) to prioritise the academic at the expense of the everyday can be detected [...], or teaching and learning fail" (Ibid., p. 20). This issue will be returned to later in the chapter and again in Chapter 4.

The point of the above is that everyday localised experiences and forms of strategic knowledge or commonsense developed in practice, while circulating through various social practices and within different social groups, do not provide direct access to academic or systematic codified knowledge forms. In the context of schooling forms of horizontal

knowledge may be important to utilise in order to enable learners to relate to more esoteric knowledge forms, and so provide entry points into principled knowledge. That is, enable learners to recognise themselves in these forms of knowledge and not be alienated. What is critical is that teachers become sensitive to the differences in these forms of knowledge and are able to use strategies in their practices which would enable their learners to access principled or systematic knowledge. It also raises the question of how these forms of knowledge are implicated in the teacher education curriculum, and in particular how various forms of academic, official, professional, practical and expressive knowledge (vertical discourses) are developed with reference to localised practice orientated strategic classroom know-how (horizontal discourses). Before considering this question, I will elaborate a little further on Bernstein's description of horizontal and vertical discourses summarised in Figure 4.

In Bernstein's terms we find that horizontal discourses are local and segmental in their organisation, that is, each aspect is complete in-and-of itself and dependent on the local context in which it 'lives'. It is mostly acquired tacitly within the social practice that produces it and is evaluated spontaneously in the practice as it is being acquired. An example of a truly horizontal discourse would be knowledge of table manners in a particular household. The way the table is set, what implements are used, what is polite or not polite within that context, and so on. Table manners are, in the main, learnt tacitly over time and all members of the household become aware of the rules and in strongly framed contexts they are evaluated on the spot if they transgress. So in an upper-class English household young children learn which fork to use for which dish through observation and being admonished for bad table manners. They may learn never to speak at the table, and to always use a serviette. Once the members of the household have been socialised into these habits there is nothing else to learn – it is complete. The *segmental* nature of the discourse is such that it is complete in-and-of itself, it is localised to that specific household (or culture) and completely different table manner discourses would be produced in different social contexts and have no effect on the practice of this local context at all. The discourse itself is naturalised into the 'way we do it' and no one would question this behaviour or attempt to change it. Members of the household only become aware that there are other discourses operating in different social contexts if they find themselves mixing with different social groups (classes or cultures) in different settings.

It is quite conceivable that there are aspects incorporated into teacher education curricula which may be very 'close' to this type of discourse – particularly aspects that are experiential,

practice oriented and developed under the guidance of a practicing teacher who has her way of doing things based on years of experience. Or aspects of 'methods' courses where what is learnt are 'tips' for teachers that come directly from the experience of the teacher educator ('I do 'this' when I teach 'that' and I find it very useful, try it out') (Also see Ensor, 2003). However, while aspects of horizontal discourse may appear at times in the teacher education programme, particularly those aspects that are directly connected to practice, the programme would also generally draw a variety of vertical discourses into its curriculum. What are of interest are not only the pure academic discourses that may be drawn in, but also the forms of practice (craft) and expressive (art/ drama) knowledge that could form part of a teacher education programme.

Vertical discourses 'live' in communities of experts and specialists and are of a distinctly different nature to horizontal discourses, particularly with respect to their internal knowledge structures. For Bernstein vertical discourses are divided into two types – those with hierarchical and those with horizontal knowledge structures⁶⁵. What is common between these vertical discourses is that they are both systematic and principled. However there are internal differences. A vertical discourse with a hierarchical knowledge structure is described by Bernstein as a form

of knowledge [that] attempts to create very general propositions and theories, which integrates knowledge at lower levels, and in this way shows underlying uniformities across an expanding range of apparently different phenomena [...] motivated towards greater and greater integrating propositions, operating at more and more abstract levels. (Bernstein, 2000, p. 161)

Thus in hierarchical knowledge structures, development of knowledge is seen as production of theory which is more general, more integrating than previous theory, and therefore based on integrating codes.

On the other hand, a horizontal knowledge structure,

consists of a series of specialised languages, with specialised modes of interrogation and criteria for the construction and circulation of texts [...] Thus in the case of [...] Sociology, on which we shall focus, the languages refer for example to functionalism, post-structuralism, post-modernism, Marxism, etc. The latter are the broad linguistic categories and within them are the idiolects (theories) of particular favoured or originating speakers. (Ibid., pp. 161 - 162)

Thus horizontal knowledge structures are based upon collection or serial codes and development and development consists of the accumulation of languages.

⁶⁵ This language does lead to problems and confusion. Horizontally structured vertical discourses are different from horizontal discourses (everyday local knowledge), although some may be very close in terms of their recontextualizing principles. For example many forms of craft knowledge are acquired tacitly rather than explicitly.

Bernstein introduces the notion of strong and weak grammars to distinguish between different vertical discourses with horizontal knowledge structures. He suggests that one of the difficulties of acquiring a horizontal knowledge structure is the wide range of languages that have to be coordinated, each with its own procedures, terms, and meanings. Introducing the idea of a grammar, enables him to distinguish between horizontal knowledge structures whose serial languages have “explicit conceptual syntax capable of relatively precise empirical descriptions and/or of generating formal modelling of empirical relations, from those languages where these powers are much weaker” (Ibid., p. 163). He identifies mathematics as having a horizontal knowledge structure possessing one of the strongest grammars, while sociology would be considered as having a weak grammar.

Teacher education is a complex domain and any specific programme would potentially involve variety of different forms of knowledge discourses, some vertical with different internal knowledge structures and grammars, and others true horizontal discourses. In the context of MTE, access to a range of specialised knowledge discourses would have to be provided, including access to: the discipline of mathematics, a vertical discourse with a horizontal knowledge structure and a very strong grammar; the field of mathematics education research, also consisting of a vertical discourse with a horizontal knowledge structure, but with a much weaker grammar; and knowledge from-and-in mathematics teaching, part of which may be codified and therefore also be of the same type, but with an even weaker grammar, while part may consist of experiential knowledge developed in a localised segmental horizontal discourse. While Bernstein’s thesis is underdeveloped, it does signal an important issue that teacher education needs to take into account, and which later I will draw on to produce a model for considering specialised knowledge within a teacher education curriculum in this research project.

A central concern of this research project is an attempt to understand how pedagogic discourses for MTE are being constituted across the HE field in South Africa and through the different fields/ arenas of the pedagogic device, in particular in the ORF and in the university sector (UPRF). The purpose is not to attempt to evaluate any particular formation, but rather consider what we can learn from the way the field has been constituted since the publication of the NSE to advance the field of MTE. That is, to learn from the real rather than supposing that the ideal⁶⁶ would ever be instituted in practice. In this section I have discussed a number of

⁶⁶ Real and ideal are used in here the same sense as described in Harley et al. (2000)

conceptual/ theoretical resources from Bernstein's work which will form some of the central theoretical referents for this research project as it unfolds.

At this point I return to focus on the South African teacher education context. In the preceding section I had given an account of the changing terrain and indicated that together with the structural transformation of the system there were policy changes that were significant for the development of curricula in teacher education. In the next section I return to that discussion and use the theoretical ideas presented here to provide an analysis of the regulatory context of teacher education and the opening of pedagogic spaces for the production of curricula and criteria for specialising the consciousness and conscience of teachers within the transformed institutional context.

4 Regulation of teacher education in SA

As indicated in Section 2 of this chapter, HEIs in South Africa have been given greater responsibilities for teacher education as a consequence of post-apartheid transformation initiatives. In Bernstein's terms, teacher education under apartheid operated largely within the field of reproduction under the control of apartheid state education departments, that is, largely within the OPRF. There were major differences in quality of provision across the system, it was "a segregated, fragmented, authoritarian, and dangerously unequal and inefficient education system" (Welch, 2002, pp. 22 - 23). During that time possibilities for systematic intellectual growth and the development of research-based specialist knowledge, practices and identities for teacher educators and teachers were severely limited. Generally, within the colleges, research was not highly valued, practical experience in schools and subject knowledge and pedagogic knowledge relevant to the delivery of the school curriculum were most valued, and pedagogic discourse was filtered through an ideological screen structured by the philosophy of fundamental pedagogics.

By 2001, the new state had restructured the teacher education landscape, the college sector had been incorporated into the HE system and teacher educators and the public HEIs had been repositioned. Within the new system, HEI's were now responsible for all formal teacher education qualifications for all phases of the schooling system. They had become the principle 'providers' of public teacher education responsible for the 'delivery' of in-service and pre-service qualifications which would be funded through subsidies from the national DoE. In terms of the discussion in Chapter 2, the structural transformation resulted in the 'universitisation' of public teacher education in SA. However, what has not been revealed is

the extent to which this system maintained single purpose teacher education campuses as separate divisions, geographically (and epistemologically) separated from the general campuses of the university. This question will be returned to later in Chapter 5 where a survey of the field of initial MTE provision and curricula is presented.

HEIs as relatively autonomous from the state and operating under their own Acts had to negotiate this change in function. There were major issues related to the incorporation of the colleges and particularly to the lack of funding provided for this take-over of function from the colleges which had various negative effects on the system. I will not be examining these issues here. My focus in this chapter is on issues relating to the control of the pedagogic device and the possible pedagogic spaces opened/ closed for HEIs to insert their bias and focus into teacher education within the new regulatory environment.

What is clear at this stage is that the changes in the institutional landscape simultaneously positioned teacher educators as curriculum designers, teacher education ‘providers’ and knowledge producers. This potentially placed them in the UPRF, in a position to exercise power and to redefine knowledge and practices for the education of teachers, and in particular, to re-insert disciplined and disciplinary inquiry into teacher preparation programmes. At the same time however, teacher educators were also positioned as practicing academics within the field of production, under significant pressure along with the rest of HE academics, to ‘publish or perish’. It is noted that this dual positioning and the tensions it creates could have a consequence of pushing activity away from the serious investment needed in curriculum development for productive teacher education curricula to flourish. On the other hand, it could just as easily enhance teacher education, particularly if education and teacher education were to develop as serious research domains⁶⁷ in university faculties/ schools of education and be used to inform the development of curricula and pedagogic practice. How the tensions between these activities are balanced at the institutional level will have effects on the quality of teacher education provided across the system. It is also of significance that the structural transformation opened a further space by creating the possibility for initial teachers to be educated in a general university environment within a range of academic departments (that is, not only academics located in education schools or faculties) and created the potential to reposition other university academics (e.g. mathematicians) in relation to teacher education. It thus created the possibility, in MTE, for the development of new and productive relationships,

⁶⁷ It is noted here that the NSE specifically places research in teacher education on the agenda and requests providers to use research as a basis for developing their curricula (e.g. see DoE, 2000c, p. 9).

in both economic and educational terms, between mathematicians and mathematics teacher educators, and between the discipline of mathematics as practiced at higher levels and mathematics education. Whether and how these spaces have been recognised and realised within the reform context is still to be explored.

The de-location and re-location of teacher education by the SA state therefore opened up the possibility for the weakening of state control over teacher education curricula, and hence control over what counts as legitimate knowledge for teachers and teaching. While potential spaces appear to be opened by these structural re-arrangements, autonomy to engage this space is always relative (Bernstein 1996, Apple 2002). In particular, while a re-emphasis on disciplinary knowledge and research-based practices might be recognised within the sector, the dominance of the social logic of competence in education (Bernstein, 1996), reflected in various education policies and the implementation of the NQF and curriculum policy for schools, creates contradictions for its realisation. In addition the increased regulation of teacher education qualifications through the NSE and Criteria may be seen as a constraint to autonomy within the sector.

In the following sections I illuminate the space created by this structural transformation by considering the nature of state regulation of teacher education that developed within the reform climate.

4.1 A new system of qualifications: their regulation and quality assurance

In Section 2 of this Chapter, we saw that the dramatic rationalisation in the provision of teacher education and the shift of responsibility for provision of all state funded teacher education to Universities, followed extensive post apartheid education policy developments. These reflect a change to a competence based education and training system for the country, the blurring of boundaries between formal education and work-based training, the introduction of a National Qualification Framework (NQF) for all levels in the system, and an elaborate system of governance through setting up of a range of *different* (mostly independent statutory) bodies to register, accredit, fund, and quality assure education qualifications, through different processes (see Parker, 2003a). The DoE, as the major employer, has the statutory responsibility to regulate the development of new qualifications for teachers employed in public schooling under the Employment of Educators Act of 1998 (DoE, 1998a).

In January 2001 when the colleges were physically incorporated into the various HEIs, new regulations for teacher education qualifications, specifically the NSE (DoE, 2000c) and the Criteria (DoE, 2000a) were in place. In terms of this policy, if HEIs wanted their qualifications to be funded and recognised for employment in public education, they had to respond to various requirements. The DoE provided the guidelines for a framework of qualifications and for generating curricula for teachers through the NSE. Once designed all new qualifications and their curricula had to be taken through a series of complex bureaucratic processes that involved registration on the NQF through SAQA, accreditation through the Council for Higher Education (CHE), a body constituted under the HE Act, and funding through the DoE (DoE, 2000c). Further, they had to be submitted to the DoE to be evaluation for purposes of recognition for employment in public education (DoE, 2000a). The splitting of responsibility for these various functions created a vacuum in decision making and this, exacerbated by lack of capacity within the system, produced contradictory and confusing interpretations of HE policy and responsibilities. This coupled with the structural re-positioning discussed earlier created further opportunities for teacher educators to exercise increased autonomy. Of course this does not mean they have taken up these opportunities. Authoritarian systems in operation in the past and overly bureaucratic responses to regulation and quality assurance may have led to the opposite, decreased autonomy through interpretations of policy that limit possibilities for action.

The professional body for teacher education, the South African Council for Educators (SACE), unlike councils for other professions such as Engineering, Accounting or Medicine, does not regulate and quality assure the development of HE qualifications for professional employment in public schooling. According to the NSE, quality assurance measures for teacher education qualifications, would “be put in place by SAQA, the Council for Higher Education and its Higher Education Quality Committee, and/ or the relevant Sector Education and Training Authority” (DoE, 2000c, p. 30). This reflects the split responsibilities and the confusion over who had responsibility for this function.

In 2005, the CHE began a quality assurance review of teacher education qualifications and their associated programmes or curricula. Some critics saw these developments as part of wider moves towards increasing state control over HE (for example, see Jansen, 2004). However, rather than being seen as constraining moves by the DoE and the state, these developments could be seen as proactive moves by the ‘relatively independent’ CHE to assure quality in the HE system and weed out opportunistic programmes of low quality. In the face of

the proliferation of qualifications and the absence of clarity over which body was ultimately responsible for quality assurance in HE, the CHE proactively entered into memorandums of agreement with various stakeholders in the different fields of learning to set up mechanisms for quality assurance (DoE & DoL, 2003)⁶⁸.

The Higher Education Quality Council (HEQC) of the CHE began their work through a re-accreditation process focused on the provision of Master in Business Administration programmes offered through the various universities in 2004. Teacher education followed, beginning with the Master in Education programmes in 2005 and followed by the B.Ed, PGCE and Advanced Diploma in Education (ACE) in 2006 and 2007. For the teacher education review they recruited personnel from faculties and schools of education within the HEIs to assist with the production of criteria for quality assurance. Thus the criteria on which the re-accreditation of a programme leading to a qualification in education would be confirmed, conditionally accepted or denied were produced, not by agents working in the direct interest of the state, but by teacher education academics positioned as they now were within HEIs. The process therefore included teacher educators who had been involved with the development of curricula and teaching of programmes that would be evaluated. The process was implemented through teams of recognised education academics, supported by members of the HEQC, that is, through a peer review process. While an analysis of the re-accreditation process and its effectiveness as a quality assurance mechanism for the system would be fascinating, I do not consider this here. My only point in referring to the process is to emphasise that quality assurance of teacher education programmes did not fall to the DoE, that is, it was not controlled within the ORF/ OPRF. The UPRF exercised considerable power within this process. Also that the process was carried out through a peer review system involving teacher educators from HE, meant it was not significantly influenced by other stakeholder bodies, professional bodies, teacher unions or government agents. Thus teacher educators and HEIs had significant control over these processes.

Together the elaborate policy and governance system and the move to set up quality assurance mechanisms through the HEQC may seem, at first appearance, to reduce possibilities for autonomy in teacher education and constitute curtailment of academic freedom in HEIs. In the following section I analyse the policy which frames the production of teacher education

⁶⁸ In terms of the resolution of this responsibility, it is only recently that the CHE has been assigned the responsibility for quality assurance and standard setting for all higher education qualifications and programmes, as had been proposed in the NQF review (DoE & DoL, 2003). The draft bill is now out for comment (January 2008) and is due to be finalized and published in a government gazette soon.

qualifications in general and with respect to specialist mathematics teaching in particular. I show that what appears to be strong regulation over the production of curricula, may be better understood as an open pedagogic space providing possibilities for productively claiming control over curricula for teacher education. In particular I argue that in the reform climate, opportunities for teacher educators to provide strong foundations for beginning teachers to develop internal loyalty to specialist (mathematics, mathematics education and mathematics teaching) discourses, and access to alternative education discourses (like philosophy and sociology of education) which might equip them to become critically aware of the forces that structure their professional re-formation (in the new order of things), are opened up. I also argue that if teacher educators take these opportunities they could counter the tendency for the study and teaching of education to operate in the realm of what Harley and Wedekind (2003), following Durkheim, call ‘mythological’ rather than ‘scientific’ truth.

4.2 Teacher education under the 2000 Norms and Standards for Educators Policy

The NSE policy,

describes the roles, their associated set of *applied* competence (norms) and qualifications (standards). It also establishes key strategic objectives for the development of learning programmes, qualifications and standards for educators. These norms and standards provide a basis for providers to develop programmes and qualifications that will be recognised by the Department of Education for purposes of employment. This policy on Norms and Standards for Educators needs to be informed by continued research, and provides a focus for that research. (Italics in original, DoE, 2000c, p. 9)

The NSE provides, through its description, a general direction for the development of teacher education curricula. There is a commitment to the general regulative discourse of the state, most visible in the description of the ‘Community, citizenship and pastoral role’, where the

educator will practice and promote a critical, committed and ethical attitude towards developing a sense of respect and responsibility towards others [and] uphold the constitution and promote democratic values and practices in schools and society [...] will develop supportive relations with parents and other key persons and organisations based on critical understanding of community and environmental development issues (Ibid. p. 14).

While “providers have the freedom and responsibility to design their learning programmes in any way that leads learners to the successful achievement of the outcomes as represented in their associated criteria” (Ibid. p. 12), it is clearly stated that the lists provided for each role are “meant to serve as a *description* of what it means to be a competent educator [and] not meant to serve as a checklist against which one assesses whether a person is competent or not” (Ibid. p. 13, italics in original). Indeed these descriptions are general enough to cover all specialisations, even though all qualifications “must be designed around the specialist role as this encapsulates the ‘purpose’” (Ibid. p. 12).

For the specialist role the FET teacher:

will be *well grounded* in the knowledge, skills, values, principles, methods and procedures *relevant* to the discipline, subject, learning area, phase of study or professional or occupational practice [and] will know about different approaches to teaching and learning [...] and how these may be used in ways which are *appropriate* to the learners context. The educator will have a well developed understanding of the knowledge *appropriate* to the specialism. (Ibid. p.14, italics added for emphasis)

A list of 17 competences is given for this role. For example, under practical competences, teachers must be skilled at “Selecting, sequencing and pacing content *in a manner appropriate* to the phase/ subject/ learning area” (Ibid. p. 21, italics added for emphasis).

This indicates in fairly clear terms that the lists do not specify criteria: they are ‘place holders’ for criteria yet to be designed, necessarily empty because they cover all specialisations, broad enough to give direction for the intended pedagogic discourse without giving any substantive details. Competences are mostly described in generic language, focusing on specialisations that are not specified, relying on words such as ‘appropriate’, ‘relevant’ and ‘effective’. As such they are *rubber sheet* descriptions that can take on *any* meaning. They have “at their heart an emptiness” which makes the notion of ‘competent teacher’ self-referential (Bernstein, 2000, p. 57).

In an analysis of the technical report that formed the basis for the NSE, Shalem and Slonismky (Shalem & Slonimsky, 1999) critically examine the idea that ‘criteria’ for ‘good teaching’ can be prescribed. They challenge some taken-for-granted assumptions or misconceptions about the way criteria can provide epistemological access to good teaching. They use this conception to show that the provision of lists of criteria by the state cannot create consensus on what counts as good practice and is unlikely to position all South African educators as members of a common culture of teacher education.

While Shalem and Slonismky wrongly assume that the criteria listed in the NSE are written for, and would be used by teachers to help realise good practice, their examples are useful since they rightly point out that there are a complex set of meanings that constitute the notions ‘education’ and ‘teaching’. What counts as ‘good’ or ‘appropriate’ education and teaching practice has given rise to long and heated debates based in different schools of thought, so it is very doubtful whether it is possible to get all educators to agree about the content of teaching and ethical and politically acceptable ways of teaching it. For example, even if agreement is reached in favour of ‘democratic teaching’ there could still be heated debate over the relationship between authority and participation, between personal knowledge and public

knowledge, between what is empowering and what is not, about the nature of the learner etc. They point out that while “all our knowledge, everything we assert or question (or doubt or wonder about ...) is governed [...] by criteria” (Ibid. p. 19), we cannot grasp the object by being told about it. Their central argument is that the ‘internal goods’ of a practice cannot be described by giving lists of criteria, no matter how detailed.

For Shalem and Slonismky, inscribing and legislating criteria, through describing roles and competences, as a way of defining what good teaching is, “carries the danger of promoting facile forms of ventriloquism, more so for the not yet competent educator” (Ibid. p. 27). Thus they suggest enabling access to criteria of good practice is a pedagogical problem not a regulatory one. That is, it is the work of teacher education and cannot be expected to happen on the basis of the provision of lists. Defining the internal goods of ‘good’ teaching must be related to the evaluation criteria (rules of recognition and realisation) for the legitimate text related to a particular practice.

The NSE can be interpreted as a policy for knowledgeable teacher education specialists to use to provide a broad framework within which they would generate their teacher education curricula, and not as a prescription of what should be in their programme. It seems clear that the lists of ‘empty’ criteria in the NSE give no guarantee of the outcomes. However this is the challenge for teacher education. The criteria are open to interpretation and, indeed, the way the NSE is formulated in its final version, suggests that teacher education providers are expected produce (generate) meaningful criteria for their teacher education programmes and that these should be purposeful, specialised and based on research (DoE, 2000a; Asmal, 2001). It is this openness that has enabled the HEQC to use teacher education experts to develop specific criteria and standards for quality assurance within the framework provided by the NSE. It is also this openness that has enabled, as will be shown in Chapter 5, HEIs to produce different curricula for their contexts.

It is important to recognise the NSE as symbolic policy rather than as a ‘generic’ curriculum statement. While it provides strong direction, as will be shown in Chapter 4, particularly with respect to a general regulative discourse that would be in line with the new constitution and human rights culture the state hopes will be instituted widely through the education system to support the new democracy, it leaves open the substantive realisation of the curriculum to the providers themselves. Thus, while it may seem that teacher education is heavily regulated by the state through the NSE, and that a competence-based, integrated curriculum focused on

generic skills for teacher education is being imposed, this is not the case. The curriculum for specialised teacher education is not prescribed: it is open to interpretation and generation by relatively autonomous agents, i.e. teacher educators located in HEIs. That this space is not well recognised and that the policy is interpreted as prescriptive may well have occurred across the field. There is no guarantee that teacher educators within the system have well enough developed specialised identities for productively producing criteria for their programmes and taking up the pedagogic challenge of enabling access to these.

4.3 The specialist role and subject knowledge

With reference to initial qualifications for FET mathematics teachers, the policy does not prescribe what ought to be taught, how it ought to be taught, or what “the disciplinary basis of content knowledge, methodology and relevant pedagogic theory” (DoE, 2000c, p. 28) is in substantive terms. While the specialist role is marked out as “the overarching role into which the other roles are integrated, and in which competence is ultimately assessed” (Ibid. p. 12), there is no indication of how this integration should take place or how competence should be assessed. It is left up to the teacher education professionals to produce the criteria for the development of this specialisation of consciousness and to provide paths for student teachers to acquire them. While this is the case, the reform context, does create the expectation of a new regulative order. Thus teacher educators are expected to be “in the criteria”(Shalem & Slonimsky, 1999): experts in their fields, able to design the kind of curricula that will lead to the production of mathematics teachers who are able to recognise and realise a notion of ‘best’ practice appropriate for the transformed context (Ensor, 2003); competent to teach new kinds of mathematics⁶⁹ in new ways, and able to creatively select and produce the type of materials that provide learner centred activity to meaningfully mediate productive knowledge acquisition and moral development (Adler et al., 2002).

Further, teacher educators are expected to draw on expertise within their broader institutions to deliver high quality education. The former Minister of Education, Professor Kader Asmal (2001, pp. 3 - 4), emphasised this when he said:

Our greatest collective challenge is [...to...] start delivering high quality teacher education [...and institute a...] disciplinary approach [...that...] should have a beneficial impact on teachers. We know that one crucial weakness of our teachers is their lack of subject content knowledge. A solid foundation in the disciplines that underlie the school curriculum will address this weakness especially in the Further Education Band.

The implication here is that teachers should not only be taught by teacher educators who are

⁶⁹ In the case of mathematics teachers for the FET in schooling described in the NCSM. This will be discussed in more detail in the next chapter.

researching education, mathematics education and teacher education, but that they could also be taught by other academics within disciplinary departments⁷⁰.

Asmal's reference to 'quality' and 'subject content knowledge' has to be seen in relation to the National Teacher Education Audit (Hofmeyr & Hall, 1995), discussed earlier in this chapter, which highlighted the poor quality of education in the colleges, and to research into the implementation of the original version of C2005 reported in the often quoted and influential President's Education Initiative (PEI) report *Getting Learning Right* (Taylor & Vinjevold, 1999). The PEI research suggested that teachers lack subject content knowledge and that there has been too much focus on general teaching methods (such as group work) and too little on the underpinning conceptual knowledge that needs to be taught. It was suggested that teachers with *more* subject knowledge will be able to teach better, no matter what kind of teaching practice is in place, or how teachers come to know this knowledge. However, this has been contested within the mathematics education community (see, for example, Adler et al., 2002; Brodie, 2004). These debates have brought into focus questions about teacher knowledge, the relationship between mathematical knowledge and practice in mathematics teaching, and the *kind* of knowledge that teachers need for practice, within the mathematics teacher education community within SA. That these are not simply local concerns, and represent international problems in teacher education more generally, and in mathematics teacher education in particular, was established in Chapter 2.

In a "socio-cultural and political context deeply scarred by apartheid education" (Adler, 2005, p. 165), the unequal distribution of knowledge and 'ability' is starker in the field of mathematics than in most other areas of the school curriculum. The National Strategy for Mathematics and Science (DoE, 2001) highlights the dismal performance of African⁷¹ candidates and points to a context in which prospective teachers who would not normally 'make the grade' for entry into university mathematics courses become the major source of new teachers. This is a major challenge: it is not only necessary for student teachers to develop an identity as 'mathematics teacher', it is also important to develop an identity as 'able mathematics learner' of a kind of mathematics that is qualitatively different to what they may have experienced at school, or what may be traditionally offered by university mathematics

⁷⁰ The extent to which this has or has not occurred in practice will be discussed in the survey reported in Chapter 5.

⁷¹ African is the term used in the document to indicate black South Africans whose mother tongue is an African language. In 2000, only 4.1% of African candidates wrote mathematics on higher grade, and of these only 15.5% passed, compared with the national average where 50.1% of the candidates who wrote HG passed

departments (Parker, 2004a). It also points to a key problem of epistemic access to the discipline of mathematics, particularly for economically and socially disadvantaged students.

4.4 Changing spaces and challenges for mathematics teacher education

I have argued that a productive space for teacher educators and academics to control pedagogic discourse for mathematics teachers and teaching has opened up and that there is a need for establishing the criteria (or evaluative rules) for its recognition and realisation. It is important that mathematics teacher educators do take up this challenge, because if they do not, the possible consequence could be the institutionalisation of problematic, even dangerous practices in the name of reform. However the establishment of such criteria will take place in a highly contested terrain. This contestation includes competition for space in the curriculum with other demands, particularly if the NSE competences are interpreted as prescriptive and lead to a curriculum design heavy with courses meant to develop ‘generic’ knowledge/practices. The inclusion of such forms of generic knowledge can be interpreted in terms of what Ensor (2000) calls the myth of transfer. This is when policy principles are translated into descriptions of (generic) ‘best’ practice, for example, ‘learner-centred’ classrooms where the teacher is the ‘facilitator of learning’. There is an assumption that such descriptions, based as they are on images of what is ‘good’ for everyone, can be unproblematically transferred across contexts and to the teaching of specific contents. Such forms of generic knowledge and skills are often so dislocated from substantive practices that they become totally meaningless (Breier, 1998) and while learner teachers may be able to recall and list such strategies for examination purposes, they are unlikely to be able to use them for productive learning in any classroom context.

It is useful to exemplify the kinds of problematic practices that can be, and indeed have been, produced within the vision-reality gap of post-apartheid education reform which are relevant to this project. Lacking criteria for new practices being advocated by the state (such as ‘learner-centred classrooms’, or ‘activity-based learning’), teachers may opt for strategic mimicry (Mattson and Harley, 2003), or facile ventriloquism (Shalem and Slonismky, 1999). Here teachers are aware that they are expected to carry out various new roles and practices, but do not have access to the evaluative rules which enable the recognition and substantive realisation of these, and so flounder and imitate what they believe is required. Put another way, at an ideological level they have been caught into the rhetoric of outcomes-based education (OBE) and believe in the GRD that the reforms hope to achieve. They want to ‘look

modern' (Fuller, 1991) and implement these new practices, but since they are not 'in the criteria' (Shalem & Slonimsky, 1999), all they can do is mimic the images they have of these practices. This kind of interpretation is made possible by the type of 'work-shopping' that has been used by agents working in the OPRF to 'cascade' training into new practices required by the reforms of the new curriculum. For example, 'group work' becomes a place-holder for 'learner-centred teaching', and often results in vacuous activity where the teacher 'facilitates' access to what learners already know. This 'form over substance' has been seen in a number of different research projects (see, for example, Brodie, 2000; Taylor & Vinjevold, 1999), including empirical research on teachers' take-up from a professional development programme (Brodie, Lelliott and Davis, 2002) and is highlighted as a major problem in the report on the review of C2005 (DoE, 2000c). Davis (2001) accurately describes such examples as tragic-comic consequences of over-hyped policy principles.

A similar problematic practice emerges from an ideology that imagines increased access to mathematics through the idea of 'relevance' - that access to school mathematics can necessarily be achieved through links to learners' everyday knowledge. While such connections can productively create access to powerful mathematics learning, this does not necessarily occur: where the principle of integration overwhelms the mathematical purpose, everyday knowledge becomes the focus of learning to the detriment of conceptual knowledge (Adler, Pournara and Graven, 2000).

In Bernstein's terms, the latter example reflects the tendency for school mathematical knowledge to be treated as a horizontal discourse, motivated by the belief that this will provide access to mathematics for the socially and economically disadvantaged. However, as discussed in an earlier section of this chapter, everyday and academic knowledge are produced in different social contexts and are fundamentally different knowledge forms (Muller, 2000); attempts to integrate across these forms produce potentially negative consequences. These include the assumption that "the everyday experiences of all learners are the same and thus is blind to the differential distribution of different forms of experiences across different social groups" (Ensor and Galant, 2005, p. 287). It can therefore compromise vertical progression within the school curriculum for learners who do not already have access to the right type of experiences to enable the recontextualisation across the academic and the everyday to be mathematically meaningful. A radical integration of everyday and school knowledge in order to make specialised knowledge relevant and more accessible to all has the paradoxical

possibility of undermining access to school knowledge, particularly if teachers do not have a sensitivity to the differences between these forms (Taylor, 1999).

It is widely acknowledged that there is a push from within education policy more generally to embrace the local knowledge of learners (Davis, 2005; DoE, 2000d; Taylor, 1999). To simply suggest that this is wrong, and to insist that these forms of localised knowing should be excluded from the classroom would ignore contemporary society and may alienate learners whose life experiences are part of the globalised consumer-based culture. In teaching within the context, there is a need to motivate learners so as to enable them to recognise themselves within the school knowledge they are to acquire. However, in order to provide access to powerful forms of knowledge, it is important for teachers to provide systematic learning opportunities (Morrow, 2007) that will lead their learners to make distinctions, which as Muller (2000) points out is surely a major aim of education;

Splitting hairs, making a distinction where before one was not made, is the basis of knowledge. Teaching our youth how these distinctions have been made and how to make them lies at the heart of education. (p.1)

Mathematics teachers need to develop considerable skill, strategic thinking as well as learn the type of mathematical problem solving for teaching (Ball et al., 2004) that will enable them to move learners from their 'illegitimate', yet sensible and localised texts developed through their life experiences, to achieve access to intelligible, legitimate mathematical texts (concepts, specialist mathematics practices etc.).

The above discussion points to an intense political debate in education in South Africa; the push for social justice in education through attempts to make knowledge accessible and encourage the local knowledge of learners to enter into the learning context, may lead to the opposite of what is intended, that is, to reduce access to powerful forms of knowledge (Harley and Wedekind, 2004). In each of the above examples, the practices that have been implemented are not based on access to principled knowledge forms or on research of what are recognised as real practices in the field of teaching. Thus teachers do not have access to the 'inside' of the practices that would produce productive learning and enable the transformation agenda to be realised.

Lack of access to powerful forms of knowledge is a key issue underlying the poverty of mathematics education in South Africa, amongst teachers as well as pupils. That this is a product of the uneven distribution of knowledge under Apartheid is well known. The problem is that it may continue to be so in the post-apartheid order unless the space identified within

teacher education is exploited to alter these patterns of access. As will be established in the following chapter, the NCSM produces a post-apartheid image of official school mathematical knowledge that is qualitatively different from ‘traditional’ apartheid practices. What is clear from what has been presented so far, is that simply stating these new outcomes in a curriculum document cannot lead to access – access to the criteria for the realisation of these outcomes requires the production of pedagogic discourses for teachers and teaching that would enable the recognition and realisation of these new legitimate mathematics texts and mathematics teaching texts. This is the work of MTE and is a pedagogic problem that must be dealt with responsively (Slonimsky & Shalem, 2006) if the spirit of education reform is to be meaningful and productive.

5 Conclusion

I have argued that within the transformed teacher education context, relations between the HEIs and the state within the field of symbolic control create conditions for academics to position themselves to constitute pedagogic discourse relatively independently of the state. They therefore have an opportunity to design the criteria, or evaluation rules, for what could become recognised as ‘good practice’ for learning mathematics and mathematics teaching, and through their teacher education programmes provide access to these criteria. The space opened up within this reform context creates the possibility of producing teachers who can operate productively (and not cynically or through mimicry) within the education system – teachers who have access to the mathematical and educational foundations that will enable them to work within the system, supporting the general regulative discourse of the state, and yet at the same time accessing knowledge bases that become tools for critical awareness of the potentially problematic practices instituted in schools in the name of reform and social justice.

The space that is potentially the most productive for this is opened up in the NSE by the introduction of the four-year Bachelor of Education (B.Ed) degree, a qualification that integrates academic, professional and occupational aspects of learning. This programme has the potential to become the major vehicle for producing new teachers (as opposed to the degree + PGCE route) and it is here that the possibility of breaking the cycle in the poverty in (mathematics) education and teacher education lies. It is within this programme that teacher educators have the greatest opportunity to (re)construct pedagogic discourses for teachers to internalise new criteria for school mathematics teaching as well as criteria for the foundations of that knowledge. The programme provides time (four-years) for student teachers to be

engaged in new learning to specialise their pedagogic identities. A crucial struggle for control of the curriculum in teacher education is therefore around the selection of knowledge discourses made accessible to student teachers over the four years of the B.Ed programme, and how these are made available.

Competent mathematics teacher educators and mathematics academics with an interest in producing specialist mathematics teachers who can provide epistemic access to all their learners (both socially disadvantaged and advantaged) have a responsibility to contest for space and time in the curriculum, to argue for the specialised focus, to compete for resources and to project their particular ‘bias and focus’ based on research in the field (rather than on mythological truth) into the official pedagogic identities they are attempting to institutionalise. A responsibility to produce pedagogic discourses for novice teachers to navigate the acquisition of recognition and realisation rules for constituting pedagogic identities and practices that are profoundly *mathematical* (specialist). This will require clear understandings of what constitutes ‘best’ practices for their context, what *kind* of knowledge discourses and practice(s) mathematics teachers should acquire to support such practices and *how* these should be acquired.

I have shown that there is a visible increase in state regulation over qualifications for teachers. However, the standards and competencies described, including those of the specialist role (e.g. mathematics) are underspecified and open-ended. Coupled with the relocation of teacher education in HEIs, a space opens up for a productive selection and transmission of (mathematical and other) knowledge and practices for teachers and the work of teaching. I have argued that teacher education policy in South Africa, despite its heavy regulative appearance, is not prescriptive. HEIs, as providers, have the opportunity to design specialised meaningful criteria for teachers to acquire new knowledge discourses and teaching practices. Thus HEI based teacher educators and academics are powerfully positioned, to influence the selection, distribution, recontextualisation and evaluation of knowledge for mathematics teachers and teaching, and thus to insert their ‘bias and focus’ into the official knowledge and pedagogic discourses for mathematics teacher education and school mathematics practices.

However the space identified for exercising this power is fragile. Whether new teacher education programmes emphasise generic competences or the development of intrinsic subject loyalty will vary in terms of institutional providers’ available intellectual and economic resources and participation in wider struggles for control over pedagogy. Nevertheless, I have

illuminated possibilities for academics located within the HEIs to take advantage of the current situation, and so influence the knowledge careers and pedagogic identities of new (mathematics) teachers. I suspect that unless they exercise this power to project their particular ‘bias and focus’ of research-based criteria which enable the recognition and realisation of mathematically orientated practices, ‘default’ positions are likely to take hold. The proliferation of new generic forms of practice within a mythological notion of ‘relevant’ school mathematics knowledge and social justice, or, the reinforcement of old forms of consciousness created during student teachers’ prior (apartheid-based) mathematical training, could be the result. This could severely limit extended access to powerful mathematics by South African FET mathematics teachers and learners.

While the NSE is open enough to allow varied interpretations of how curricula can be designed and organised, it does however provide a fairly strong official image of a competent teacher. In addition the NCSM provides details of official knowledge and practices for school mathematics for Grades 10 – 12. In the next chapter I explore the official identities projected from the ORF through these policies. This will form the back drop for the rest of the thesis, in which I consider how two HEIs within the PRF have recognised and realised the pedagogic spaces that have been identified within this chapter, and the identities they project through the design and implementation of their mathematics teacher education qualifications.

Chapter 4

Official pedagogic identities and discourses for mathematics teachers and teaching: Projections from South African Policy⁷²

‘Official Knowledge’ [is] educational knowledge that the state constructs and distributes in educational institutions. [...] changes in the bias and focus of this official knowledge [is] brought about by contemporary curricula reform [...]. The bias and focus, which inheres in different modalities of reform, constructs different pedagogic identities. From this perspective, curricula reform emerges out of a struggle between groups to make their bias (and focus) state policy and practice. Thus the bias and focus of official discourse are expected to construct in teachers and learners a particular moral disposition, motivation and aspiration, embedded in particular performances and practices. (Bernstein, 2000, p. 65)

1 Introduction

In the previous chapter the local policy and institutional context of teacher education in South Africa was described in some detail. This regulatory context was theorised through drawing on Bernstein’s (Bernstein, 1977a; 1996; 1999; 2000) sociology of pedagogy. Specifically we saw that the institutional and policy landscape provides significant space for teacher educators to design and develop their own qualifications and curricula. Nevertheless teacher educators are involved in educating teachers for a specific purpose, that is, to teach within the post-apartheid schooling system and therefore, as was suggested, teacher educators must be able to provide access to discourses that will enable teachers to work productively within this system. It is therefore important to consider what official pedagogic identities the new state expects will be constructed in its teachers and learners. This is the focus of the present chapter.

As suggested in the opening quote to this chapter, all curriculum reform is concerned with changing the “the bias and focus of official knowledge” in order to construct new *pedagogic identities* in teachers and learners” (Bernstein, 2000, p. 65). South Africa is no different. In particular radical school curriculum changes implemented since 1997 and described as “unprecedented in the history of curriculum reform” (Harley & Wedekind, 2004, p. 195) have been explicitly aimed at overturning the unjust distribution of power and control relations characterising South African society. The Constitution of The Republic of South Africa (Act 108 of 1996) is identified as providing the basis for curriculum transformation in the country.

⁷² The work that forms the basis for this chapter has been published in two separate papers (Parker, 2006a, 2006b).

Thus a key principle of the new curriculum is social transformation aimed at “...ensuring that the educational imbalances of the past are redressed, and that equal educational opportunities are provided for all sections of our population” (DoE, 2003, p. 2).

The changes in the ‘bias and focus’ of official knowledge that supports this transformation aim, will be reflected in the intended pedagogic identities for teachers and learners expressed in policy documents. These documents, produced within the ORF of the state, project images of what the state considers worthwhile knowledge and pedagogic practices for schooling that will advance the transformation ideals of the new democracy. For secondary school mathematics these are embedded within the formal mathematics curriculum statements, the Revised National Curriculum Statements for Grades 7 to 9 (RNCS) and the National Curriculum Statements for Mathematics for Grades 10 -12 (NCSM). These are a construction of *what* counts as legitimate mathematical knowledge, skills and values and legitimate pedagogic modes for acquiring these (*how*): that is, they are expressions of official school mathematics knowledge and official pedagogic discourse.

As argued in Chapter 3 successful implementation of a new curriculum requires internal changes in teachers’ orientation to knowledge and meaning, and therefore identity. This is necessary so that disruptions caused by radical changes to official knowledge do not result in vacuous implementation of the new order, and therefore a form of ‘non-pedagogy’ (Hoadley, 2006), or outright resistance to it, and entrenching of past damaging practices that are no longer acceptable within the new social contract. It therefore becomes important to ask: What changes in orientation to knowledge and pedagogy are required of South African secondary mathematics teachers by the new curriculum documents? And what are some implications of these expectations for the production of curricula for educating mathematics teachers in-and-for this new curriculum context?

Asking these questions does not imply that teacher educators or teachers should take up the official curriculum uncritically, or that teacher educators should attempt to teach the school curriculum directly to their student teachers. Teachers have a responsibility to interpret official documents and to recontextualise them in ways that are meaningful and productive in their contexts. They need to be in the position to interpret these documents in ways that will enable them to practice productively, both mathematically *and* socially. Teacher educators therefore have a responsibility to enable access to discourses which will provide the foundations for teachers to learn to carry out this complex and reflexive task.

The main focus of this chapter is the official pedagogic identities projected from the NSE and the new South African National Curriculum Statements for Mathematics (NCSM) for Grade 10 - 12 in schooling (DoE, 2003). I provide a description of the main orientations to knowledge and teaching expected by the policies and reveal some aspects of the 'bias and focus' of the ORF, and illuminate some implications of this for teacher education more generally. This will be drawn on later in the thesis to reflect on the findings from the empirical case studies.

In what follows I begin with a discussion of the NCSM its structure and the general regulative discourse (GRD) which appears to underpin it. I then focus on the relationship between the NCSM and the teacher roles described in the NSE showing how the policy implies some fundamental changes in teacher identity. This is followed by a more detailed analysis of the NCSM in order to explore the main orientations to knowledge required of mathematics teachers by these new curriculum documents, and hence attempts to reveal some aspects of the 'bias and focus' of the new school mathematics curriculum. In particular the analysis attempts to reveal the change in focus within school mathematics through asking the question: *What is the new official 'legitimate text' for school mathematics for Grades 10-12, described in the national curriculum statements?*

2 A New Curriculum for FET Mathematics

All school curriculum reform activity from 1994 through to 2003 in South Africa was focussed on radically transforming the General Education and Training (GET) curriculum for Grades 1 - 9, while the curriculum for FET schooling has remained much the same. In 1994 the old apartheid syllabi for Grades 10 -12 “were ‘cleansed’ of their most offensive racist language and purged of their more controversial and outdated content” (Chisholm, 2005, p. 193). In mathematics, where the focus of the old curriculum was almost entirely on esoteric domain (Dowling, 1998) mathematical texts with virtually no reference to contexts outside of mathematics (Ensor & Galant, 2005), minimal ‘cleansing’ had to be done. The major changes made were to the aims of the curriculum, which now referred to broader aims of mathematics and mentioned the need to change pedagogy to more learner-centred practices. This old document essentially reflects a view of mathematics implemented in the old education system (for whites) under the apartheid social order.

The new NCSM represents, as will be shown in what follows, new orientations to mathematical knowledge and meaning for Grades 10 -12. The NCSM was first published by the DoE in 2003, and unlike the case of the C2005 the original version of the GET curriculum, its implementation was relatively slow⁷³. The NCSM was introduced into schools in Grade 10 in 2006 and the first matriculation examinations based on this curriculum will be written in 2008. Between 2006 and 2008 teachers would be teaching the old *outgoing*⁷⁴ curriculum, at the same time as they would be implementing the new *incoming* NCSM. By 2009 the new curriculum would be fully implemented throughout the school system, four years later than was originally envisaged⁷⁵.

2.1 The Structure of the NCSM

The new NCSM is specifically focussed on the academic stream of the FET and targets learners who intend to continue with studies in mathematics or who intend to enter into careers in which mathematics is a requirement. The document is divided into 4 chapters each with a specific purpose. Chapter 1 introduces the national curriculum statement, outlines its principles, and is common to all subject areas. Chapter 2 gives an overview of the field of learning for mathematics, its definition, purpose and scope as well as an outline of the specific learning outcomes (LO's). Chapter 3 focuses on the assessment standards (AS's), content and contexts. Chapter 4 focuses on assessment (common to all subject areas) and gives an outline of specific subject competence statements.

2.2 The general discourse of, and principles underpinning, the new national curriculum statements for Grade 10-12 (schooling)

The first chapter of the NCSM lays down in general terms the overall principles and the general regulative discourse for the whole curriculum – it is an assertion of a view of curriculum which can be recognised in terms of key elements of Bernstein's (1996, pp. 55 - 56) description of the "social logic of competence". Bernstein distinguishes between two models of pedagogic practice: competence and performance.

In general competence models of pedagogic practice and context are directed at revealing what the student/ learner knows and can do at the end of the learning process. The focus of assessment is on the differences between learners rather than on stratifying learners in terms of

⁷³ I do not consider the mechanisms that were used to train existing teachers by agents of the OPRF here.

⁷⁴ I use the description 'outgoing' and 'incoming' curricula, coined by Graven (2002b) to in her analysis of the implementation of C2005 in the GET.

⁷⁵ C 2005 was to have been fully implemented throughout the South African by 2005, hence its name. This was held up by the review (DoE, 2000d) and the revision of the school curriculum for the GET.

their mastery of specific texts. Assessment is affirming of assumed innate abilities rather than illuminating lack of ability or ignorance of specific texts. Classification is weak, and evaluation rules are implicit and thus an invisible pedagogy is produced. On the other hand performance models focus on particular learning contents and texts to be constructed by the acquirer and on the specialised skills needed to produce these predetermined texts. Here assessment focuses on the stratification of the learner's performances rather than differences between them. Classification is strong and the evaluative rules are explicit and thus a visible pedagogy is produced.

Bernstein suggests that competence as a concept appeared to converge, at an international level, within the social, psychological and linguistic fields in the 1960s, and has since been recontextualized within the field of education to create new competence based pedagogic models. This has had significant consequences for identity formation within the pedagogic context. By *social logic* Bernstein is referring to an implicit model of the social, of communication, of interaction and of the subject (individual person), embedded within the concept of competence. Broadly, competence theories see in the pedagogic subject “an in-built procedural democracy, an in-built creativity, an in-built virtuous self-regulation.” (Ibid., p. 56).

In Bernstein's (Ibid.) terms there are five features of the social logic of competence, the first of which is an assumed competence, an “announcement of a universal democracy of acquisition”; *all* subjects are capable of this acquisition, there are no deficits. Secondly, “the subject is active and creative in the construction of a valid world of meanings and practice. Here there are differences but not deficits”. Thirdly, there is an emphasis on the subject as self-regulating and autonomous, a critical thinker who is responsible for their own learning and whose development is not necessarily advanced by formal instruction. Direct teaching is suspect since acquisition of what is to be learnt is a tacit, invisible act not subject to public regulation. Fourthly, there is “a critical, sceptical view of hierarchical relations”. The teacher's function should be focused on facilitation, accommodation and context management. “Competence theories have an emancipatory flavour”. Finally, there is “a shift in temporal perspective to the present tense. The relevant time arises out of the point of realization of the competence, for it is this point which reveals the past and adumbrates the future”.

The social logic of the concept of competence is visible in most of the principles underlying the new NCSM. The NCSM is a feature of our times – driven not only by local changes to a

new democratic order, but also by responsiveness to global influences and an international convergence in knowledge movements. The foundation of the new curriculum is explicitly identified as *outcomes-based education* (OBE) which promotes a learner-centred and activity-based approach to education and “serves to enable *all* learners to reach their maximum potential by setting the Learning Outcomes to be achieved by the end of the education process” (DoE, 2003, p. 2, emphasis added). In addition, the principle of *High knowledge and high skills* clearly articulates an emancipatory flavour announcing high level aims so as to empower “those sections of the population previously disempowered by lack of knowledge and skills (Ibid., pp. 3 - 4). A further principle, *Human rights, inclusivity, environmental and social justice*, is underpinned by the adoption of “an inclusive approach [...which...] acknowledges that *all* learners should be able to develop to their full potential provided they receive the necessary support”. (Ibid., emphasis added). The social logic of competence is also apparent within the principle of *valuing indigenous knowledge systems* and not only ‘western knowledge’ – the curriculum it is announced, is inclusive of all forms of knowledge:

Now people recognise the wide diversity of knowledge systems through which people make sense of and attach meaning to the world in which they live. Indigenous knowledge systems in the South African context refer to a body of knowledge embedded in African philosophical thinking and social practices that have evolved over thousands of years. The National Curriculum Statement Grades 10-12 (General) has infused indigenous knowledge systems into the Subject Statements. It acknowledges the rich history and heritage of this country as important contributors to nurturing the values contained in the Constitution. As many different perspectives as possible have been included to assist problem solving in all fields. (Ibid., p. 4)

Given the discussion on teacher competences in the previous chapter, it is not entirely surprising to find that the announcement of these underlying principles do not come with any clear criteria for their meaning. This is perhaps a feature of the competence model that inheres within the statements – it is taken-for-granted that the meanings are transparent, that teachers as self-realising competent subjects/ agents will know what they mean, will recognise the practices, and will be able to realise these. For example, they will know what *appropriate* means when told that “(t)he intellectual, social, emotional, spiritual and physical needs of learners will be addressed through the design and development of *appropriate* Learning Programmes and through the use of *appropriate* assessment instruments” (Ibid.: p. 5). Here we see that the evaluative rules for the principles to be applied are vague – it is assumed that there is universal access to their meaning. Yet the internal workings of the practices being advocated may be invisible to teachers. This can be related back to the discussion in the previous chapter where Shalem and Slonimsky (1999, p. 12) show that criteria cannot be used to give access to the “internal goods” of a practice or discourse, that is, to the internal logic or meaning. To grasp what is meant by the statements teachers will need to be “in the criteria”.

A particular specific example of this is the announcement that the curriculum is “learner-centred and activity-based” (DoE, 2003, p. 2). However, what is meant by a ‘learner-centred’ and an ‘activity-based’ approach is not defined – in the document it is assumed that these categories are well understood and the pedagogy underlying them is transparent. In the 90 page curriculum document the words ‘learner-centred’ and ‘activity-based’ are used exactly once, and that is in on page 2 in the rationale. Yet, as was discussed in Chapter 3, research has shown that what this means is not transparent to teachers, and these over promoted policy principles have been a major stumbling block in the implementation of the new GET curriculum⁷⁶. No elaboration of what is meant by these terms is provided in the document. The words ‘learner’, or ‘learners’ are used a fair number of times, but this is mostly in sentences which indicate *what* should be learnt or acquired, for example, “Assessment Standards are criteria that collectively provide evidence of *what* a learner should know and be able to demonstrate at a specific grade.” (DoE, 2003: 7, emphasis added). Every outcome and assessment standard is also is stated in terms of what the learner should know and be able to do. Thus there appears to be an *assumed* responsibility placed on the learner for their own learning, rather than on the teacher for ensuring access to that learning. Such statements position the teacher as an ‘invisible’ pedagogue (Bernstein, 1996). This is a characteristic of learner-centred or invisible pedagogy.

In Bernstein’s terms, *invisible* pedagogy is the practice of a competence-based model, and involves the apparent ‘disappearance’ of the teacher (rather than the disappearance of the learner, that is common in more traditional performance-based pedagogies). The hierarchical rules, the rules of organisation and criteria are implicit, that is framing is weak. The basis of the rules for such a practice would be derived from

complex theories of child development, linguistics, linguistics, gestalten theories and sometimes derivations from psycho-analytic theories. In the case of invisible pedagogic practice it is as if the pupil is the author of the practice and even the authority (Bernstein, 1996, p. 112)

Muller describes this in terms of favouring “a democracy of relations [...] This entails that the transmitter or pedagogue must be seen to direct the pedagogic process as undirectively as possible”(1998, p. 186). A characteristic of this practice would be the personalisation of classroom relations (in Bernstein’s terms the framing of hierarchical relations would be weak) in which learners are encouraged to introduce their own voices through bringing in their local knowledge (that is weakening of discursive framing relations). Such pedagogic practice can be

⁷⁶ (See for examples, Brodie, 2000; Brodie, Lelliott, & Davis, 2002; Davis, 2001; Ensor, 2000; Harley et al., 2000; Harley & Wedekind, 2004; Mattson & Harley, 2003; Taylor & Vinjevoild, 1999)

productive, as shown by Davis' (1996) description of an example of pedagogic constructivism seen in a problem-based approach popular in South African mathematics education during the 1990s. Here the traditional pedagogue effectively vanishes but the pedagogy continues to operate in the interests of reproducing academic knowledge. However, Davis also points out that in order for this to be effective, the teacher needs to be highly skilled in directing the learning through evaluation, while at the same time appearing not to do so. Muller suggests that producing such teachers will be costly and not easy to achieve since,

to get teachers to internalize the implicit rules of this person-oriented, highly particularistic, 'invisible pedagogy' will entail in-depth craft training not easily conveyed by short courses or by non-apprenticeship models such as distance education. Second, there will necessarily need to be selectivity because not all aspirant teachers will absorb the moral universe of hyperpersonalized pastoralism, or rather they may absorb the rhetoric but not the practice (Muller, 1998, pp. 186 - 187).

This points to the issue around teachers having access to the inside of a practice in order to put it into practice, or as Ensor (2001) puts it, to gain access to both the recognition and realisation rules of the practice. I will return to this discussion a little later once the analysis of the curriculum is complete as it points to important issues for the work of mathematics teacher education generally and the design of curricula more specifically. This is particularly so, if as suggested in Chapter 3, teachers need access to the discourses that structure their work so that they can develop reflexive competence. I now return to the analysis of the document to consider what images of 'good' mathematics and 'good' mathematics teacher it projects.

3 A new *kind* of mathematics teacher for the FET

A partial picture of the pedagogic identity teachers are expected to assume in delivering the new curriculum is provided by the description of the *kind* of teacher and learner envisaged by the NCSM. The document visualises teachers as:

key contributors to the transformation of education in South Africa [...] qualified, competent, dedicated and caring [...] able to fulfil the various roles outlined in the Norms and Standards for Educators (DoE, 2003, p. 5)

and expects *all* learners to be:

imbued with the values and act in the interests of a society based on respect for democracy, equality, human dignity and social justice as promoted in the Constitution. [...] have access to, and succeed in, lifelong education and training of good quality; demonstrate an ability to think logically and analytically, as well as holistically and laterally; and be able to transfer skills from familiar to unfamiliar situations (Ibid.)

This describes a general orientation of the pedagogic subjects – that is, teachers and learners - to knowledge and pedagogy. The role of teachers as *competent* agents of transformation for a new democratic order is clearly articulated. The description of the *kind of teacher* envisaged

refers to the *roles* outlined in the NSE, the policy governing the production of qualifications for teaching introduced in previous chapters.

3.1 The roles of a teacher

The NSE policy provides a vision of a competent professional teacher able to integrate a complex set of seven teacher roles with social, economic and moral responsibility while meeting the specialist demands of the school curriculum. The image of competent teacher produced through the role descriptions is significantly different from the existing practices that currently dominate teaching in secondary schools. The differences between the outgoing and incoming curricula are seen both in terms of official knowledge and pedagogic discourse (the structure and contents of the curriculum documents and orientations to knowledge demanded of teachers in carrying out the specialist role), and in terms of the practices that dominate teaching in schools. The main changes, in intended pedagogic practices embedded in the roles, are briefly discussed below.

The role of *learning mediator* reconceptualises the purpose of teaching from ‘conveyor of knowledge’ to ‘mediator of learning’ (Graven 2002a). This implies a movement from teaching methods that predominantly involve ‘talk and chalk’ and teacher exposition, the dominant practice in most secondary schools, to methods that involve a greater focus on co-operative learning and discussion. It highlights the importance of language and communication and being “sensitive to the diverse needs of learners, including those with barriers to learning” and constructing “learning environments that are appropriately contextualised and inspirational” (DoE, 2000c, p. 13). The importance of being inclusive of all and sensitive to different needs is stressed: there are no deficits, only differences and any barriers to learning connected to these differences must be addressed by the teacher.

The second role, *interpreter and designer of learning programmes and materials*, constructs a image of the teacher as responsible for designing her own learning programmes for mediating classroom learning through the selection, preparation and organisation of learning materials into sequences of activity that will be sensitive to the needs of diverse learners and provide opportunities for learners to demonstrate successful achievement of the learning outcomes. The teacher is expected to interpret the broad outcome descriptions and assessment standards in the new curriculum statements and select contents and learning activities and materials to provide learners with *appropriate* experiences to achieve the outcomes. The current (outgoing) practice is markedly different. Teachers follow a content laden syllabus prescribed by the

department of education and pedagogy is strongly externally controlled or framed through a high stakes matriculation examination which focuses on an orientation to *received knowledge*⁷⁷. Within the existing grade 10 – 12 syllabus, the sequencing and progression of knowledge content to be taught is clearly defined. Text books containing fairly traditional contents and exercises that meet the syllabus requirements are selected and prescribed by the education department and are generally used as the focus of classroom activity. The new image is of a teacher who has high level conceptual and educational knowledge and skills within their specialist area, as well as creative abilities and technical and productive skills to select, (re)design and produce learning activities and texts to carry out these new expectations in practice. This role points to a central change: from teaching given texts to organising and managing learning and providing contextually relevant learning environments and activities for this purpose.

It is noted here that the NSE policy reflects the discourse of the time it was produced, that is, in 2000 within the curriculum framework of the first moves to OBE and the C2005. In its original conception of C2005 the DoE envisaged that teachers would use a wide range of texts (called “learning support materials”) created from a variety of sources including “print-based, electronic, physical, combinative and organisational” (DoE, 1998c, p. 1) developed by a range of different agents, including teachers. It was explicitly expected that teachers would become involved in co-operatively producing their own contextually relevant materials. This was coupled with a marked decline in expenditure on text books from approximately R900 million in 1996 to R80 million in 1998 (Vinjevold, 1999). There was a strong ideological position that pushed the belief that an over reliance on text-books would limit a teachers’ ability to be creative and that teachers as self reliant extended professionals were best equipped to make decisions about the learning of children in their care. Since the review of C2005, the shortcoming of this approach has been recognised and text-books have been re-established as a key resource for supporting teachers to provide systematic learning opportunities. While it is clear that this was a really problematic aspect of C2005 implementation, it was driven by the recognition that many teachers in the system, particularly in disadvantaged schools, used textbooks inflexibly and as scripts from which to teach. This problematic practice persisted and been observed in a number of different research projects where text books are inappropriately⁷⁸ used (see, Davis & Johnson, 2007; Hoadley, 2005).

⁷⁷ As discussed in Chapter 2 with reference to Boaler (2002a) and Boaler and Greeno (2000)

⁷⁸ In Davis and Johnson’s (2007) project the teacher is observed teaching the example, and failing by example. In Hoadley (2005) a teacher is observed opening a textbook to an arbitrary page and beginning to teach,

The third role, *Leader, administrator and manager*, not only refers to the management and administration of learning in a classroom, but also to participation in school decision-making structures as a whole. This implies a change in the way in which schools work and in the hierarchical management structures that are typical of traditional schools. The new GRD of the state/ society is emphasised in that teachers are expected to show they are competent to interact “in ways which are *democratic*, which *support* learners and colleagues, and which *demonstrate responsiveness* to changing circumstances and needs” (DoE, 2000c, p. 13, emphasis added). The ideology of the new state is to be carried by its teachers who will now be expected to work in a context where traditional authority structures and authoritarian relationships are to be replaced by democratic non-authoritarian ways of being.

In the fourth role, *scholar, researcher and lifelong learner*, teachers are seen as extended professionals who take the responsibility to continue learning and researching in their area of specialisation and develop themselves through formal and informal learning and research practices. This role also links to the ideal of a teacher becoming a reflexive (as opposed to reflective) practitioner – it provides an image of teachers who seek out new ideas and research to interrogate and improve learning in their classes. It also represents a move, specifically within the NSE, but not necessarily recognised, to the notion of *reflexive* practice, rather than reflective practice. This was an attempt to insert an academic orientation to what is principally an occupational/ professional orientation. Reflexive practice implies access to discursive resources that enable a teacher to look at themselves and others in practice with a gaze that could lead to development and improvement of practice.

The fifth role, *community, citizenship and pastoral role* extends the teachers involvement with her learners beyond the traditional care giver. This role was discussed in Chapter 3. Here we see the teachers being projected as *critical* agents who will be the standard bearers of the new order of things, taking responsibility for development of attitudes and dispositions that move well beyond caring for learners in their classes and providing access to specific forms of knowledge and practices. As mentioned in the previous chapter, this is the role that most emphasises the GRD of the new state and the specific ideological orientation that the state intends its education system to institutionalise.

The sixth role is that of *assessor*. Here the teacher is required to move away from traditional teaching and testing practices to expand their notions of assessment and develop the ability to design and use a variety of assessment forms to holistically assess learning. In terms of current practices, while pencil and paper tests and the high stakes matriculation examination are still the major focus, new forms of assessment are already being introduced with project work and investigations being encouraged and all learners having to produce a portfolio of work that forms part of their final assessment at the end of Grade 12. This is clearly seen as a key role to develop and as an essential ingredient to change practices in the system: there is an entire section of the NSCM devoted to assessment and assessment practices. While the first part of the chapter is generic, subject specific competence statements are also provided.

The final role is that of *Learning Area/ subject/ discipline/ phase specialist*. In the case of the FET teacher this is defined as a subject/discipline specialist. This role is seen as the overarching role into which all other roles should be integrated. It was discussed in some detail in Chapter 3 and that discussion will not be repeated here. However, a major issue for the production of curricula in MTE, is how does the specialist gain primacy in practice, without taking too much space and undermining critical foundations in the study of Education (see Harley & Wedekind, 2003).

3.2 The roles and pedagogic identity

As discussed in Chapter 3, roles are not identities. They describe functions that are related to a specific occupation/profession, in this case teaching. In using the roles to project an image of an ideal teacher for the new South African context, the NSE sets up a *symbolic image*, not only of the individual teacher, but of the profession as a whole. What should be clear from the above description is that the image projected does not fit with the existing reality of schools and teachers⁷⁹. Rather, it provides a new orientation and direction which emphasises the shift in the general regulative order of society as a whole and an intended shift for the profession. Reading and interpreting this policy as a basis for developing curricula therefore would be dependent on recognising this. For example the policy suggests that all the roles (and competences) “must be developed in all initial educator qualifications” (DoE, 2000c, p. 11), which might suggest that the lists of competences should provide a blue print/ tick list for teacher education programmes. However, this is tempered with a pragmatism that suggests the roles,

⁷⁹ In particular it does not fit with the existing realities in rural and more disadvantaged contexts and has exacerbated the problems related to the inequitable distribution of knowledge and power during the apartheid era (see Harley & Parker, 1999; Harley & Wedekind, 2004; Mattson & Harley, 2003)

should not, however, be seen as static. They *may* be developed in *different ways*, with *different emphases* and at *different depths*. *Providers have the responsibility* to decide how this should be achieved, and before designing a learning programme it will be necessary to establish the particular nature of the clients and which qualification the learners are to be prepared for. A number of factors will impact on this decision, including: the type of learners in the programme; experience; the context - rural, urban or peri-urban; the phase(s) to be catered for; language experience (Ibid., emphasis added)

and soon after, this is qualified with,

Some competence may be seen to be more suitable for experienced rather than beginning educators, e.g. designing original learning programmes, accessing and working in partnership with professional services and other resources in order to provide support for learners (Ibid., emphasis added).

and, the roles and competences provides a

description of a competent educator [... and are ...] *not meant to be a checklist* against which one assesses whether a person is competent or not [...] and should *inform* the exit level outcomes of a qualification and their associated assessment criteria. (Ibid., p. 13, emphasis in original)

In other words, the inclusion or exclusion of particular competences is left up to the providers, who are expected to be competent to make these decisions, but are at the same time expected to work in the interests of the new democratic society as a whole. The assumption of the logic of competence therefore snakes its way through all levels of the system, including teacher education. Robinson's (2003) small scale exploration of some teacher educators' perceptions of the NSE policy in the context of their need to redesign their teacher education programmes to meet the new regulatory context, led her to the conclusion that they read the competences as outcome statements and saw the underlying competence approach as behaviourist, although they generally supported the contents of the policy. She concluded that "(c)oncerted attention needs to be paid to the development task of changing practices in teacher education" (p. 31) to enable a nuanced and productive interpretation. While, as was argued in the previous chapter, the NSE policy is symbolic and relatively 'open' to interpretation, and structural transformation has opened up possibilities for changed control relationships over teacher education between the UPRF and ORF, teacher educators themselves may not be recognise these opportunities, or be sufficiently 'in the criteria' of research-based practices to be able to create productive pathways to navigate the challenges presented by the new environment. In particular to use their research to avoid the "social meliorism" trap of policy "where commitment to a vision of *what should be* clouds the serious ability to see *what is*, so that the good intentions of social reconstructionism have more influence [...] than social and school realities" (Mattson & Harley, 2003, p. 285).

Underlying the role descriptions is a demand for major changes from teachers in both their orientation to knowledge and learning and in their conception of their work. However the NCSM simply mentions the roles in a passing sentence about the *kind* of teacher the new curriculum requires – it does not give any substantial detail or any access to the criteria for the practices that the sentence is meant to invoke. This underlines the discussion in Chapter 3 that

it is the challenge of teacher education to define what will become recognised as new ‘good’ practice in terms of more principled forms of knowledge produced in the disciplines/fields of mathematics, mathematics education, mathematics teaching and education, rather than allowing over-hyped and generic reconstruction ideals to dictate, and for ‘mythological knowledge’ to be institutionalised.

That new mathematics pedagogic identities cannot simply be ascribed to or adopted by teachers without major internal changes to their orientations to mathematical and teaching knowledge and meaning, to who they are or want to become, and to the social and educational context in which they practice, should by now be clear. The new “incoming” practices described in the NSE (and through their mention, in the NCSM) are simply symbolic and require entirely new ways of seeing the world and making meaning within it if they have any chance of becoming embedded in practice. They stand in stark contrast to the “outgoing” but still implemented practices that are based within the real existing social, material and historical context of South African schooling. In addition, the roles taken as individual elements cover the full functioning of a school, rather than of an individual teacher in a school (as was shown in Harley et al’s (2000) research into the teacher roles). This implies that any attempt to ‘cover’ all the roles and all the competences in an initial teacher education programme is likely to create a lack of coherence and depth, particularly with respect to the specialist role and to the study of education, and to result in curricula that are overloaded with forms of ‘generic’ knowledge and competences, which I would argue are essentially meaningless, since they are not rooted in specific practices (e.g. mathematics teaching) or discursive fields (e.g. mathematics education, or the study of education).

To summarise, new roles (functions of schools and schooling) place high demands on teachers. Teachers do not teach: they mediate learning (or facilitate) through the use of learning materials and programmes. The control of the pedagogic space is displaced towards the text (activity/ learning material) and learners are self-actualising thinkers who take responsibility for their own learning. There is a move from directly teaching given texts towards the management of learning and the teacher is to disappear (become invisible). This represents a shift in the locus of control and a flattening of hierarchical relations. In terms of the earlier discussion in Section 2.2, the outgoing curriculum for FET, and teachers’ practices within it, present the features of a performance model, while the new incoming curriculum and the roles expected of the teacher fit within the logic of competence.

Above I have shown how the logic of the rationale for the new curriculum document fits fairly well with Bernstein's description of the social logic of competence. I now go on to look more carefully at the actual statements for Mathematics grade 10-12, to see to what extent an underlying logic of competence is followed through into the specific mathematics assessment statements.

4 Inside the NCSM

The discussion in the previous sections appears to suggest the new policy represents a competence-based model⁸⁰. However, the principle of systematic progression of mathematical knowledge, that is the development and advancement of complexity in knowledge and skills through the grade levels, and hence the development of hierarchy within the subject is also promoted as a general principle in the rationale for the NCSM. This does not seem to fit neatly with the logic of competence as described by Bernstein, in that it suggests specific content that should be mastered and assumes hierarchy within the discipline, which would necessarily extend to the relationship between the learner and contents to be learnt, as well as between the learner and the teacher. This suggests that while the logic of competence drives the general regulative discourse in which the curriculum is based, there are other interests at work, and that features of the logic of performance may also be recognised in the new curriculum statements.

In the previous sections I have focussed on the general orientation of the new policy and the general regulative discourse that (new) teachers are expected to internalise. This reveals the ideological screen that the ORF of the state hopes will be the basis through which pedagogic discourse for mathematics teacher education and school mathematics will be filtered. I now move to look more specifically at the specialist mathematical focus of the policy: how mathematics is conceived of in the new NCSM documents, and the kind of mathematics teacher and learner this promotes. That is, official discourse of school mathematics and official pedagogic identities of mathematics teachers and learners embedded in the NCSM.

4.1 The nature of mathematics in the NCSM

The NCSM provides a definition of mathematics in the new curriculum that projects an image of mathematics as *practice*, a "human activity practised by all cultures" that enables creative

⁸⁰ A number of different competence models have been described in the literature (see for example, Bernstein, 1996; Graven, 2002b; Muller, 1998; Taylor, 1999). I do not try and to distinguish which is evident here as it is not significant to the argument that I present.

and logical reasoning. It sees mathematical knowledge as constructed by “observing patterns, with rigorous logical thinking, [...] lead(ing) to theories of abstract relations”. It is thus a systematic way of seeing the world and thinking about the world using structured abstract principles. Further it is “developed and contested over time through both language and symbols and by social interaction and is thus open to change”. Mathematical problem solving is seen as a key element which “enables us to understand the world and make use of that understanding in our daily lives” (DoE, 2003, p. 9).

The idea of empowerment as a purpose of mathematics learning is visible: access to mathematical knowledge empowers learners “to make sense of society”, by enabling them to “respond responsibly and sensibly to personal and broader societal concerns” and to engage “responsibly with quantitative arguments relating to local, national and global issues” (Ibid., p. 10). However, at the same time, mathematics is specifically characterised as a “discipline in its own right and pursues the establishment of knowledge without *necessarily* requiring applications in real life” (Ibid., emphasis added). It is also specifically emphasised that mathematics is more than a cannon of specialised knowledge contents, “competence in mathematical process skills such as investigating, generalising, and proving is more important than the acquisition of content for its own sake” (Ibid.). While there is a focus on application of mathematics, the idea of an unproblematic transferability of everyday knowledge into mathematics is absent – the focus is on the “establishment of *proper* connections between Mathematics as a discipline and the application of Mathematics in the real world” (Ibid., emphasis added). Mathematical modelling is seen as the means to analysing and describing the world mathematically. Other proper connections are in relation to the use of mathematical tools for problem solving in other subject areas, such as physical, social and management sciences.

Thus there is a focus on mathematics as a *discipline*, a *practice* and a *tool* – it is a specialised knowledge form with its own unique conventions, symbolism and structure; it is a specialised practice involving specialist processes of thinking, reasoning, proving; and it is a powerful tool for problem solving in a variety of contexts including mathematical (for example, abstract problem solving) and nonmathematical (for example, as applied in issues of public health, finance, or other subject areas such as the physical sciences). In addition, mathematics has a *history* – it is viewed as socially constructed within historical contexts.

This description of the nature of mathematics appears to be underpinned by what Ernest (1991) refers to as a fallibilistic philosophy of mathematics education. Ernest distinguishes between absolutist and fallibilist philosophies. An absolutist philosophy is underpinned by a belief that mathematical truth is certain, objective, absolute, incorrigible and unquestionable. Mathematics is viewed as a rigorous system of pure timeless truth. It is universally valid, value and culture-free. In contrast, an opposing humanised image of mathematics informed by constructivist and post modernist thought, finds academic support in fallibilist philosophies. Its basis is a reconceptualised view of the nature of mathematical knowledge as human, corrigible, historically embedded and changing. Mathematical knowledge is fallible and eternally open to revision in its proofs and concepts. From this philosophical perspective mathematics is historically, culturally and socially embedded.

This description of mathematics is given in very general terms, however, it provides us with a view of mathematics that indicates a number of orientations to meaning. These can be recognised in terms of Graven's (2002a) analysis of the C2005 GET curriculum for mathematics, in which she identified four different *orientations to mathematics*. She summarised these as:

- (1) mathematics for critical democratic citizenship – allowing learners to critique mathematical applications in various social, political and economic contexts
- (2) mathematics as relevant and applicable to aspects of everyday life and local contexts
- (3) mathematics for inducting learners into what it means to be a mathematician, to think mathematically and view the world through a mathematical lens
- (4) mathematics involves conventions, skills and algorithms to master in order to gain access to further studies

Most of these orientations seem to be present in the overview of mathematics given in Chapter 2 of the NCSM. However there are some changes. The emphasis of (2) in the NCSM seems to be focussed on what might be seen as a form of applied mathematics, including problem solving and mathematical modelling, within different contexts including real life and other disciplines. (3) can be seen as expanded to include mathematics as practice – a disciplined, rigorous and systematic way of thinking about, viewing and structuring the world, and communicating in the world. (4) is expanded to include mathematical structures as a focus of study. Finally there is an added focus on investigating historical aspects of the development and use of mathematics in various cultures. Thus a further category can be added to the four

mentioned above – (5) mathematics as a human activity produced historically in cultural and social contexts.

In the next sub-sections I analyse the specific assessment standards in the NCSM in more depth.

4.2 Inside the assessment standards

Mathematics in the curriculum is defined in terms of four learning outcomes (LO's): LO 1: Number and Number Relationships; LO 2: Functions and Algebra; LO 3 Space, Shape and Measurement, and LO 4: Data Handling and Probability. The intention for each LO is elaborated through assessment standards (AS's). This is supported by further content and context statements. It is emphasised that “content must serve the Learning Outcome and not be an end in itself”, and suggested “contexts [...] will enable the content to be *embedded in situations* which are *meaningful* to the learner and so assist learning and teaching” (DoE, 2003, p. 44, emphasis added). This once again raises issues with respect to attempts made to bring local knowledge into the pedagogic context in order or make mathematics more meaningful, and reemphasise the challenge to mathematics teacher education discussed in the previous chapter.

Assessment standards are supposed to be:

criteria that collectively provide evidence of what a learner should know and be able to demonstrate at a specific grade [...and...] the knowledge, skills and values required to achieve the learning outcomes [...they also...] show how conceptual progression occurs from grade to grade.” (Ibid., p. 7)

For each learning outcome a number of AS's are prescribed – they are written in a language which indicates, to a competent teacher, what is required for a learner to demonstrate the achievement of the outcome. For example, in LO 3, which deals with ‘Shape, Space and Measurement’, the first two ASs for Grade 11 are described as follows (Ibid., p. 33, bullet points in original):

We know this when a learner is able to:

- Use the formulae for surface area and volume of right pyramids, right cones, spheres and combinations of these geometric objects
- (a) Investigate necessary and sufficient conditions for polygons to be similar
(b) Prove (accepting the results established in earlier grades):
 - that a line drawn parallel to one side of a triangle divides the other two sides proportionately [and so on]

Clearly the teacher is required to have access to the substantial meaning of the mathematics described in these statements. They will have to have the recognition and evaluation rules associated with the specific knowledge objects (contents), their relations to one another and to

the mathematical practices that they represent. I will not present more examples here or elaborate on the specific contents. However, while a consideration LO's and AS's shows progression across the grades, it seems clear that for the statements to be useful, the teacher is required to understand the content and logic of the mathematical practice (disciplinary, practical or pragmatic) suggested by the standards, for example in terms of the five orientations to knowledge identified in the previous section, and to know what it means to recognise when learners demonstrate acquisition of that content. For most South African teachers, adoption of this very new orientation to their work will require major change in their identities. This is supported by Naidoo and Parker's (2005) research in which an analysis of teachers' perspectives on the changing curriculum and assessment practices in Grade 9 mathematics through the implementation of the National Common Task Assessments, showed that teachers' existing identities were in contradiction to the new expectations which had major consequences for the aim of access to mathematics for all.

To help support the teacher some “*suggested* content and contexts” are given for each assessment standard. This wording implies teacher have a choice not to select this content. What is interesting about this is that the details in the selected content and context are almost exactly the same as the detail in the assessment standard⁸¹ – the only difference being the adding of general statements such as:

The learner will use the following content in order to calculate and estimate accurately in solving standard problems, as well as those which are non-routine and unseen. The problems will be taken from mathematical and real-life contexts such as health and finance. (DoE, 2003, p. 44, with reference to LO1)

This does not seem to give the teacher much more to work with, but does suggest an orientation towards mathematics: the esoteric domain of mathematics takes primacy as the first context mentioned, but other contents and contexts should also be used to help make it meaningful to learners. It is assumed teachers will find *appropriate* ‘real life’ problems but what this actually means is underspecified – competent teachers who have a mathematical gaze (Dowling, 1998), will be able to see what examples could be usefully employed in the service of mathematics. However, if they do not there is the danger that ‘real life’ will become the focus rather than systematic entry into the academic domain of mathematics, that is, mathematics (and perhaps even real life) will suffer from a form of symbolic violence. Teachers will need to expand their understanding of their subject and its links to other areas of

⁸¹ For example, the contents of the first AS for LO3 Grade 11 (quoted on the previous page), is now described as “Apply the formulae for the surface area of right prisms, right cones, spheres and combinations of these shapes” (DoE, 2003, p. 53), which apart from the use of the word “apply” in place of “use” is the same wording to the AS and gives no additional information. No formulae are given and no further information about what an appropriate application would be.

activity to be in a position to put this curriculum into practice. We also see aspects of the social logic of competence creeping in here - that is the belief that strong framing over the teachers' actions is to be avoided. Thus the teacher has a choice: to select this content, or not to select it, and do something else in its place. The evaluative criteria for the new practice are opaque, but the assumption is that the teacher, who is necessarily a self realising subject and thus has an inherent competence, will choose appropriately – that is, will recognise and choose the content suggested.

The analysis so far has supported a view of the curriculum as largely competence-based. It has also highlighted issues raised in the previous chapter and underscored the challenges to MTE if it is to produce teachers for the new reformed context who will be able to work productively, both in the interests of mathematics and for the social good. The analysis has so far been at a fairly general level. I now move to consider the assessment standards in more detail.

4.3 Orientations to knowledge within the assessment standards

What orientations to mathematical knowledge are apparent across all the LO's and AS's? This is considered through a simple count. Each learning outcome and its assessment standards are considered and then coded in terms of the five orientations to mathematics identified earlier. These are then summed and converted to percentages so that an overview of the orientations within the document can be identified. Table 3 shows the overall results of the count.

Note that each AS is looked at in terms of all its possibilities. A single assessment standard could thus be associated with more than one orientation, which means that the total number of instances (55) across the different AS's does not fit neatly with the total no of AS's (26). For example, the assessment standard “Demonstrate an understanding of the definition of a logarithm and any laws needed to solve real life problems (e.g. growth and decay)” (DoE, 2003, p. 17, Grade 12, LO1, AS1), has two orientations: understanding the definition and laws (Orientation 4) and these as applicable to real life problem solving (Orientation 2). Other examples of coding are included in Appendix B. The simple count for each of the orientations is converted into a % of the total number of AS's to provide a broad picture of the distribution of orientations visible across the AS's. It shows some interesting patterns.

Table 3: Orientations to mathematics knowledge expressed in the NCSM

Learning Outcome	Number of Assessment standards for the outcome	Orientation to mathematics per outcome and assessment standard				
		Maths for democratic citizenship	Maths as applicable through problem solving and modelling	Mathematical practices – ways of thinking and seeing the world	Maths as a structured discipline - Conventions and skills	Maths as historically produced human activity
1 Number and number relationships	6	1	4	2	6	0
2 Functions and algebra	8	1	3	5	8	0
3 Space and shape	7	0	2	4	6	1
4 Data handling and probability	5	1	4	1	5	1
All 4	Tot (26)	3	13	12	25	2
All 4	%	11.5	50	46.1	96,2	7,7

Firstly over 95% of the standards indicate some form of orientation towards (4) - mathematics as a structured discipline involving conventions and skills to master in order to gain access to further studies, which is the major focus of the outgoing Grade 10 - 12 curriculum. There is also a clear focus on applied mathematics and problem-solving (including in real life contexts), that is, orientation (2) and towards orientation (3) which involves mathematical practices. The latter two orientations were not a significant part of the old curriculum and form a focus that would be new to most existing teachers, and to student teachers who learnt their school mathematics through that system. What is interesting though, given the upfront commitment to education for critical democratic citizenship and a commitment to indigenous knowledge systems in the introduction, is the relative lack of focus on orientations (1) and (5) in the actual standards.

This raises the question as to what is the real bias and focus of this curriculum is. It seems, at least from Table 3, as if the dominant focus in the assessment standards is very much towards entry into the esoteric domain of mathematics, a focus on progression within the discipline, on its structure and formal methods, which is not a focus that sits neatly with the competence model that seems to be dominant in the first chapter of the statements.

The original version of the GET curriculum discussed by Graven (2002a; 2002b) suggested a “radical form of an integrated curriculum [... involving ...] profound transferability of

knowledge in real life” (DoE, 1997, p. 32). The NCSM seems to be suggesting a different focus, that is, on progression and advancement of specialist mathematical knowledge and practices. This raises questions about the principle of integration of knowledge and skills that should be “achieved within and across subjects and fields of learning [...] and terrains of practice [and] is crucial for achieving applied competence” (DoE, 2003, p. 3). How is integration envisaged within the NCSM? To what extent is the principle visible within the actual assessment standards, and what is the nature of integration implied by these standards? Is integration a major principle underpinning the NCSM or is this merely an announcement, a rhetorical device? In the rest of this section of the chapter I explore these questions.

4.4 Integration in the mathematics curriculum

In terms of Bernstein’s theory, (1977b; 1996) integration in a curriculum refers to the classification between contents and is thus related to the strength of the boundary *between* different contents. When the boundary is strong, the contents are well insulated from one another, the ‘voice’ of the subject/ discipline dominates and thus classification is strong. When the boundary is relatively weak, other ‘voices’ enter into the subject/discipline and thus classification is weakened, and the curriculum becomes more integrated. There are different types of integration: between subjects/disciplines and local/everyday knowledge, referred to as *inter-discursive* integration; between different subjects/disciplines (e.g. between mathematics and physical science) referred to as *inter-disciplinary* integration; and within a particular subject/discipline (e.g. between algebra and geometry as two branches of mathematics), referred to as *intra-disciplinary* integration.

When considering the actual contents of the NCSM, the focus of integration becomes more visible. Integration is not principally aimed at the boundaries between mathematics and nonmathematical discourses. Rather it seems to broaden the focus of school mathematics learning from entry into a single discipline (pure mathematics) into a region: the mathematical sciences. This includes the study of aspects of ‘pure’ mathematics, applied mathematics and mathematical statistics. Thus there is a focus on access to the discourse of abstract mathematical knowledge, its structure and processes for entry into further studies in the mathematical sciences. Each of the components of the mathematical sciences is relatively strongly insulated within the NCMS, i.e. there is a principle of internal classification which enables clear distinctions to be made, for example between statistics and mathematics, and between mathematics and applied mathematics. Statistics is most strongly insulated appearing in the document under a single outcome: Data Handling and Probability, which is an entirely

new area in the FET curriculum. Other previously insulated topics in mathematics are spread across the other three learning outcomes and integrated horizontally in terms of mathematical structures, conventions and processes.

Thus the NCSM promotes the notion of mathematical activity as a knowledge field, rather than a single discipline. In Bernstein's (1999) terms school mathematics in the NCSM is characterised as a vertical discourse with a horizontal organisational structure. The strength of its grammar, if true to the discipline would be strong. However, how the grammar of school mathematics in the NCSM is constituted will depend on the extent and type of integration that is intended.

A count of the focus of the different assessment standards across these three constituent disciplines and on the focus of integration within the mathematical sciences and between these and contents outside of these discourses is given in Table 4. Once again there is some overlap. For example, "solve non-routine, unseen problems" (DoE, 2003, pp. 20 - 21, LO 1, AS 6, all grades) could be interpreted in the context of mathematics or applied mathematics, and therefore is counted in both columns.

Table 4: The focus of integration in the NCSM

Learning Outcome	Number of assessment standards in outcome	Discipline in the mathematical sciences			Focus of integration		
		Mathematics	Applied Mathematics	Statistics	Within mathematical sciences	Between math sciences and other subject	Between math sciences and everyday/ societal concerns
1	6	4	4	0	4	2	4
2	8	6	3	0	8	2	2
3	7	6	1	0	7	1	1
4	5	0	0	5	5	2	4
All	26	16	8	5	24	7	11
% (all)	100	61,5	30,8	19,2	92,3	26,9	42,3

The count shows that 92,3% of the AS's indicate intra-disciplinary integration. Thus there is an emphasis on integration of knowledge, but it is focussed mostly on a weakening of boundaries *within* school mathematics rather than on transfer of knowledge from outside of mathematics. For example the idea of 'function' is a key integrating principle that brings together aspects of trigonometry, algebra and calculus. This represents a weakening of classification values within

the field itself. Instead of ‘topics’, such as algebra, trigonometry, geometry and calculus, that were well insulated from one another in the old curriculum and organised in vertical ‘silos’, the contents of the NCSM are organised in terms of four learning outcomes – Number and Number Relationships; Functions and Algebra; Space, Shape and Measurement; and Data Handling and Probability – and are connected horizontally through mathematical processes such as “making conjectures, proving assertions and modelling situations” (Ibid., p. 10). This marks out a change in the nature of official school mathematics knowledge, from what was earlier described as received knowledge to *connected* knowledge and knowing, that would necessarily imply a leaning towards relational rather than instrumental understanding (see Skemp, 1976, for a discussion on these types of understanding).

We could argue that this shows that the field of Mathematics Sciences in the NCSM remains fairly strongly classified in relation to contents outside of the field, but there is a weakening of classification values within the field itself. However the table also shows that 42,3% of the statements refer to inter-discursive integration and 27% inter-disciplinary integration. This indicates that the way in which integration is working within the NCSM is complex. While it appears that the mathematical sciences are fairly well insulated as a field of study, it also appears that relatively strong connections are to be made between the field and local/everyday knowledge, and some connections between the field and other sciences/subjects.

This marks out a significant change in the organisation of the contents of the NCSM curriculum from that within the old still existing curriculum. In the old curriculum, mathematics as a pure science was insulated from other fields and within the discipline various topics were also well insulated from one another. That is classification was strong in all three aspects, whereas now it is strong in only one aspect.

4.5 Domains of mathematical practice and integration in the mathematics curriculum

Given the complexity of the way in which the classification seems to be working in this curriculum, it would be useful to consider the AS statements in another way, in order to further unpack the implied relationships between mathematical contents within the curriculum, and between these and contents outside of mathematics itself. To do this the assessment standards were coded using Dowling's (1998) domains of mathematical practices.

Dowling (1998) uses the concept of classification to produce a model for analysing different types of mathematics statements in pedagogic texts and provides a language for describing relationships between school mathematics and other domains of practice. He does this through considering the strength of classification of school mathematics practices along two axes: content (signified) and mode of expression (signifier), to produce four domains of school mathematical practices: the *esoteric domain*, the *descriptive*, the *expressive* and the *public* (see Figure 5). Dowling used this language to analyse different types of mathematics textbooks. However, it seemed that the idea of domains of mathematical practices could be adapted to analyse the NCSM statements. These statements are pedagogic texts that teachers must interpret in order to make selections of content appropriate for their learners to gain access to school mathematics and school mathematical practices as defined by the NCSM.

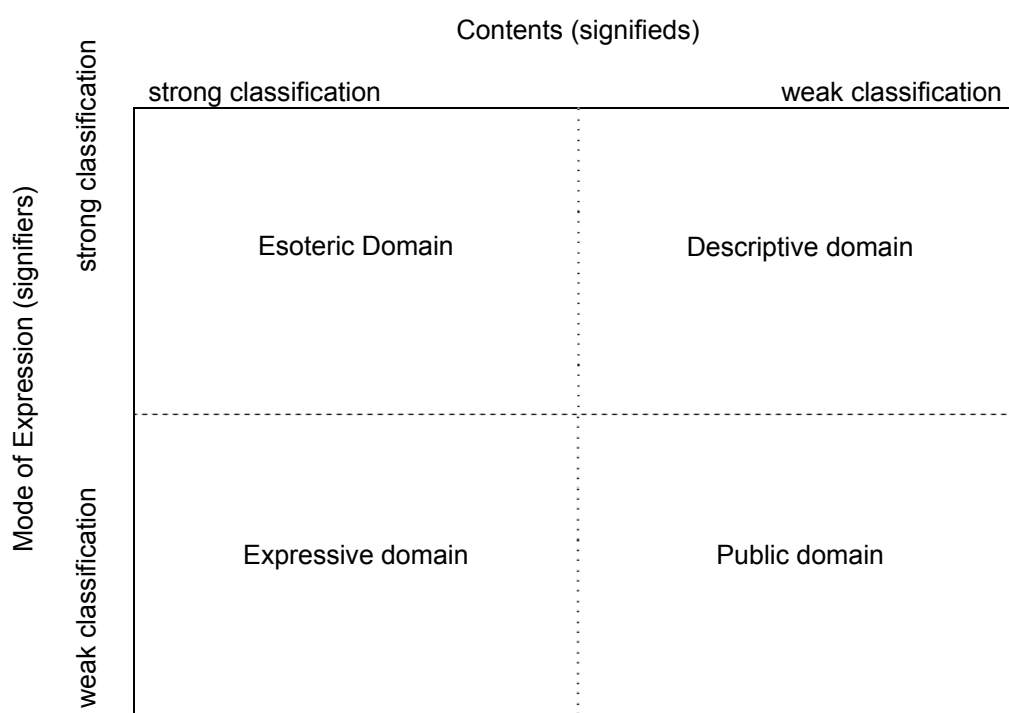


Figure 5: Dowling's domains of mathematical practice (Dowling, 1998, p. 132)

Dowling makes the point that all activities must look beyond themselves for pedagogic reasons otherwise there would be no point of entry into the esoteric domain for the novice, who for him, needs to be apprenticed into the specialist activity of school mathematics. In order to do this the esoteric domain looks beyond itself, casting a gaze upon external practices, which are then recontextualised by it in various forms. Recontextualising, for Dowling, involves the subordination or partial subordination of the forms of regulation of one activity to the regulatory principles of another. The type of practice produced through the recontextualisation depends on the relative strength of classification along two axes, content

(what is signified) and mode of expression (how it is signified, i.e. the signifiers). Classification here refers to the boundary strength between mathematics as specialised knowledge and practices, and everyday knowledge and practices. Recontextualising leads to the production of a space constituting domains of practice.

The *esoteric domain* is most strongly classified with respect to other activities. Both the forms of expression and the content are specialised. Ambiguity is minimised and therefore specialised denotations and connotations are prioritised. It is therefore within this domain that the principles which regulate the practices of the activity can gain their full expression. Highly specialised abstract mathematical statements which might be elaborated either as a set of principles (relational) or set of procedures (instrumental) are identified as belonging to this domain.

An example of this in the NCSM is found in L O 1, AS 3, Grade 12 (DoE, 2003, p. 19):

- a) Correctly interpret sigma notation.
- b) Prove and correctly select the formula for and calculate the sum of series, including:

$$\sum_{i=1}^n 1 = n ; \quad \sum_{i=1}^n i = \frac{n(n+1)}{2} ; \quad \sum_{i=1}^n a + (i-1)d = \frac{n}{2}[2a + (n-1)d] ;$$

$$\sum_{i=1}^n a.r^{i-1} = \frac{a(r^n - 1)}{r - 1} \quad r \neq 1; \quad \sum_{i=1}^{\infty} a.r^{i-1} = \frac{a}{1-r} \quad \text{for } -1 < r < 1$$

Statements such as these are the easiest to code. There is no ambiguity, they are highly specialised and abstract and belong unambiguously to the esoteric domain of mathematical practice.

The *public domain* is where there is relatively weak classification of content and mode of expression. Here the forms of expression and content are generally selected from public domain contexts (the everyday) and they are referred, by the mathematical gaze of the esoteric domain, to mathematical contexts. The example given by Dowling is of shopping lists where the task is to work out the total cost of a given shopping basket. In his example the domestic context of shopping is recontextualised, and so reinterpreted in terms of a different practice, arithmetic. In considering where such examples arise in the curriculum document under discussion, statements which are not unambiguously mathematical, either in terms of the

content that they refer to, or the language which is used to do this, were coded as public domain. Examples are:

Critically analyse investment and loan options and make informed decisions as to the best option(s) (including pyramid and micro-lenders' schemes) (LO 1 AS 5 Grade 12, Ibid., p. 21);

Demonstrate an appreciation of the contributions to the history of the development and use of geometry and trigonometry by various cultures through a project (LO 3, AS 7 Grade 10, Ibid., p. 36).

Activities selected for the former AS would necessarily involve non-mathematical contents. The successful 'critical analysis' of different options would involve subjecting these contents to a mathematical gaze. It is clear that the content is not mathematics, and that the forms of expression that might be used in doing the critical analysis would not necessarily be highly specialised mathematical language. The successful achievement of the AS would however entail an orientation that required a mathematical gaze on the public domain practices. If a mathematical gaze is not produced, then the practice will remain in the everyday, for example as a described list of loan options or a story of the history, rather than a focus on the internal logic of the mathematical practices that are targeted at those most economically disadvantaged, or the mathematical ideas and thinking practices that have contributed to the development of powerful trigonometric and geometric structures. Statements that fell into this category were also fairly easy to identify.

The *descriptive domain* arises when specialised mathematical expressions are imposed on non-specialised contents. So here the contents are weakly classified whereas the expression is relatively strongly classified. Here specialised expressions (e.g. algebraic) formulae are imposed on non-specialised content (a situation from a non mathematical context) from the position of the esoteric domain. In the coding, the assessment standards/ contents are located in the descriptive domain when the standards/contents appear from the language in which they are couched to be mathematical, but where the content is not necessarily mathematical. An example of this is LO 3, AS 6, Grade 10,

Solve problems in two dimensions by using the above trigonometric functions and by constructing and interpreting geometric and trigonometric models (examples to include scale drawings, maps and building plans) (Ibid., p. 36).

The *expressive domain* is produced through a different type of recontextualisation, where the gaze combines specialised content with non-specialised forms of expression. Here the classification of content is fairly strong while the classification of expression is weak. The example that Dowling gives is of a 'machine chain'. Here the non-mathematical element (machine) is recontextualised within mathematical practices (a formula unpacked into its constituent parts to show the operations on inputs to produce outputs) in order to give

expression to the mathematical content. Mathematical statements that are unambiguously mathematical in content but are couched in relatively unspecialised language are coded in terms of the expressive domain. In the NCSM statements I found no examples that belonged exclusively to this domain, although these were examples (see below) that could include this, if the teacher interprets the statements in a particular way.

In the analysis, some standards were identified as finding expression in more than one domain and in these cases were coded under more than one possibility. For example LO 2, AS 3a, Grade 10 and 11,

Recognise relationships between variables in terms of numerical, graphical, verbal and symbolic representations and convert flexibly between these representations (tables, graphs, words and formulae) (Ibid., pp. 22-23).

Here, depending on the choice of the representation, the practice might be entirely within the esoteric, the descriptive, or the expressive domains. It would be unlikely that this AS would find expression in the public domain.

I do not have space to elaborate with further examples. In Table 5 I simply provide a summary of the crude counts made across the various outcomes using the kind of coding described above.

Table 5: Coding of assessment standards in terms of Dowling's domains of practice

Learning Outcome	Number of assessment standards in outcome	Domain of Mathematical practice (number of instances coded per outcome)			
		Esoteric	Expressive	Descriptive	Public
1	6	4	2	4	2
2	8	6	2	3	1
3	7	4	1	2	1
4	5	3	0	5	3
All	26	17	5	14	7
%		65,4	19,2	53,8	26,9

There are cases, as shown in the last example, where a statement is considered to provide possibilities for the focus to be in more than one domain and therefore the resultant percentages do not total 100. They show the percentage of assessment standards that include each domain. Also these are totalled across all the grade statements and so are not disaggregated and therefore cannot show the changing focus across grade levels. However in doing the analysis it was noted that as the grade level progressed so the focus on the esoteric became more pronounced. While this is a fairly crude count, it does help us see that although the major focus of this curriculum is on entry into the esoteric domain, access to the esoteric

domain seems to be largely through the descriptive domain, with some focus on the public and the expressive. This indicates a commitment to a fairly strong classification of contents and expressions within mathematics from contents outside of mathematics, but at the same time to an understanding of the necessity of providing access to the esoteric through use of other contents and modes of expression, in particular the descriptive domain. This is important because it indicates a commitment to mathematics which gives more meaning to the earlier suggestion that the NCSM promotes the 'proper' connections between mathematics and other subjects and real life contexts. Here we see that such connections work in the interests of mathematics.

4.6 Some comments with respect to the analysis of the NCSM

I began this chapter by referring to the notions of competence and performance curricula. These seem to have been proposed as dichotomous, the one being incompatible with the other. However the three analyses show that in the case of the NCSM aspects of both models are visible. While the counts are fairly crude, they do give some evidence to the claim that the NCSM is a hybrid curriculum, one that exhibits features of a competence model and a performance model.

On the level of rhetoric and general orientation of the introduction and aims of the curriculum, the bias and focus can be seen as politically motivated and expresses the very real need for social justice and transformation of South African society as a whole, valorising indigenous knowledge systems, democratic access to mathematics for all through the weakening of boundaries and integration of knowledge, and a social logic in which the pedagogic subject has no deficits. From this point of view the NCSM seems to be proposing a competence-based pedagogic model. However, the specific instructional discourse that becomes evident when analysing the assessment standards, contents and contexts indicate a different view. For example, the focus on the orientation to mathematics as a structured discipline involving conventions and skills to master in order to gain access to further studies (96% of the AS's), and the strong classification between mathematics and other fields of knowledge (92% of the AS's refer to contents within the discipline itself), both imply a strong disciplinary bias towards the acquisition of the hierarchical structures and conventions of the discipline. That is, they require a specific text to be mastered and acquired. This would appear more consistent with a performance model than a competence model. However, in terms of the domains of mathematical practices that are implied by the various AS's, only 65,4% fall within the esoteric domain, and there is a spread that includes other domains of practice, which could

imply some weakening of the boundaries between the contents of mathematics and other types of knowledge, more characteristic of a competence model. However, it is the case that access to the esoteric appears to be constructed through the descriptive domain, which would, if interpreted with a mathematical gaze, involve induction into mathematics in-and-for itself.

I have shown that in terms of its *general regulative discourse* (GRD) the NCSM has a bias and focus that fits with the *social logic of competence* as described by Bernstein. However, I have also shown that a deeper look into the details of the intended curriculum expressed in the specified assessment standards and suggested content and context of learning, reveals a hybrid curriculum characterised by substantial content that requires the development of hierarchical forms of mathematical knowledge and esoteric mathematical discourse. That is a specific instructional discourse which would necessarily be framed by strong evaluative criteria in order to be reproduced; this would theoretically be more consistent with a performance-based pedagogic mode. Thus while at first the curriculum document appears to promote a competence based pedagogic mode, the strong framing of the assessment standards and contents indicate the need for explicit and visible criteria and thus a performance-based pedagogy. While the curriculum focuses on entry into the esoteric domain of mathematics, it does not see this as being isolated from other domains. In particular, access into the esoteric is through the descriptive domain with some focus on the public and the expressive as well. The ability of a teacher to choose appropriate contents to enable this access will depend upon her induction into the mathematical practices and orientations to mathematical knowledge that are emphasised by the curriculum.

5 Official discourses, official pedagogic identity and teacher education

In terms of the pedagogic discourse to be realised at the classroom level the NCSM implies new relationships between teachers and learners and between these actors and the subject matter to be taught – changes in both the instructional and the regulative discourse (the what and how) – both in general terms (GRD) and in very specific terms (SID/SRD) in relation to what is seen as legitimate mathematical knowledge (concepts) and ways of knowing it (habits of mind and the regulatory order for its learning). In terms of the discussion on mathematics teacher knowledge and identity in Chapter 2, whereas the earlier curriculum was very much product oriented working on the basis of ‘received’ knowledge and ways of knowing - a hierarchy of concepts, facts and skills expressed as definitions, products and methods to be learnt and practiced – this curriculum is not. It is more practice oriented and focused on

producing ‘connected’ knowledge and ways of knowing. It focuses on the practices of mathematics (e.g. investigating, making conjectures, justifying, generalising, etc.) as well as the skills (e.g. factorising) and the products (e.g., ‘laws of exponents’); and on making meaning through problem solving contexts. The implication of this curriculum is that teachers’ mathematical identities should be constructed as ‘connected’, they should have productive dispositions (Kilpatrick et al., 2001) towards mathematics and be able to engage in a ‘dance of agency’ (Pickering as used by Boaler, 2002a). This does not seem to be a reform curriculum that is based on ‘generic’ knowledge and a ‘watering down’ of mathematics, rather it seems it is a curriculum that is very concerned with mathematics and mathematical ways of being and seeing – but these are not images that are necessarily common in the South African context.

If these new orientations are to be adopted by teachers more generally, and by newly trained teachers specifically, it implies an internal change in their mathematical identities, not simply an orientation to new methods or ways of teaching. It implies that they will have to (re)learn mathematics in order to have a foundation on which to base their new subject/discipline loyalty. In Bernstein’s (Bernstein, 1971, p. 56) terms it is “systematic socialisation into subject loyalty” that is the “linchpin of the identity”. He argues that once an educational identity is established through systematic socialisation into subject loyalty, it is very *difficult* to change, because of the psychic defences that tend to maintain the identity by rejecting the new (as a fad, as unworkable, as madness, as something for others not for me, etc.). For Bernstein “change of an educational identity is accomplished through a process of resocialisation into a new subject loyalty” (Ibid) a change that would involve teachers recognising that the previous classification principle was arbitrary and internally contradictory and then internalising the evaluative criteria for the new orientation (legitimate texts) (Bernstein, 2000). Clearly in addition to this, for teachers to be in a position to teach this new kind of mathematics, they will also need to develop an internal loyalty to a new pedagogic discourse, that is new orientations to mathematics teaching and the *foundations* (recognition and realisations) for this. Both of these aspects are a challenge for MTE.

In this thesis my focus is on the production of curricula for initial secondary mathematics teachers. Below I briefly explore the implications of the above analysis for this challenging task.

The NCSM opens up new areas of mathematics for schooling, it changes focus from pure mathematics to the mathematical sciences, and it introduces a view of mathematics as

historically developed. The new secondary mathematics teacher, to work productively with this curriculum needs to be competent in these extended curriculum areas – she needs to develop a number of specialised pedagogic identities, each related to a specialist knowledge discourse: an identity related to mathematics; applied mathematics, statistics and the history of mathematics. These mathematical identities are related to the novice teacher's access to practice in the field of mathematical sciences *in-and-for-itself* (and not necessarily for the purpose of teaching). They have to do not only with the novice teacher's growth as an 'able mathematics learner' (in all three discourses that constitute the mathematical sciences) and thus her development of subject loyalty in relation to the disciplines themselves, but also to new ways of learning and engaging with these. It is this loyalty that may be a key to her interest in, involvement in and passion for the mathematical sciences that could, given the appropriate opportunities, become the basis for the development of a different set of identities related to mathematics teaching.

The changes in the mathematics curriculum represent major shifts for most prospective mathematics teachers whose mathematical identities were constructed under an 'old' (outgoing but still existing) education system. Teachers are required to implement these new ideals in their classroom practice. This means that they are required to develop new images of 'good practice' for mathematics teaching (recognition rules), and new pedagogic identities (forms of consciousness) that enable them to carry out these practices (realisation rules).

Initial teacher education, through the four-year degree programme, is thus faced with a complex task – a need to provide curricula to create paths for the acquisition of mathematical science discourses for teachers who in their own schooling have probably experienced an impoverished mathematical education. However, the development of these consciousnesses is insufficient for a South African teacher hoping to institute the new curriculum, in particular the changes in practice implied by the roles discussed earlier. Teachers also need to develop practices for teaching these mathematical discourses as distinct from learning them. That is, in addition to acquiring the criteria (recognition and realisation rules) for these specialised forms of consciousness in the mathematical sciences (in-and-for themselves), the new teacher needs to develop a specialised pedagogy in relation to each “for the complex task of transforming this knowledge into appropriate opportunities for learning in school” (Adler et al., 2002, p. 151). And this is related to the *mathematical work of teaching* in practice and the development of *mathematical knowledge for teaching* (Adler & Davis, 2006; Ball et al., 2004), a knowledge discourse and its practice, that is different from, and possibly works in an opposite direction

to, the discourses and practices of the mathematical sciences.⁸² From this perspective learning *mathematics teaching* is not simply a matter of learning from experience, or reflecting on experience. It is about access to subject specific pedagogic problem solving that enables the teacher to work productively with mathematics to evaluate learning in classroom contexts.

In terms of the theoretical ideas introduced earlier in Chapter 3, while the curriculum statements can project images of ideal mathematics teachers, these intended identities will not necessarily be acquired. What happens in practice will depend on what occurs in real educational contexts and how the student teachers respond to these. The *design* of teacher education curricula can only work at the level of officially projected identities. These can influence the emergence of new teacher identities through the relations they set up with the particular knowledge discourses and practices they make available. *What* resources are used as a basis for the specialisation of the consciousness and *how* these are made available to the student teachers will be a crucial issue. Acquisition of the recognition and realisation rules for a specific practice (say learning mathematics or teaching mathematics) will depend on the evaluation rules of the pedagogic discourse – the criteria of what is seen to be the ‘legitimate text’. So a different specialised consciousness could be acquired depending on the selection and organisation of knowledge contents and how they are made available to teachers: i.e. what is recognised as legitimate knowledge and practice, and the pedagogic modes of its transmission.

In terms of the various paths to becoming a teacher in South Africa mentioned earlier, it is in the new four-year B.Ed programme that such a (re)education in the mathematical sciences and in mathematics teaching becomes a possibility – that is, teachers coming to know and work within the *mathematical sciences in and for themselves*, and, teachers working with transformed school mathematical knowledge within a classroom and knowing and practising *mathematics for teaching*. Gaining access to these forms of knowledge provides a possibility for breaking the cycle of poverty in mathematics education that is a feature of the South African educational context. Key areas of curriculum contestation in relation to these teacher education tasks are linked to questions related to: *what* knowledge should be selected?; *how* should it be organised in the teacher education curriculum?; and, *who* should be involved in teaching this selection to teachers. For example, should teachers be taught mathematics

⁸² See the discussion in Chapter 2 on teacher knowledge. Also see Ball and Bass (2000) for a discussion on the idea that mathematicians work at compressing knowledge, while mathematics teachers need to decompress it; Ball, Bass and Hill (2004) for a discussion on the need for teachers to learn to ‘unpack’ familiar mathematical ideas; and, Adler and Davis’s (2006) extension of this idea in their understanding that teachers are required to unpack mathematical knowledge for the purposes of teaching and evaluating the acquisition of mathematics.

relevant to the school curriculum by mathematics educators modelled in a way that they ought to teach it? On the other hand, should they be taught mathematical sciences by academics within the disciplinary departments of the university at a level above school mathematics and possibly divorced from school mathematics? Or would some combination of these be best? In terms of teachers learning to select and transform mathematical knowledge for teaching, similar questions can be asked about mathematics teacher education academics and experienced mathematics teachers.

In the context of designing initial four-year teacher education programmes the preceding discussion becomes important. The development of the teacher as an ‘able mathematics learner’, learning the mathematical sciences and thus developing disciplinary identities, must be part of the initial education programme, particularly in the light of the generally low level of personal mathematical competences developed in our prospective teachers through their prior schooling experiences, and the high demands of the new curriculum (Parker, 2004a). This is to be co-ordinated with a second specialist curriculum challenge, one that develops specialised mathematical practices for and in teaching.

On the basis of the above discussion I suggest that practising *mathematics teaching* (learning a specialised school mathematics teaching practice) and *practising mathematics* (learning to work with academic mathematics) are two distinct types of activity related to different knowledge discourses, the one more like a craft and the other a vertical discourse with a horizontal knowledge structure with a strong grammar (Bernstein, 1999). Initial mathematics teachers require access to *both*, particularly in times of reform where *new* mathematical learning identities *and* teaching identities need to be formed. These are clearly connected discourses, although they have different internal structures, and work in opposite directions (as Ball and Bass (2000) clearly show with their discussion on compressing and decompressing mathematical knowledge). In addition to the above, I also identify a third distinct discourse that would be implicated in the specialisation of mathematics teachers. This is the growing research domain of *mathematics education*, which focuses on developing knowledge *about* teaching and learning mathematics (learning mathematics education).

In the next chapter I use the above ideas to develop a model of specialist discourses and identities that can be used as a basis for the empirical research that follows. In particular I theorise that there are at least three different mathematically related pedagogic identities that a novice specialist mathematics teacher should develop through a teacher education programme.

An identity as a student of mathematical sciences (becoming an able mathematics, applied mathematics and mathematical statistics learner, thinker and actor); an identity as a student of mathematics education (becoming someone interested in learning from research in the field of mathematics teaching and learning); and an identity as a mathematics teacher (becoming someone who can utilise their knowledge to help learners develop productive mathematical identities and be motivated to learn the discipline at higher levels). Each of these identities would be a product of access to different knowledge discourses, and in each case recognition and realisation rules for what comes to be seen as the ‘legitimate’ discourse and its practices might be developed throughout a teacher’s career.

In any specific MTE curriculum, the knowledge resources and practices selected and organised for developing the specialist role, would influence different realisations of these identities. A debate and issue of contention is centred on the extent to which these should be integrated or not in teacher education practice, and related to this who should take responsibility for developing them in teachers (mathematicians/mathematics education specialists/teachers). Thus in examining any curriculum, different combinations of contents related to these three specialised discourses and their practice are likely to be found. There are also likely to be different boundary relations between them and forms of classification related to the knowledge discourses, their agents and the spaces in which they are made available to student teachers. The specific constitution of the pedagogic discourses for these forms of knowledge the construction of specialised identities that are made possible through this, are likely to vary across the field.

6 Conclusion

I began this chapter with a discussion of the general regulative discourse underpinning the NCSM and showed that it exhibited all the main features of a competence model underpinned by the logic of competence. I analysed the NSE roles to produce an account of the official pedagogic identity of teachers projected from the ORF and embedded in policy (in this case the NSE and NCSM). I showed that this image of the teacher is underpinned by the logic of competence, and makes demands on teachers to make significant changes in their identity. The ideal symbolic images projected by the role descriptions do not fit easily with teachers’ existing identities and practices and present a major challenge for teacher educators.

This was followed by an in depth analysis of the NCSM in order to probe the specialist demands being made of teachers and to provide an account of the projected pedagogic identity

of mathematics teacher from this policy. I analysed the statements in three different ways. Firstly, drawing on, and extending, Graven's (2002a; 2002b) description of orientations to mathematical knowledge in the C2005 curriculum, I analysed the orientations to mathematical knowledge embedded within the NCSM. Secondly, I analysed the classification of mathematical knowledge in the NCSM using theoretical resources drawn from Bernstein (Bernstein, 1977b, 1996) identifying the complex way in which integration of knowledge worked within the NCSM. Finally I considered the nature of this integration and its implications for teacher identity by analysing the statements using Dowling's (1998) domains of mathematical practices.

The analysis has shown that the NSE together with the NCSM projects an image of a specialist mathematics teacher who is able to work in new ways with new forms of mathematical knowledge and able to productively teach this mathematics through what could be described as a socio-constructivist, learner-centred and discussion-based approach. Access to the criteria for the realisation of these new texts for novice mathematics teachers cannot be ascribed, or simply stated. To produce such teachers is a pedagogic problem, not a regulatory one, and requires the production of pedagogic discourses for mathematics teaching that enable the recognition of the meaning of, and realisation of, these new legitimate mathematics texts and teaching texts. The production of the criteria (evaluative rules) for the definition, and internalisation of these *new* practices is the work of teacher education. In the following chapters I examine the production of curricula within the PRF of mathematics teacher education, firstly through a survey of programmes in the field and secondly through two in-depth case studies in which I examine examples of curricula in sites of MTE practice.

Chapter 5

The construction of teacher education curricula in the PRF: Forms of knowledge and practice.

1 Introduction

In the preceding chapters I showed that the institutional restructuring of teacher education together with the new policy to regulate the production of teacher education qualifications opened up spaces for teacher educators to take some control over the specialisation of teachers within the new SA context. In addition I showed that new policies, in particular the NSE and the NCSM, project *symbolic images* of what is expected of mathematics teachers in the new reformed system. These are *official* images of a desired pedagogic identity, that is, policy images rather than constructed realities based in practice. These images project a vision of a *competent* mathematics teacher for post-apartheid South Africa that the state expects would be produced through curriculum reform in teacher education. Teacher education is thus charged with a major challenge: to produce new teachers in this new image through newly designed pre-service and in-service teacher qualifications, and so, to institutionalise the ‘bias and focus’ of official discourses.

In Chapter 3 I argued that, given their increased autonomy by virtue of their new structural position, teacher educators are uniquely positioned to insert their own ‘bias and focus’ and thus to influence, shape and perhaps even control what comes to be institutionalised as official knowledge and official discourse for teachers and teaching, particularly in the new four-year degree. I argued that this could involve inserting a bias towards disciplinary and principled knowledge and research-based (codified) practical knowledge/ craft and expressive/artistic knowledge, while at the same time working towards specialising teachers who could work productively in the system. I also suggested that unless they do this, other interests, particularly those which might push for an insertion of experiential (practice) oriented teacher education and a valorising of local knowledge at the expense of more principled forms could flourish. The consequence of filling programmes with so called generic knowledge and ideal policy images that are too far removed from practices in real classrooms can lead to unintended and problematic consequence. The dangers inherent in this path are prefigured in the some of the more damaging effects of the vacuous implementation of new policies that have been recognised within schools. These could continue to flourish into the future unless

teachers' consciousness and consciences are specialised to adequately recognise and realise productive teaching and learning practices within the post-apartheid context.

In this chapter I move from theorising the position of teacher educators within the new context and from analysing policy projections and regulatory prescriptions which could influence and structure their work, into the empirical field of teacher education itself. That is to consider the production of curricula for mathematics teacher education that has occurred across the field with the introduction of the new regulations. This chapter therefore focuses on addressing questions 3, 4 and 5 posed in the introduction to this thesis. That is the questions:

3. How have Higher Education Institutions in SA responded to the changes in the teacher education landscape, and, how have they attempted to fill the pedagogic spaces made available for the production of mathematics teachers within this new context?
4. What are the range of MTE programmes available in these institutions, and how has knowledge and practice been organised within them?
5. What knowledge discourses and practices appear to have been made available to mathematics student teachers across these diverse sites?

To answer these questions it was necessary to carry out a survey of specialist initial mathematics teacher education curricula offered at all South African public HEIs. While information was collected for all initial MTE programmes offered by institutions (i.e. PGCE and B.Ed programmes), the chapter only focuses on forms of knowledge and practice within B.Ed programmes offered by institutions across the HE field.

I begin the chapter by elaborating a model to identify possible knowledge domains that could be included within any specific MTE programme. The model is based on the three mutually constitutive pedagogic discourses and their practices that I began theorising in Chapter 4. This model is used as a basis for processing the curriculum documents and the information that was collected from the empirical field. I then describe the process for collecting information from the empirical field: this involved an attempt to comprehensively survey the range of initial mathematics teacher education programmes offered at all public HEIs. I give an overview of problems that I encountered as I attempted to collect this information and a description of what was collected. I raise some concerns related to the limitations inherent within this information. This is followed by a presentation and analysis of data produced from the information collected. The chapter therefore provides an overview of the way in which knowledge and practices in the various *intended* programmes were organised (at that time) and thus gives an

indication of how the pedagogic space identified in the first part of my study was being filled by teacher education providers. The survey also enables me to describe how the various institutions positioned themselves with respect to the regulatory environment.

2 Knowledge discourses and practices for mathematics teachers and mathematics teaching: a model

In Chapter 3 I argued that in SA, teacher educators are crucial agents for constructing the ‘what and how’ of pedagogic discourse for (mathematics) teachers and teaching. They are required to recontextualise knowledge for teachers who are learning to teach within a particular social context, a transforming society in which the general regulative discourse of the state is strongly articulated through the constitution and the new curriculum documents. The distributive rule operating throughout the education system is powerfully determined by this context, and teacher educators within HEIs have no choice but to be profoundly affected by it. However, in their dual positions as knowledge producers and recontextualisers, they have an opportunity to bring particular ideological screens into play: that of the academic and intellectual, where scientific knowledge counts and disciplined activity is valued, as well as that of the mathematics teacher (whether located in a university education faculty or science faculty) whose commitment is to fostering the mathematical learning of others (student teachers, and by proxy, their learners).

In Chapter 4, I argued that the new context will require teachers who are able to interpret the national curriculum documents for school mathematics with a *mathematical gaze* (Dowling 1998) and who have access to the mathematical and educational knowledge resources to be able to ‘unpack’ the curriculum and so carry out the required specialised mathematical work of teaching. This it was suggested is particularly important in initial teacher education within the new undergraduate B.Ed, where access to academic and professional knowledge for teaching must be provided. Here various pedagogic discourses for teaching mathematics, including disciplinary knowledge (mathematics as a discipline in-and-for-itself), educational knowledge (mathematics education and education as discursive fields of study and research) and knowledge for mathematics-teaching-in-practice (as a field of practical accomplishment as well as a growing research domain) could be provided and co-ordinated within the curriculum, to support the construction of new teacher identities.

In particular I suggested that, within the reform context, there are at least three different mathematically-related specialised pedagogic identities that a novice teacher could construct: an identity as a student of mathematics (becoming an able mathematical thinker and actor); an identity as a student of mathematics education (becoming someone interested in learning from research in the field); and an identity as a mathematics teacher (becoming someone who can utilise their knowledge and practice and the mathematical problem solving necessary to help learners develop productive mathematical identities). If these are to be developed then recognition and realisation rules for what is to count as ‘legitimate’ mathematical knowledge and mathematics teaching practice need to be developed for each, and knowledge discourses and their practices need to be selected and made available in the curriculum for this purpose. It was suggested that it is not only important to focus on what is selected (and therefore privileged) but also on how it is made available, who makes it available, and what relations are set up within and between the selected discourses and their practices. On the basis of this I now discuss a model for the specialist (mathematically related) discourses that could be found in any teacher education programme.

2.1 The model

The model for the possible specialist mathematically related domains of knowledge and their practices that might be selected into a four-year initial B.Ed for SP and/FET mathematics teachers is shown in Figure 6. Three distinct specialist domains are identified as possible components in any given programme: Mathematics (M), Mathematics Education (ME) and Mathematics Teaching (MT). The discussion below the figure elaborates some aspects of the model.

The three domains and their constituent discourses are deeply interconnected and yet each has its own distinct features. Empirically, in any particular programme, they may be more or less integrated with one another other. They are discussed separately below.

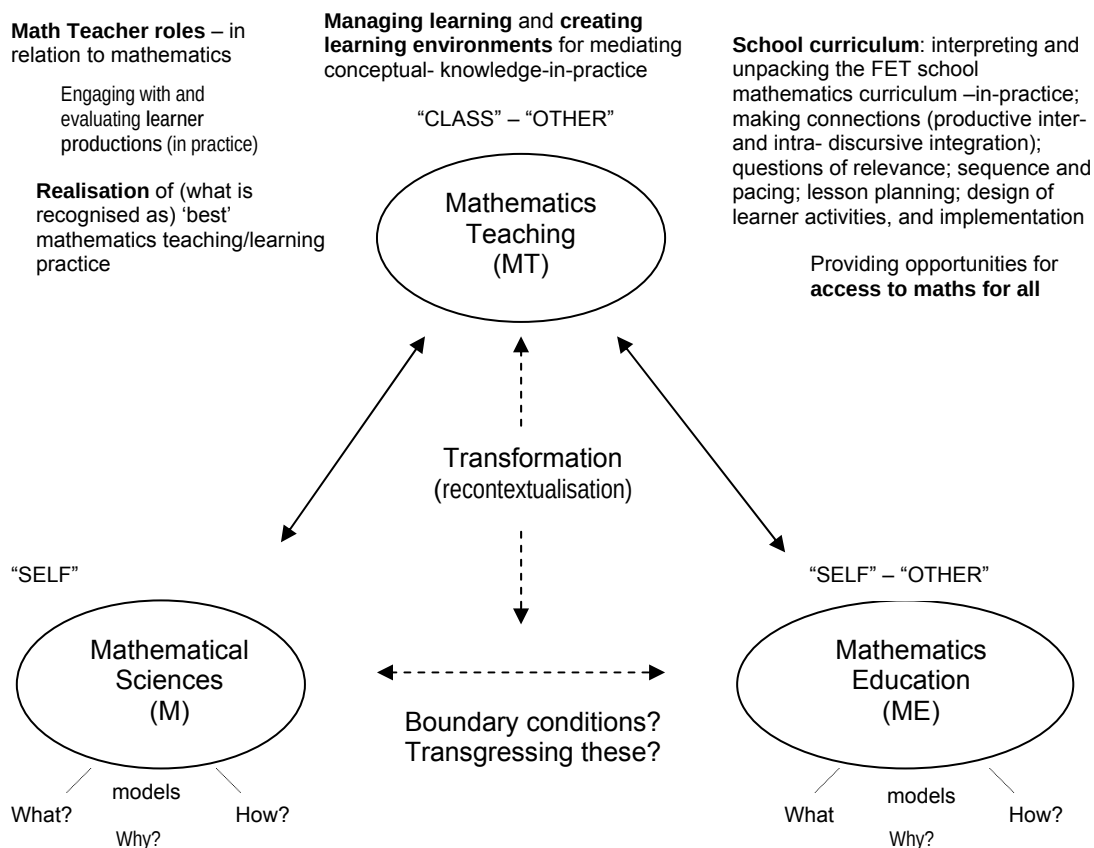


Figure 6: A model of possible specialist discourses selected into an initial four year mathematics teacher education programme

2.1.1 Mathematical Sciences (M)

Mathematical sciences (M), a domain consisting of the *primary disciplines* of mathematics and mathematical statistics, as well applied mathematics⁸³. Mathematics has been described as a vertical knowledge discourse with a horizontal organisation (or structure) and a very strong grammar (Bernstein, 1999). It has a horizontal structure since it is comprised of different languages (for example, Algebra, Geometry, Group Theory), each of which forms its own area of specialisation. In any particular university mathematics department you could expect to find highly specialised experts producing knowledge within each specific area. It has a strong grammar since the various languages that constitute the discipline are unambiguous, internally consistent and hierarchical. Each language becomes increasingly symbolic and abstract (esoteric) as one moves up the vertical hierarchical structure. There is also horizontal consistency and coherence, and any horizontal ambiguity is directly dealt with conceptually through restrictions/ definitions/ principles/ rules. Since it has a strong grammar the legitimate text, particularly lower down, is unambiguous, however, this does not mean that the discipline is complete and infallible. There is continuous production of new knowledge at the highest

⁸³ For convenience, I will generally refer to mathematics meaning the domain of the mathematical sciences and its constituent disciplines.

levels however most students, and especially prospective teachers, are unlikely to reach these levels. Similar comments could be made about mathematical statistics and applied mathematics. In SA the new selections of school mathematics for the FET⁸⁴ is a recontextualization of aspects of these specialised disciplines which are selected to provide access to mathematical practices that will enable entry into higher education studies in the discipline and applied sciences or fields which use the languages of the disciplines.

It is expected that FET mathematics teachers would need to develop the language and thinking of at least some (selected) aspects of the mathematical sciences that will enable them to develop a (deep) sense of what it means to do mathematics, think mathematically, understand its processes and practices, and so have entry into the fundamentals of the discipline in-and-for-itself. This is knowledge *for* the teacher (*self*) and relates to developing a mathematical identity and a mathematical gaze. We might expect to find different selections into M across the field with some curricula focussing on mathematical content relevant to the school curriculum, and others that focus on selections from university level mathematical science courses. There may also be some which have different combinations of both. Thus we could expect that in a specific programme access to the discipline and thus a disciplinary identity may be constructed through various combinations of content and practices from school and university mathematics. It may also be possible to consider the breadth and depth of contents selected, with some that focus on going deeper into school mathematics (into the roots of the selected knowledge) and some that go beyond that (to know what school mathematics provides access to). The focus here is on providing access to fundamental concepts and practices in the discipline and on the teachers' personal engagement and proficiency within the discursive knowledge domains that make up the mathematical sciences (mathematics *for* the teacher). That is, developing an identity as an able mathematics learner through the study of **M for the "self"**.

2.1.2 Mathematics Education (ME)

Mathematics education (ME) is seen as a *secondary domain* of knowledge production. It is a developing research domain in its own right - it is not simply a 'recontextualization' from mathematics, from the general field of education, or from other fields of knowledge in the social sciences or psychology, although it may draw theoretical inspiration from some of these and build on theory developed within them. It would not be seen as a discipline in the same way that mathematics is (it is more region than a discipline), however it is a specialised

⁸⁴ See discussion of the NCSM in Chapter 4 where this was established.

knowledge domain in its own right and in Bernstein's terms would be described in terms of a vertical discourse that has a horizontal knowledge structure and a weak grammar. It is a vertical discourse since it is a discursive domain produced through research in the field. It is horizontally organised since it is made up of a large number of different languages all with their own particular vocabulary, meanings etc. It has a weak grammar, since for the most part, these languages do not speak to each other, and specific words/ concepts can have different meanings depending on which language is being used. In specific areas of focus, the developing domain keeps producing new ways of speaking about research problems in order to better describe the area. So for example in the field of mathematics teacher education, we find descriptions of different types of knowledge littering the field (see discussion in Chapter 2 for examples). While this is a different *kind* of specialised knowledge domain from that of the mathematical sciences, it may also be considered as being essential for developing the specialised 'consciousness and conscience' of a mathematics teacher. It would include, for example, a study of research into aspects of what following Shulman (1986b; 1987a) has been called pedagogic content knowledge; curriculum knowledge; specific research into teaching and learning specific school mathematics topics (which is a rapidly growing field); various theories and approaches to mathematics education grounded in the sociology of, psychology of, or philosophy of mathematics education, and so on. There may be more or less focus on these discursive resources within a particular initial MTE programme. This will depend on what access the teacher educators have to these discourses and what they privilege from their own ideological positions. The focus in this domain is on gaining access to the domain of research in ME in-and-for-itself (for the development of the self as someone interested in and working with research from the domain of ME), and theorising how this domain might help in the practice of teaching mathematics to others (theorising aspects of mathematics *for* teaching (others)). It is a broad field – but is essentially theory/ research based, and a discursive knowledge domain. The focus here is **ME for the “self” and “other”**.

2.1.3 Mathematics Teaching (MT)

Mathematics Teaching (MT) is seen as a *tertiary domain*. In some cases it may be very close to being considered a horizontal discourse; it involves the development of specialised pedagogic skills for teaching mathematics, and could involve aspects of practical (craft) knowledge as well as aspects of expressive (art) knowledge, as well as a variety of local experiences and the development of practical wisdom⁸⁵. It might include an increasingly more disciplined focus (an emerging vertical discourse) what might be called the 'mathematical

⁸⁵ This could be connected to Ensor's (2003) notion of developing a 'professional argot' for mathematics teaching.

work of teaching' in practice. It is complex, nuanced, tacit and involves developing ways of using (managing) the knowledge resources or reservoir learned in the other domains (M and ME) to develop a repertoire for mathematics teaching in the complexity of practice in a school classroom and/or simulated context. Its full development and acquisition is a life-long journey within a context of the work of mathematics teaching and only a beginning can be made in the initial teacher education programme, an orientation. In the teacher education programme this beginning (in theory) should not be left to a general domain of 'school experience' since it involves specialised knowledge-in-practice (specialised to mathematics teaching and learning – using mathematics *for* teaching). It is however quite possible that in empirical contexts it might be constructed as simple experience and developed as a localised horizontal discourse rather than being understood a form of practical knowledge that may not be learnt through experience, especially if the experience is not alongside a 'model' teacher. The focus here is on **teaching the other**.

There are clearly other contents that will be selected into any specific teacher education programme. It is assumed that we would see in any particular programme aspects of something which could be recognised as the 'study of education' that might also be variously formed, and other non-specialist yet important contents, for example academic literacy/computer studies etc.

2.2 Selection of contents into the various domains

In each domain, choices have to be made. Teacher educators would necessarily be forced to select particular knowledge resources from the vast 'reservoir' that makes up each domain (*what*) and make choices about how these should be presented and made accessible to their students (*how*). These choices will work together to constitute the pedagogic discourse instituted in practice. This will become the 'privileged reservoir' that will provide the bases (models/ images and discursive resources) for the student teachers' recognition of what mathematics, doing mathematics and teaching and learning mathematics is all about *and* how to go about teaching it to others. This will provide a major resource for developing their mathematics teaching competence and form a basis for the development of a privileged repertoire for realising (putting into practice what they come to recognise as) best mathematics teaching/learning practice⁸⁶.

⁸⁶ This description uses Ensor's (2000; 2001; 2003) use of Bernstein's (1996) distinction. This was discussed earlier in Chapter 2.

What is selected and made accessible to particular students through a specific MTE programme will be a reflection of the different interests involved in designing the curriculum and in particular the positioning of the teacher educators involved with respect to the ORF and to the field of knowledge production itself. Mathematicians, mathematics education researchers, and school mathematics practitioners might all make different choices. Any particular curriculum may include or exclude these different interests (specialised voices).

2.3 Organisation of the various domains in an initial four-year MTE curriculum

The different contents and practices that are selected and therefore privileged for transmission and acquisition in any particular initial MTE programme will be organised in ‘time and space’ over the four years of the undergraduate degree. There could be a wide range of different ways of organising these contents across different institutional contexts. Figure 7 indicates some possible organisations in time of selections from the different domains into the MTE curriculum. In all the figures the three domains are represented in a specific space. The particular area given in these diagrams is fairly arbitrary, but we could imagine a wide variety of different proportions of time allocated to each. They are all shown here as separate domains. However, we could imagine that in any particular curriculum they might be more or less integrated – that is the classification values could vary fairly widely. The models say nothing about possible framing relations.

In Figure7a) M is a focus in the first year of study. As the years progress so ME and MT become more and more in focus until the fourth year, where these dominate. MT always remains a fairly ‘thin’ wedge in the model – this is not because this it is not seen as important, but rather because it represents the most complex aspect and represents a beginning for these student teachers – a ‘gaze’ that will develop in practice throughout their teaching careers. It represents the transformation (recontextualisation) of knowledge-into-practice, and the development of reflexive and applied competence.

In Figure7b) access to aspects of M is provided before the introduction of any ME and MT. Figure7c) represents a model similar to the degree + PGCE route, the academic M is covered first and is fairly strongly classified, and in the final year there is a focus on ME and MT. In Figure7d) there is a focus on all three all the way through the programme. Finally in Figure 7e) we see an early focus on M and ME, with M taking up most of the time. This is then followed by a total focus on MT (say for example through an internship year, in the second or

third year of the degree). In the final part of the programme the focus is once again on M and ME with ME dominating the time. Figure 7 shows only some possibilities, but it illustrates the point. In the empirical field we might find a large number of different organisations of these domain in a particular curriculum in MTE in practice.

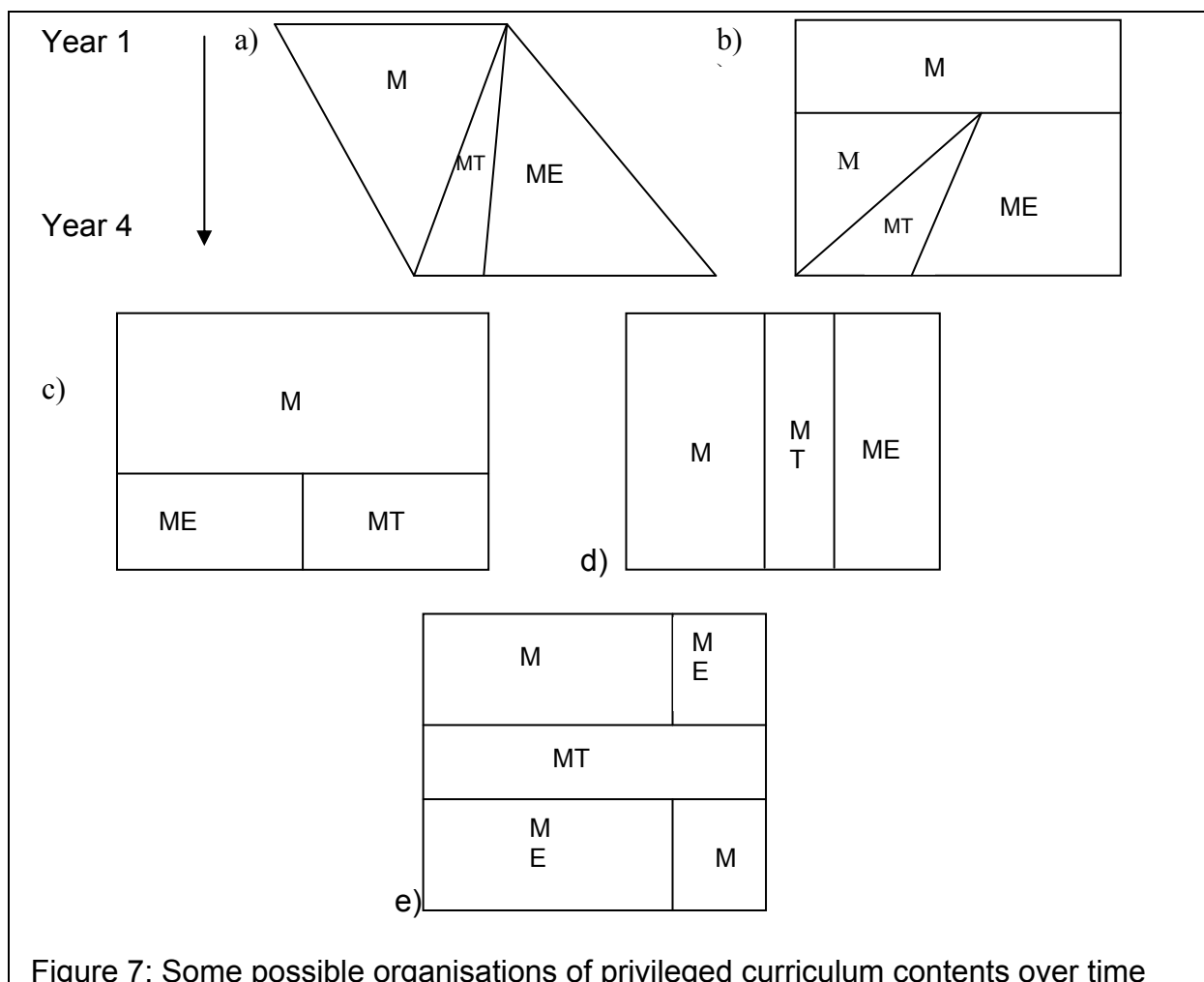


Figure 7: Some possible organisations of privileged curriculum contents over time

2.4 Classification of specialist contents in the curriculum

The next issue to consider is related to the boundary conditions between the various discourses selected into the curriculum. Are they all integrated into one ‘course’ of study, or are they separate? Do the students learn for M, ME and MT through different modules/ courses in different spaces, being taught by different lecturers (agents)? Or are they all taught by the same lecturers, simultaneously in the same classroom and through the same courses?

For Bernstein (1977c) a curriculum is a particular arrangement (of contents) that emerges from a system of choices that has a social basis. “A curriculum is defined in terms of the principle by which certain periods of time and their contents are brought into special

relationships with each other” (p. 79). He suggests that any curriculum can be examined in terms of:

- 1) how much time is allocated to given contents,
- 2) the relative status of the contents (e.g. those that are compulsory and those that are optional), and
- 3) the relationships between the various contents

The relationship between contents refers to the notion of classification. The relationship between contents can be seen in terms of the boundaries between contents – are they clear-cut or blurred? That is, to what extent are they insulated from one another: are they in a *closed relation* to one another (well insulated from other contents) or in an *open relation* (reduced insulation from other contents)? Classification refers to the relationships between contents; the nature of the differentiation between contents (Are contents in an open or closed relationship to one another?) Strong classification (+C) implies insulation and strong boundaries between contents. Weak classification (-C), implies reduced insulation (increased hybridity) and weak/ blurred boundaries. Classification therefore refers to the degree of boundary maintenance between contents.

For Bernstein (Ibid.) the relations between the various contents organised in time and space lead to two broad types of curriculum: collection and integrated, although these can be thought of as a continuum rather than a straight dichotomy. Figure 8 provides a summary of the characteristics of each type.

Collection type (contents insulated from one another and in a closed relationship to each other)		Integrated type (contents stand in an open relation to each other)
		
Extreme collection type	(degrees of integration)	Extreme integration type
No contents are open. All contents separate and autonomous. Time-periods firmly fixed for specific contents. What is taught is in the hand of those who teach it and evaluate it. Teachers have relative autonomy within 'prescribed limits'. Teaching practices vary with individual contents and individual teachers.		All contents open. No fixed time periods given to specific contents. Contents are subordinate to an idea/narrative that reduces their isolation and encourages hybridity. Contents are seen as part of a 'greater whole' part of a 'big picture'. The selection of what is taught is subordinated to the 'general idea' (theme) and subject to change. A move towards a common pedagogy and assessment style – a common teaching practice.

Figure 8: Summary of characteristics of collection type and integrated curriculum codes (following Bernstein, 1977c, pp. 79 - 84)

In the teacher education curricula submitted for recognition and evaluation for employment purposes, the contents are given in terms of broad credit point specifications. This is specified in the Criteria (DoE, 2000a, p. 16): “The total number of credit points must be given”. In addition to this

the minimum or maximum credits required at specific levels, including evidence that the minimum specialist requirements in the case of a 480C B.Ed, as described in the Norms and Standards for Educators are complied with. (Ibid.)

The various submissions can therefore be analysed in the first instance in terms of these credit points, which translate in into time allocated to specific aspects in the curriculum. In terms of SAQA regulations, one credit is equivalent to ten notional study hours (1C = 10nsh). All the Norms and Standards compliant curricula should follow this basic equation. While one notional study hour is fairly arbitrary, it does give an indication of the importance of a particular aspect in terms of its overall weighting in the curriculum. The amount of time allocated to each of the specialist domains (if they are visible) and other domains can be calculated which will give some indication of the relative importance of each.

Depending on the specific formulation of the documents the intended contents of the specialist modules/ courses may be more or less visible. The documents can be examined to see to what extent the various specialist modules are integrated/ insulated from one another. For example, are selections from M, ME and MT taught together in the same module, or are they taught separately in different modules. Information from the questionnaires (see description of information collected in Section 3.2) can be used to assist with these details.

In terms of classification in a curriculum, the boundaries are not only considered in terms of the selection of contents, but also in relation to other aspects of the social organisation of learning. Specifically, Bernstein (1996) distinguishes between classification of knowledge (selection of contents and the relations between them), agents (who teaches these and the relations between these agents) and spaces (where are they taught and how open/ closed are these). Classification of contents has been discussed above. In addition we can consider the classification of agents. For example, if there is strong classification between agents, this would imply that different lecturers would lecture students for different M, ME or MT modules, and there would be minimum contact between them. For example if M is learnt in a mathematics department and taught by mathematicians, ME is learnt in the university education department taught by mathematics education academics, and MT is learnt in

practice in a school under the guidance of an experienced mathematics teacher, we would recognise strong classification of knowledge, agents and spaces. We can imagine a wide variation of possibilities here. In the next section I focus on the survey of initial mathematics teacher education qualifications, offered across public HEIs.

3 A survey of mathematics teacher education qualifications offered at South African HEIs: Collecting the information

As my interest was specifically in the production of curricula for initial mathematics teacher education, I first had to identify the institutions that offered these programmes. Once that was done I could go about obtaining information about the design of their programmes leading to B.Ed qualifications, and specifically for SP/FET or FET mathematics teachers.

3.1 Institutions that offer teacher education programmes

The first step was to identify those institutions that offered initial MTE programmes. In order to do this I needed to know which institutions offered teacher education more generally. Thus I began the process by considering the incorporation of colleges of education and the institutions that had been given the responsibility to provide teacher education programmes by the DoE.

As indicated in Chapter 3, by the end of 2000 there were 25 colleges of education that were still operating, and The Minister declared theses to be incorporated into 18 earmarked HEIs on 31 January 2001 through the *Government Gazette* (Vol. 426): *Declaration of Colleges of Education as subdivisions of Universities and Technikons* (DoE, 2000b). Table 6 on the next page gives details of the colleges that were incorporated into various existing HEIs. The table also includes 8 additional institutions that did not incorporate a college but that were identified as institutions that would offer public teacher education programmes.

The table shows that on incorporation the college campuses were not all kept intact as education campuses. While some were absorbed into the institution as sub-divisions and single purpose education ‘colleges’ were retained to be operated as separate campuses, others were absorbed into the general university campus as part of the general campus, or as additional centres for the university and used for a variety of purposes and not exclusively for education. Some were closed. In the cases of closure, the campuses reverted to the provinces to be used for various purposes, including in-service teacher education.

Table 6: HEIs responsible for teacher education and the incorporation of colleges in January 2001 (source: DoE, 2000b, personal communication with each faculty/ school of education)

Province	Higher Education Institution (University or Technikon) tasked with provision of teacher education	HA/ HD ⁸⁷	College(s) incorporated as divisions of University/ Technikon	College campus retained or closed for purposes of university based (teacher) education
Eastern Cape	University of Port Elizabeth	HA	Dower Col of Ed	Closed
	Port Elizabeth Technikon	HA	Algoa Col of Ed	Incorporated for general use
	Eastern Cape Technikon	HD	Cicira Col of Ed Transkei Col of Ed	Closed
	University of Transkei	HD	No college incorporated	n/a
	University of Fort Hare	HD	No college incorporated	n/a
	Rhodes University	HA	No college incorporated	n/a
Free State Province	University of the Free State	HA	Bloemfontein Col of Ed	?
	Vista University – Bloemfontein Campus	HD	Thaba 'Nchu Col of Ed	?
	University of the North – Qwaqwa campus	HD	Tshyia Col of Ed	?
	Technikon Vrystaad	HA	No college incorporated	n/a
Gauteng Province	The University of the Witwatersrand	HA	Johannesburg Col of Ed	Campus retained almost exclusively for education
	University of Pretoria	HA	Onderwyskollege Pretoria	Campus retained for education and some other functions
	University of South Africa	HA	South African College for Teacher Education (SACTE)	Closed
	Rand Afrikaans University	HA	No college incorporated	n/a
KwaZulu-Natal Province	University of Natal	HA	Edgewood Col of Ed	Retained exclusively for education
	University of Zululand	HD	Esikhawini Col of Ed Eshowe Col of Ed	Closed
	Natal Technikon	HA	Gamalakhe Col of Ed Indumiso Col of Ed	Retained – limited use for education
	University of South Africa	HA	The South African College of Open Learning (SACOL)	Retained – general UNISA Pmb centre
	University of Durban Westville	HD	No college incorporated	N/A
Northern Province	University of the North	HD	Mapulaneng Col of Ed Mokopane Col of Ed MASTEC Col of Ed	Closed
	University of Venda	HD	Makhado Col of Ed Giyani Col of Ed	Closed
Western Cape Province	Cape Technikon	HA	Cape Town Col of Ed (Mowbray) Boland Col of Ed	Retained for education and other uses
	University of Cape Town	HA	No college incorporated	N/A
	University of the Western Cape	HD	No college incorporated	N/A
	University of Stellenbosh	HA	No college incorporated	N/A
North West Province	University of Potchefstroom	HA	Potchefstroom Col of Ed	Incorporated into the general uni campus
	University of the North West	HD	Mankwe Col of Ed	Campus retained for education and community outreach
Total number institutions	25 ⁸⁸		25	

The Northern Cape and Mpumalanga did not have HEIs and so no colleges were incorporated in those provinces.

⁸⁷ HA = historically advantaged HEI (HEI for 'whites' under apartheid); HD – historically disadvantaged (HEI for 'blacks', i.e. exclusively for Africans/ Indians/ Coloureds).

⁸⁸ This is the number of universities not campuses. For example, UNISA is found twice in the column, once in Gauteng and once in KwaZulu-Natal. In the literature and policy (see Chapter 3) 23 public higher education institutions were earmarked to provide teacher education. In this table 25 appear to be involved in providing programmes. Later after the consolidation and merging of the various HEI institutions in 2004, it was expected that 23 would remain.

In terms of the NSE (DoE, 2000c) and the Criteria (DoE, 2000a), all institutions had to design new B.Ed qualifications and take them through the various regulatory processes described in Chapter 3 by 30 June 2001. The following clause explains the process:

The change of nomenclature in accordance with the Norms and Standards imply more than a mere redesignation of the current programmes. It requires that existing programmes be redesigned in order to reflect the notion of applied competence and its associated assessment criteria and the seven educator roles. The June 30, 2001 date allows institutions sufficient time to register, accredit, seek funding approval and approval for employment purposes through the CHE, SAQA and DoE processes to ensure that all their qualifications are suitably named for the academic year 2002. (DoE, 2000a, p. 14)

It was expected that institutions would begin to offer their B.Ed programmes from 2002.

While it was expected that most HEIs would begin offering their new programmes in 2002, however, they were given some leeway:

All existing qualifications formally approved by COTEP and HEDCOM may continue to be offered until June 30, 2003. A student admitted to such a qualification as late as January 2003 would still be able to complete his/her qualification. All COTEP and HEDCOM approved qualifications will continue to be recognised for purposes of employment. This lengthy time span is designed to allay fears and uncertainties. However, providers and students are urged to move across to the new framework as soon as possible. The process of incorporating teacher education and colleges of education into higher education is likely to enable many students to transfer from their existing qualifications to qualifications compliant with the Norms and Standards for Educators (February 2000). (Ibid.)

Institutions were permitted to begin offering their new B.Ed programmes in 2001. Alternatively they were also able to continue with their existing programmes⁸⁹ for the interim. However the final possible intake of students for old programmes would be in 2003 and all new programmes should be place and have been taken through all the various stipulated processes by 30 June 2003.

I made the decision to carry the survey of the field out in July 2003, by which time the various institutions should have had their B.Ed programmes designed and have taken them through the various regulatory processes and would have started offering them. As had been indicated in Chapter 3, the various responsibilities for registering, accrediting, funding and recognition of qualifications were split between SAQA, CHE and the DoE. This was not only the case for teacher education qualifications. In terms of the new regulations governing all qualifications (under the SAQA Act), every existing HE programme (including teacher education programmes) had to be taken through registration processes with SAQA, accreditation with CHE and funding with the DoE. An Interim Joint Committee (IJC) was constituted in order to manage and streamline this initial process. The IJC operated from July 2000 though to July 2003. All teacher education qualifications had to be taken through the IJC and then evaluated for recognition for employment in education with the DoE. Since all qualifications had to pass

⁸⁹ e.g. Higher Diploma in Education (HDE), Secondary Teachers' Diploma (STD). Bachelor of Primary Education (B.Prim Ed) and so on.

through the IJC, and the process for HE qualifications was managed by the CHE, I thought that the most effective way of obtaining the information I required would be through the CHE.

3.2 Gaining access to formal documentation and identifying institutions offering initial specialist MTE programmes

I approached the CHE in July 2002 and requested permission to collect the information required. This proved to be more difficult than I had initially imagined. After six months of telephone conversations, e-mails, and visits, the CHE informed me that it was reluctant to allow access to the documents until such time as I had approached the various HEIs and received permission from them to obtain the documentation. In February/ March 2003 I duly contacted the registrar of every institution listed in Table 6. In a formal letter I requested permission to be allowed to access their information from the CHE (See Appendix C.1).

I realised that it may take some time to obtain this information. I was also concerned that the formal documentation might be in a very generic form which would not give me sufficient detail about the individual initial MTE programmes offered. I therefore also wrote to the Dean of the Faculty/ Head of School of Education at the various institutions to request further information about their MTE programmes (see Appendix C.2). This letter was followed by a telephone call and a direct conversation with each Dean/ Head of School and in some cases a faculty officer/ personal assistant. Through this process I was able to identify which institutions offered initial MTE programmes, either B.Eds or PGCEs or both for SP/FET teachers. I was also directed to the relevant mathematics section heads. I contacted these people telephonically and requested further information about their courses and programmes, and requested that they complete the questionnaire sent to the Dean/ Head (see attachment to the letter in Appendix C.2). The telephone call was followed up with a personal e-mail request, which had the letter to the Dean/ Head and the questionnaire attached.

Of the 24 institutions from whom information was requested, 22 returned slips indicating that I could gain access to their formal submissions to the CHE/DoE. I managed to contact and speak to 22 Deans and 21 of the mathematics section heads. However, after numerous follow up calls and e-mails, only 17 institutions completed the questionnaire. (See Appendix C.3 Table 1, which gives details of the various responses from institutions). In addition to the questionnaire I received variable amounts of information from these 17 institutions. Some provided course outlines while other provided whole study guides/ course notes and detailed plans of action about relevant to their specialist initial MTE programmes.

Once I had obtained permission from the various universities to collect their information, I contacted the CHE once more, requesting access to the information in July 2003. However, the head of the HEQC at the time was still not amenable to providing access to the information and suggested it would be problematic for them to provide access, even if the registrars for each institution had given their written consent.

At this point I contacted the DoE and was directed to the HE sub-directorate for the recognition and evaluation of qualifications in education. The directorate was very helpful and allowed me access to the formal documentation that had been through their evaluation process. These included all the qualifications that had been through the IJC *and* had also been evaluated and recognised for purposes of employment in education. I was able to make photocopies of the documentation submitted to the DoE by the various institutions as well as of the evaluation documents produced by the DoE with respect to each qualification, and was also provided with an *Index of approved programmes for employment in education* (DoE, 2002b). The index listed all the programmes that had been taken through all the necessary processes by 30 June 2003, and as far as the DoE was concerned, the only ones that were formally recognised for employment in education at that stage.

In addition to collecting the formal documentation, I also interviewed the Deputy Director and Assistant Director who were involved in evaluating the programmes and who assisted universities in the development of their curricula. This interview was taped and transcribed. It provided insights into the processes that had been put in place with the publication of the NSE and the Criteria and with the way in which the DoE interpreted and evaluated the curricula.

3.3 Limitations of information collected

The information collected for the survey proved to have many limitations. The formal documents were all submitted in a bureaucratic form (see Appendix C.4 for details), which while following the requirements of the NSE and Criteria were in most cases presented in generic language. This meant that I had to interpret each one to identify the various discourses that were embedded within it. While it was clear that the form was meant to make this process easier, there were a wide variety of interpretations over what should be in each section. While some institutions clearly already had a curriculum worked out (especially in the cases of named qualifications e.g. B.Ed (FET: Mathematics and Science) and in the sections where credit specifications at specific NQF levels and the rules of combination were required, they

had named modules and allocated credits, many institutions simply indicated generic labels and appeared to have no specific curriculum in place.

In general the sections, 5) Exit level outcomes and applied and integrated teaching competence; 6) Credit specifications at specific NQF levels for the various contents, especially for the specialist role; and 7) Applied and integrated assessment (DoE, 2000a, pp. 15 - 18), were the most helpful.

Section 5 and 7 provided useful insights as to the positioning of teacher educators with respect to the regulatory environment of the ORF, in particular the language used to indicate outcomes and the use of the NSE in the documentation. However, in general outcomes were written in such generic language that they provided no information with respect to the intended curriculum. The descriptions of applied competence were similarly meaningless for providing information about contents and knowledge domains. However, they provided an additional source of information for describing the position of institutions with respect to the NSE and Criteria regulations.

Section 6 gave information with respect to the knowledge domains co-ordinated in the programme from which the general design of the curriculum could be gleaned. However, very few programmes gave any indication of their substantive contents. In particular very little substance could be gleaned with respect to the breadth or depth of these intended contents, or, what was really meant by a particular NQF level. These appeared to be mostly arbitrarily assigned. However a degree of substance was provided for qualifications from institutions who responded to the questionnaire. In the next section I present an overview of the findings of the survey.

4 Mathematics teacher education qualifications offered at South African HEIs: An overview

The programmes surveyed were analysed in terms of notional time given to various types of contents and the relations between these in terms of knowledge, agents and spaces. The analysis is used to paint a broad picture of what is offered in B.Ed programmes across the field, and to raise some issues for mathematics teacher education. In particular challenges around what is considered appropriate knowledge for mathematics teachers and teaching, the relationships between mathematicians and mathematics education academics in this enterprise, and the role of practical teaching in the specialisation of mathematics teachers is considered.

4.1 Who offers the B.Ed and in what form?

My focus is on initial specialist qualifications for mathematics teachers. The survey was therefore focussed on collecting information about mathematics teacher education (MTE) programmes that lead to Post Graduate Certificate in Education (PGCE) and Bachelor of Education (B.Ed) qualifications for teaching grades 7 – 9 (Senior phase (SP) specialists), grades 10 – 12 (Further Education and Training (FET) specialists) or, across grades 7 – 12 (SP and FET specialists).

By September 2003, 68% of HEIs had responded to the questionnaire I had sent them and had provided additional information about their courses. By this time, 72% of the HEIs had also taken their programmes through the formal processes and had them evaluated and recognised for employment purposes in education. It is noted here that these percentages do *not* represent exactly the same institutions. There were institutions who were said they were offering qualifications and returned their questionnaires but who had not taken them through any formal processes, and others who had had their qualifications recognised but did not return the questionnaires. Specifically three universities and two technikons were offering qualifications that had not been approved for employment purposes. Together this information provided a picture of specialist MTE programmes designed by 22 institutions. A summary of institutions offering specialist MTE is shown in Table 7⁹⁰.

Table 7: Types of institutions and the specialist MTE qualifications they offer (September 2003)

Type of HEI	No. who offer initial MTE	No. who incorp a College of education	No and type of MTE qualifications offered					
			PGCE			B.Ed		
			SP	SP/F E	FE	SP	SP/F E	FE
HA Univ	11	7	4	10	4	5	5	6
HD Univ	7	4	1	4	0	2	4	1
HA Techn	4	3	0	0	0	1	4	0
HD Techn	0	0	0	0	0	0	0	0
Total	22	14	5	14	4	8	13	7
% (N=22)		63.6	22.7	63.6	18.2	36.4	59.1	31.8

Source: Combination of documents from DoE (2002b) archives and HEI questionnaire responses

While information was collected about PGCE and B.Ed programmes, the focus in what follows is on the B.Ed only – it is in this qualification that selections from all three domains discussed earlier might be expected to be included in the curriculum.

⁹⁰ See Appendix C. 5 (Table 2) for the full table produced from the information collected.

B.Ed - SP (Grades 7 - 9)

This is offered by eight institutions. Six of these had incorporated a college of education. Of these institutions two are HD universities and one is a HA Technikon. In most cases the student has to specialise in two learning areas, although in one case there is the option of specialising in three learning areas. In most cases a variety of combinations are possible, although all SP qualifications require one of the learning areas to be one of mathematics, natural science or technology. This is in line with the requirement in the NSE. In at least three cases, the curriculum is fixed and mathematics has to be taken in combination with the natural sciences learning area. One of these fixed curriculum B.Ed degrees is not an initial qualification⁹¹ – it is an upgrading qualification for existing teachers and does not fit in neatly with the other qualifications in the survey. In most cases the entry requirement seems to be an attempt, but not necessarily a pass, in matric mathematics. In some cases matric mathematics at a given level (e.g. at least standard grade D) is stipulated. At least one institution has an entry test, and students who show basic competence but have not achieved the minimum set are required to take additional courses in foundational mathematics.

B.Ed - SP+FET (Grades 7 – 12)

This is the most popular programme and is offered by 13 institutions, of which 9 have incorporated a college of education and 3 are HD institutions. All four Technikons offer this programme. In most cases there are a variety of options available for specialisation. As with the PGCE, they generally enable students to qualify for one FET subject (mathematics) and two learning areas (mathematics and one other), or for two FET subjects and two learning areas. In one case it is possible to qualify in one FET subject and three learning areas. There are also at least two cases in which the combinations are fixed. In one programme mathematics has to be taken with physical *and* biological science, and the learning areas are natural sciences and mathematics. As with the B.Ed-SP, one of these fixed curriculum degrees is an upgrading qualification that is not in line with the other B.Ed degrees in the survey⁹². In

⁹¹ This should have been registered as an Advanced Certificate in Education (ACE), which is what most other institutions had done. The NSE for educators does allow for teachers who have an old 3 year college diploma to gain entry into the B.Ed degree at third year level, but only if they are assessed as competent to do that. The normal upgrading path is a specialised ACE. This institution has used this possibility in the NSE as a loop hole to offer their inset teachers an opportunity to upgrade from a diploma to a degree. However the mechanisms for quality assurance and for ensuring that this degree is equivalent to the offerings from other institutions are not clear and it appears that the formal offerings do not meet the minimum norms and standards suggested in the NSE. More than 240 credits are awarded as recognition of prior learning (RPL), but these do not appear to be connected to any assessment process. The qualification however was taken through the formal processes and registered, accredited and recognized for employment. This particular institution does not offer any full time B.Ed qualifications for initial teachers.

⁹² This is offered by a different institution to that described in the B.Ed-SP. Here the same loop hole has been exploited. However, in this case students are required to complete a full 240 credits.

general the entry requirement for this qualification seems to be the same as for the B.Ed-SP, that is, an attempt but not necessarily a pass in matric mathematics although in at least three institutions a minimum mathematics matriculation level of HG D is set.

B.Ed for FET (Grades 10 -12)

This is offered by 7 institutions, all of which are universities, six being HA institutions. Only one of these institutions did not incorporate a college of education. In most cases the entry requirement for this qualification is a pass in matric mathematics at a given minimum. In at least one case this is stipulated as at least a D on higher grade. In this institution students who do not meet the minimum requirement can complete additional foundation courses in mathematics, and if they achieve a minimum of 65% in these they may continue in the FET mathematics stream. One of these qualifications is a fixed curriculum upgrading qualification, similar to that described for the B.Ed-SP above and offered by the same institution. In this case the entry requirement is a prior diploma in secondary education with mathematics as a major. In most cases students are required to take two FET subjects. In only one institution is it possible to do a focussed FET single subject mathematics specialisation. In that institution the students are required to complete a full major in university mathematics and in place of a second specialisation to take additional courses in statistics, applied mathematics or any other university courses that the student may have an interest in, subject to the approval of the Dean.

Which institutions offer the B.Ed?

There are 19 institutions that offer a range of 28 B.Ed programmes for mathematics teachers. In many cases the entry requirement for specialist mathematics teaching in the SP and/ or FET seems to be any level pass in matric mathematics, and in at least one case an attempt, but not necessarily a pass is accepted. However there are three cases where matric mathematics at a given level (at least Higher-Grade D) is stipulated. These three are all institutions where students enter into mainstream mathematics courses and education is located on a general university campus⁹³. There are two institutions, both of whom are HA universities who incorporated colleges of education, who offer all three possible specialised B.Ed qualifications. All the technikons surveyed only offer the B.Ed (and not the PGCE). There are 4 institutions who do not offer specialist mathematics B.Ed programmes. Interestingly these are all institutions that did not incorporate a college of education. These institutions have chosen to only offer the PGCE for specialist secondary (SP/FET) teachers. Two of these

⁹³ That is the Education Faculty/ School is located on the same campus as other faculties.

institutions offer a B.Ed for primary teachers (GET), and two have positioned themselves to focus on postgraduate education and do not offer any B.Ed programmes for initial teachers.

4.2 The contents of specialist initial MTE curricula in the B.Ed across the HEIs

In this sub-section I give an overview of 25 four-year B.Ed programmes (7 SP, 12 SP + FET, and 6 FET) offered at 15 institutions⁹⁴.

The documents collected were analysed in terms of the time⁹⁵ given to various types of contents (Mathematics, Mathematics Education, Mathematics Teaching Practice, Education Studies, and general competencies) and the classification (relations between) them in terms of knowledge (what is included), agents (who teaches it), and spaces (where and with whom it is taught). While in the majority of cases the broad type of contents are visible and can be quantified, the relations between contents agents and spaces are not always clearly articulated. However, in the cases where additional information was provided they can be reasonably inferred. How these privileged contents are made available to student teachers is obscure and not possible to illuminate through the document analysis or from the information provided in the questionnaires. Such detail could only be gained from on site observation.

The total SAQA credits for the programmes range from 480 (the minimum required by policy) to 512. In general the policy minimum of 240 C for the specialist role has been adopted⁹⁶. Policy also stipulates that the specialist role is “the overarching role into which the other roles are integrated, and in which competence is ultimately assessed” (DoE, 2000: 12), however, most HEIs indicated in the questionnaires that credits towards the specialist role are isolated to the individual specialist modules, but it is assumed integration will occur during practice teaching experience. While the formal documentation submitted to the DoE all provide descriptions of the ‘exit level outcomes’ and ‘applied and integrated assessments’, these are very generic and how the specialist role is to be integrated and assessed is mostly obscure. It appears there is little attempt to integrate across specialist and general contents in practice. It is also the case that if credits are allocated to practice teaching, then they are ‘counted’ as part of the 240 specialist credits. In all cases the credits allocated to the specialist role are shared amongst the various specialisations taken in the

⁹⁴ This overview excludes 3 fixed curriculum programmes (one SP, one SP + FET, and one FET) that are offered by two HEIs as upgrading qualifications, on the grounds that they should be classified as Advanced Certificates in Education, and are not representations of the four-year B.Ed degree.

⁹⁵ Time is inferred from the SAQA credit values of various contents. 1 SAQA credit = 10 notional hours.

⁹⁶ Only one case was found where more credits were allocated to the specialist role.

specific degree programme. Where, for example, the degree is preparing a teacher for a variety of distinct SP learning areas (three when it is an SP only qualification) or FET subjects (generally two when it is an FET only qualification), the credits are spread more thinly over the different foci.

Table 8: The overall distribution of contents across different B.Ed programmes.

Type of B.Ed	Range % of total C for math specialist module(s) (Ave %)	Range % of total C non-specialist education modules (Ave %)	Range % C basic competence (language, computer, quantitative literacy)	Range % credits for practical teaching	Who assesses practical teaching ⁹⁷		
					Specialist university tutor	General university tutor	Mentor teacher
SP	9.1 – 27.7 (18.5)	25 – 37.5 (31.3)	7.5 – 13.3	0 – 13.3	0	6	1
SP+FE	20.3 – 29.7 (22.0)	17.2 – 55 (30.1)	6.4 – 13.3	0 – 13.3	1	10	1
FE	17 – 32.8 (24.4)	18.8 – 37.5 (28.7)	6.6 – 13.3	0 – 13.3	2	4	0

Source: Combination of documents collected from DoE archives and HEI questionnaire responses

Table 8 shows the broad distribution of contents across the B.Ed programmes, giving an indication of the range of SAQA credits, and hence the notional time, allocated to each type of content. This information is not linked to particular types of institutions. In each case, for comparative purposes, the credits are indicated as a % of the total credits allocated to the degree over the four years.

The DoE documentation does not clarify how practice teaching is organised and assessed and hence its role in specialising mathematics teachers is obscure. However, significant indicators could be: who evaluates the practice, how many times it is evaluated over the four years and whether specific credit values are allocated to it or not. This could indicate whether it is simply an experiential aspect of the programme – or whether there is some attempt to develop a discursive space for entry into a mathematics teaching discourses and a social space for the development/ construction of an identity as ‘good’ mathematics teacher⁹⁸. In the DoE documentation there are 8 approved B.Ed programmes offered by 5 HEIs that do not specify any credits for practical teaching at all. However, from the questionnaires returned it is clear that they all do send students out into schools for experience. The information that

⁹⁷ Very little information is available on this aspect. This information was only available from the questionnaires.

⁹⁸ See Ensor (2003) for a discussion of teacher education modalities and the need for models of ‘best’ practice that can work both at the discursive level and at the practical/tacit level for developing both recognition and realisation rules for what it means to develop best mathematics teaching practice in our context. Also see discussion in Chapter 2 and the discussion on mathematics teacher identities in Chapter 3 and 4.

was available suggests that in most cases practical teaching (whether specific credits are allocated or not) it is assessed by ‘general’ university tutor. Thus mathematics teaching-in-practice is assessed by someone who may not have access to the recognition and realisation rules of the practice and therefore it cannot be considered as something that is necessarily specialised in practice. The information supplied does not indicate how frequently the student teacher is assessed in practice, or whether their teaching is a significant factor in their achievement of the overall degree. I will return to this discussion later in the chapter.

Table 9 gives an overview of the specialist mathematics/ mathematics education contents and provides a breakdown of these in terms of the average percentage of credits allocated to each type of module across the institutions.

Table 9: Mathematically focussed contents across different B.Ed programmes: contents and agents.

Type of B.Ed qualification	Ave % of specialist maths credits for mathematics	Focus of maths content (number institutions)			Who teaches maths to teachers?			Ave % of specialist credits on maths education	Focus of maths education			Who teaches math education?		
		University level maths	Relevant school maths	Mix of relevant university + school maths	Mathematicians ⁹⁹	Maths education academics	Practicing maths teachers		Field of maths education	School maths + maths teaching	School maths + methods for math teaching	Mathematician	Math ed academic	Math teacher
SP	68.7	2	3	2	2	4	1	31.3	0	3	4	0	6	1
SP+FE	72.3	3	4	5	3	9	0	27.7	0	5	7	0	11	1
FET	73.3	3	1	2	3	3	0	26.7	0	3	3	0	5	1

Notice that all the specialised B.Ed programmes include some focus on mathematics and some focus on mathematics education/methods/didactics. Credit weighting for the specialist role varies with the purpose of the programme. The lowest proportion allocated to the mathematics specialist role is 9.1% of the credits for the programme (for an SP qualification where the specialist credits are ‘shared’ across three learning areas), with the highest being 32,8% (for a single subject¹⁰⁰ FET qualification). This illustrates the effect of the ‘spreading out’ of the credits allocated to the specialist role in those programmes where there are a number of different learning areas/ subjects in focus. In all cases a higher proportion of the

⁹⁹ Mathematician is used here to mean someone who is located in a mathematics department. This says nothing about the mathematical qualifications of academics located in education departments – they may/ may not be highly qualified in mathematically related disciplines.

¹⁰⁰ Only one case was found where it is possible to take a single subject specialisation.

specialist credits are more focused on what is identified as mathematics than on mathematics education/methods/didactics, generally in the proportion of about 70% to 30%.

What is considered legitimate mathematics and mathematics education in these programmes is not clearly visible – although the topic descriptions and the departmental location of the lecturers do give some indication of the variations in ideology. In the majority of the institutions (in 80%) mathematics is taught to B.Ed student teachers by staff located in education faculties rather than by mathematicians in academic departments. Some of these institutions appear to select topics that are directly relevant to the new school curriculum with very little university level mathematics involved (e.g. names such as: shape and space; patterns and algebra; data handling), while others appear to provide a selection across school and university topics (geometry, trigonometry, linear algebra, differential and integral calculus). It is not possible to give an accurate picture of the actual level of the contents selected or say much about *how* this mathematics is made available to novice teachers. That would require observation on site.

There are only three HEIs where the academic mathematics departments are directly involved teaching mathematics to initial teachers. This covers 8 B.Ed programmes (2 SP, 3 SP+FET, and 3 FET) – constituting 28,5% of all specialist B.Ed programmes offered at HEIs. In these instances, student teachers complete selected mathematics courses in lecture theatres together with other students who are studying mathematics for other purposes. University level mathematics topics covered are not necessarily directly relevant to school level mathematics – in two cases the mathematics major courses are taken to second year level, and in the third a specific combination of modules are selected for teachers. The selections made are driven by traditional mathematics university curricula, although in the third case mentioned the topics chosen appear to cover aspects of the field of mathematical sciences, perhaps in an attempt to be more relevant for the new National Curriculum for Grade 10 – 12. For example, selections from pure mathematics (differential and integral calculus, linear and/ vector algebra, discrete mathematics, graph theory), applied mathematics (optimisation methods, operations research) and mathematical statistics, are included. In these three institutions knowledge contents, agents and spaces are all strongly classified and appear divorced from the rest of the curriculum. They also all restrict entry to ‘good’ HG matric mathematics passes.

Most programmes make a distinction between mathematics and mathematics education (or methods/ didactics/ practice) and they appear to be taught separately¹⁰¹. It appears however, that none of the programmes project mathematics education as a distinct discursive field and aspects of what were earlier described as school mathematics and mathematics teaching are integrated into it. Selection of contents indicate a range of foci from how to teach specific school mathematics topics, through to tips for using various types of teaching styles and aspects of lesson planning, to drawing on some research related to learning theories in mathematics teaching and learning and error analysis in mathematics teaching and learning. The programmes can be divided roughly into two types: those that seem to be more concerned with teaching methods, planning, task design, and how to teach specific school mathematics topics by drawing on experience and reflection (approximately 50%), and those that seem to have a broader view drawing on theoretical ideas from the discursive field of mathematics education (e.g. van Heile levels) as well practical knowledge focused on school mathematics and school mathematics teaching. No distinct boundary appears to exist between mathematics education and mathematics teaching as fields of activity.

4.3 Some issues arising for mathematics teacher education

The survey gave a broad picture of the organisation of various initial B.Ed mathematics teacher education programmes offered in 2003, their focus in terms of various types of mathematically related contents and who teaches these. However it is not detailed enough to help us identify the official ‘legitimate text’ for mathematics teachers developed within the various programmes. The finer details of the pedagogic discourse that are instituted in individual programmes cannot be seen in such a survey and can only become visible with a closer look into what is offered at individual institutions. Nevertheless the survey data does illuminate certain features of the field and raises a number of issues and questions.

All institutions acknowledge that a study of mathematics (in-and-for-itself) and knowledge of mathematics education/teaching/learning is important for the production of mathematics teachers. The high proportion of time spent on mathematics indicates the serious concern for subject content knowledge of teachers. However, there are some differences across HEIs as to selections of *what* mathematics is seen as appropriate, and *who* should be responsible for its selection and transmission.

¹⁰¹ This does not indicate that there is no overlap/ integration in these offerings in practice – that could only become visible with a closer look at what is offered in sites of practice.

In 68% (15/22) of HEIs the B.Ed is seen as appropriate for the initial education of specialist mathematics teachers, and within these, 80% (12/15) do not ‘trust’ mathematicians to be involved in the process. The extent to which this is a result of perceived abilities of the students entering the programmes, the suitability of the mathematics courses offered in mathematics departments, or the location of education faculties on specialised campuses away from the main university is obscure. However, the data clearly shows that in general HEIs that incorporated a college campus assigned the responsibility for teaching mathematics *and* mathematics education to their education schools or faculties, thus excluding mathematicians from the process. That this opportunity has not been exploited can be partially explained by particular notions of what is relevant for mathematics teaching. Anecdotally, from telephonic discussions with the various heads of mathematics sections across different institutions, there was a strong sense that it is better for teachers to be taught mathematics by mathematics education academics than mathematicians based on what appeared to me to be a pervasive belief that what teachers *really need* is school curriculum knowledge, rather than extended access to mathematics at higher levels. Associated with this is the opinion that mathematicians do not understand what it means to teach school mathematics and that modalities of practice implemented in the university mathematics lecture room are not productive for their future careers as teachers. This belief (mythological truth?) bars the way for developing new and productive relationships, in both economic and educational terms, between mathematicians and mathematics teacher educators, and between the discipline of mathematics as practiced at higher levels and mathematics education.

The remaining 13,6% (3/22) of HEIs all leave specialist MTE entirely in the hands of the PGCE, where an undergraduate degree with some university level mathematics¹⁰² is a prerequisite. It is interesting that these institutions *did not* incorporate a college of education.

The above discussion once again raises issues about the relationships between mathematics as a discipline, mathematics education as a discursive field of study and mathematics teaching and curriculum practice as specialised activity, and the role of these in the production of mathematics for teachers and teaching. It also raises questions about the relationship between mathematicians and mathematics education academics in the field of MTE, about access to mathematics teaching and about the quality of mathematics learning of teachers being produced in the HEI system.

¹⁰² For an FET qualification 2 or 3 years of University level mathematics is expected in policy, but in practice most institutions accept students who have only one year of University mathematics, a pragmatic response to the scarcity of math graduates and the poverty of math education throughout the schooling system.

In relation to MT, there seems to be an assumption across the field that practical teaching experience is necessarily good, regardless of its form or how it is evaluated. It is mentioned in all formal documents submitted to the DoE as being a key for developing “integrated and applied competence”. It is ‘counted’ as part of the specialist role regardless of how it is evaluated, who evaluates it, or whether it is connected to the specialised (mathematical) work of teaching or not. For example, from the questionnaires it became apparent that in at least three HEIs student teachers are only seen by a university-based tutor in their final year for *one* formal assessment, yet they go out to schools once or twice every year from their first year onwards for experiential learning under the guidance of practicing teachers. It is not clear how these teachers are selected or if they receive any training in mentoring novice teachers. It is also not clear how the schools are selected, and whether or not they are functioning and have an ethos that is appropriate for the construction of the type of identity required or whether or not they provide the kind of images that will enable the development and realisation of ‘good’ mathematics teaching in practice.

Only 36% (9/25) of B.Ed programmes give specific credit weightings to the practice teaching experience, and only two institutions indicated that they provide school practice tutoring and assessment by specialists. It therefore appears that ‘mathematics teaching’ as a knowledge/practice domain, and the production of what Ensor (2003) terms a ‘professional argot’ for developing best mathematics teaching practices is mostly absent from MTE curricula. It is assumed as an accomplishment. It appears that in general the pedagogic space for MT is not opened up for discursive interrogation. Practicing teachers are assumed to be in a position to provide the ‘right models’ for novice teachers, and general university tutors are assumed to be able to assess the specialised mathematical practice of teaching. It is assumed that student teachers will be able to draw on what they have learnt in the mathematics teacher education classroom to recognise good mathematics teaching practice, and then in their experience in schools, realise this image of good practice.

The school mathematical background of student teachers accepted onto programmes also raises issues and challenges for MTE, particularly in relation to the construction of a mathematical gaze and teaching identity. That the entry requirements for the majority of the specialist MTE programmes are very low has to be understood as contextually related to the poverty of school mathematics education in SA more generally. However, given the selection of knowledge into the curriculum and the focus on selections of relevant school mathematics,

which are arbitrarily allocated NQF level 5 or 6 labels, and appear across all four years of study, it appears that fairly limited mathematical competence is being instituted. It may be that novice teachers are being given very limited access to disciplinary knowledge and the foundations to enable them to competently interpret the NCSM.

I began this Chapter by indicating that the survey would assist by providing some indication of the way in which teacher educators have responded to the opening up of pedagogic spaces for the generation of their specialist teacher education curricula. The previous section gives some insight into the way in which specialist discourses have been selected into the programmes. It shows that in most cases M is taken seriously and that ME and MT are generally considered as less important and more integrated. While M is seen as important it is clearly being selected for the most part on the basis of what is seen as relevant to the school curriculum and in many cases it seems that school level mathematics is the focus of learning. However the survey gives very little information about the organisation of the programmes over time, and also gives very little detail with respect to the substantive contents selected and the level of learning required (depth/ breadth) in the programme more generally. It clearly shows that SP only curricula are generalist and not specialist programmes. It also indicates that MT is generally considered a practical and experiential accomplishment and not a specialised domain.

In the next section I move to consider the positions that various institutions have taken with respect to the ORF and the official discourse of the NSE in the overall design of their programmes.

5 The positioning of teacher educators in the PRF with respect to the ORF

The various formal curriculum documents that I worked with had all been evaluated and the programmes they represent recognised for employment purposes. These documents had been through a process – they were not all accepted on first submission, although some were. The two DoE officials¹⁰³ who were responsible for the process went to visit most institutions (on invitation) to assist them with unpacking the requirements and the processes necessary to produce their curricula and take them through the various regulations. Some submissions were sent back to the institutions for revisions before being finally accepted. This might give the

¹⁰³ This information was revealed in the interview with the Deputy Director and the Assistant Director involved in evaluating qualifications. It is confirmed by my own experience: these two DoE officials visited my own institution on invitation to run a workshop with staff to inform them of the requirements and regulations.

impression that the regulations were prescriptive and that the analysis in Chapter 3 was incorrect. However it became clear, both in the interviews with the DoE officials and in analysing the documents, that the previous analysis was sound. Institutions were required to generate their own qualifications, and a wide range of different ways of interpreting the requirements of the NSE was accepted, particularly when it came to the contents that were selected into the programme.

All institutions that entered into the process eventually had their formal documents recognised. These successful documents all follow the ‘form’ required by the NSE and Criteria, however, they do not reveal much substance. That is, they show their compliance by ensuring that the bureaucratic form (see Appendix C.4) is adequately filled out so as to be accepted by the various authorities. These forms *must* show some links to the NSE through including some discussion of the roles. They *must* provide outcome statements. They *must* give details of credit specifications and show how the minimum specialist requirements are met. They *must* indicate how applied competence is assessed, and so on. However, the *substance* of the curriculum which the learning programme represents is often underspecified and obscure. For example there is no necessity to provide any specific course/module names or give any descriptions of their intended contents. While specification for the credit allocations to the specialist role (a minimum of 204 credits spread across all aspects of the specialism) were checked, generic descriptions were accepted¹⁰⁴. What is meant by these descriptions, however, is often obscure. Also the level assigned, while meeting the requirements, often appears to be fairly arbitrary¹⁰⁵. In working through the various submissions it appeared that many of the programmes were in the form of a ‘shell’ rather than representing a substantive curriculum that had been worked out in detail¹⁰⁶. The fact that all these documents mention the things they *must* in order to get their qualifications recognised, does not imply any commitment to the official discourse that underpins the documents, however it does indicate that the HEI is being compliant with the regulations in place. The wide variation of what was accepted as appropriate, and the lack of substantive elaboration to indicate what any specific aspect within

¹⁰⁴ For example, “12C at level 5 for ‘Shape and Space’” a module that forms part of the mathematics requirements assigned to make up the 204 C for a SP+ FET mathematics and science B.Ed offered by U19. What this means is obscure. Is it a study of geometry? Is it a study of the outcome ‘space and shape’ in the NCS?

¹⁰⁵ For example, in note 22 above, what does it mean that this module is at NQF level 5? The title appears to imply a selection from school mathematics. Without any elaboration it is accepted as being at NQF level 5. How would this compared to, for example, the pure university level Mathematics 100 modules (part of a mathematics major course of study) selected into the U11 SP+FET curriculum at level 5, which was also accepted as appropriate?

¹⁰⁶ This is confirmed by, for example, U5, who had a B.Ed SP + FET registered and approved in November 2001 (DoE, 2002b), but who indicate on their questionnaire that this was still under development, was only a proposal and had not been implemented by July 2003.

the design meant, supports the earlier conclusion that the regulatory process leaves open the pedagogic space for HEIs to insert their own bias and focus in the generation of their curricula.

In order to recognise the various positions HEIs took to the production of curricula and within the regulatory environment, so that these could be used as a basis for selecting the cases for the next phase of the study, I needed to produce some categories to work with. After considering the various documents submitted together with the replies to the questionnaire I had sent out, and specifically the question relating to the NSE, I was able to see a number of different ways in which institutions positioned themselves¹⁰⁷.

5.1 Compliance and non-compliance

Firstly there is the issue of compliance with the regulatory requirements. Did the HEI comply with the requirements and submit all their documentation to the IJC and DoE, or not? Here two positions were possible: *compliance* and *non-compliance*. Since every institution that submitted their documentation met the requirements these could all be identified as compliant.

Secondly I needed to consider what the reasons for the non-compliance of HEIs might be. In addition to those who had complied, I needed to have a way of describing the nature of the compliance? Was it possible to see whether they appeared to be committed to the official discourse of the NSE or not? And if they were, were there any differences in the way this was expressed? To assist with this I needed to look at the questionnaires and the formal documents that were submitted.

I recognised, within the documents of the institutions that were compliant, a number of different patterns:

- There were generally two positions; the one could be identified as ‘official’ and the other as ‘unofficial’.
- Those that were recognised as taking an *official position* appeared to have a level of commitment to the official discourse. Where a position was recognised as official, it appeared to work very closely with the NSE roles and competences and/ or with the SAQA SGB registered B.Ed qualification details. The exit level outcomes would be described by using (almost verbatim) the roles and/or competence statements/ outcome statements from the SGB documentation; its credit specifications and specific NQF levels would give details that appeared to be fairly generic/ connected directly to contents named to link to

¹⁰⁷ See Table 3 Appendix C.6 for the full table of data.

the various ‘roles’ (e.g. a course/ modules called “mediation of learning” or “research in education” U10); or linked to individual competences where specific credit values were given to specific competences e.g. (3 credits for “media for teaching and learning” U4). This produced two further positions:

- Where descriptions of credits and NQF levels indicate whole modules and indicate coherence in the overall design, these were recognised as *official and holistic*.
- In cases where the overall coherence was not easily recognised, and/or where credits were allocated to specific competences broken up into tiny components, the position was recognized as *official and atomistic*.
- An *unofficial position* was recognised as one where outcome statements, while mentioning the roles which are necessary for the form, tended to be fairly unique to the institution and did not appear to use standard policy wording. In these documents there is generally little mention of the roles/ competence statements in the descriptions of the credits and NQF levels. These designs appear to be based more on historical / institutional positions than on the new policy discourse. It was not possible to distinguish any further differences between these unofficial positions with the information at hand. They were recognised as being compliant but detached from the official discourse of NSE documents. There was one institution that had complied (as shown by recognition of their PGCE in the *Index of programmes* (DoE, 2002b)) but for which no other information was available. This could not be categorised.

Where there was *non-compliance* two positions were recognise.

- In the first position there was a *rejection* of the regulations as unwarranted state interference.
- In others it seemed that the decision was *deferred*. Here the institution was not specifically non-compliant, but rather just hadn’t done anything about taking their qualifications through the processes. In the questionnaire they indicated that they were using the NSE and the programmes they were using clearly would be compliant if they had been submitted.
- There were also a number of cases where there was no information available and so the reasons for non-compliance were not recognisable.

The different categories described above are summarised in Table 10.

Table 10: Positions taken with respect to the NSE/ Criteria regulations

Compliant				Non-compliant		
Official (committed to OD)		Unofficial (detached)	Other	Official (deferred)	Unofficial (rejected)	Other
holistic	atomistic	Meets basic requirements of form	meets requirements	institution has not yet submitted documents/ waiting to see whether it is really necessary/ have registered with SAQA and think that is enough/ unaware of requirements	not willing to bend to NSE requirements; see state as interfering with autonomy; reject criteria	reasons unknown: insufficient information
focus on roles and whole modules	focus on lists of individual competences/ contents with tiny credit values assigned to individual aspects	historical/ institutional traditions; generally whole modules; no clear commitment to official discourse	insufficient info available			

5.2 An analysis of positions taken by various HEIs

A summary of the various positions taken by different HEIs is given in Table11¹⁰⁸. This table includes *all* 25 institutions that had indicated they offered teacher education programmes in the questionnaire and/or who had taken their various programmes through the required regulatory processes. Note that the various institutions are spread over rural and urban areas. All rural institutions are found close to or in small towns. Urban institutions are located in or close to major Cities. There are some institutions that have campus in urban and rural locations, and in these cases, the *main* university campus is identified and counted in this table.

Table11: Summary of HEIs and their position to the official NSE discourse

Type of HEI (HA/HD)	Rural	Urban	Incorp coll	Compliant				Non-compliant		
				official (holistic)	official (atomistic)	unofficial (detached)	other	defer	reject	other
HA Univ (N=11)	2	9	7	3	2	5			1	
HD Univ (N= 9)	7	2	5	2	2	1	1	2		1
HA Techn (N= 5)	1	4	4			2				3
Total (N= 25)	10	15	16	5	4	8	1	2	1	4
% (N=25)	40	60	64	20	16	32	4	8	4	16
% (N=25)				36						
% (N=25)				72				28		

72% of HEIs had complied with the policy and by September 2003 had their qualifications approved. Of these half took official positions using the NSE as more or less prescriptive. This was the highest proportion of institutions. It is interesting that these were spread over

¹⁰⁸ The full table from which this is derived is presented in Appendix C.6 (Table 3).

historically advantaged and disadvantaged universities, and across institutions that incorporated and did not incorporate colleges of education.

Overall we see that 20 % of the compliant HEIs, interpreted the NSE in a more or less holistic way focussing their programme designs on the overall roles. These institutions did not see the lists of competences as prescriptions to implement, but appear to understand that they would make selections and to develop their own programme. However, 16 % of the institutions did consider the regulations as atomistic, using the competences as specific assessment criteria and producing fragmented curricula. It appears that most of the institutions who took official positions were historically positioned to accept the authority of the state, and this might have influenced their interpretation of the documents. Four other institutions had not submitted their documents, but insufficient information was obtained from the institutions to be able to make any firm conclusions as to why they have not followed these requirements, even though they appeared to have designed curricula in line with the regulations.

However, the table shows that the greatest proportion of institutions, while being compliant, took unofficial positions towards the regulations and the NSE roles and competences. These institutions appeared more detached from the official discourse, and produced documents that revealed more independent positions. These institutions tended to have a history of teacher education, but had not necessarily incorporated a college of education.

28 % (7) of the HEIs were still non-compliant¹⁰⁹ when the information was collected in September 2003. Of the institutions that were non-compliant, only one rejected the official discourse. This institution appeared to position itself as autonomous and to generally reject moves made by the state to regulate the design of their qualifications. This was confirmed in the interview with the DoE officials who evaluate the qualifications. The other institutions that were non compliant seem to be positioned differently. In two cases their programmes appear from the information they provided to be influenced by the NSE and the official discourse. There appeared to be a deferment of the process, rather than a rejection of it. The

¹⁰⁹ It is noted that it is highly likely that all institutions have by now (June 2008) complied with the regulations. In 2004, the DoE began to reject qualifications (e.g. PGCEs) from institutions that had not taken them through the proper processes and these universities were forced to comply in order to avoid legal cases with disgruntled students.

other 4 institutions that had not taken their documents through the processes did not provide sufficient information for me to be able to infer why they had not done this.

6 The selection of cases for phase three of the study

In the preceding sections I sketched a broad picture of the range of mathematics teacher education programmes offered across the field of HEIs in South Africa. I showed that the formal documents submitted to the DoE provided little of the substance of curricula they were meant to represent. That is, the ‘*what*’ and the ‘*how*’ of pedagogic discourse that they intend to put into practice. However, they do provide insight into the way in which the various institutions positioned themselves in their approach to the regulatory exercise. This ranged from institutions that did not submit their documentation through to institutions that appeared to take everything in the NSE as fully prescriptive. The survey revealed that while the formal documentation submitted could not tell us much about the substance of the mathematics, mathematics education or mathematics teaching discourses selected into each curriculum, it was possible to recognise aspects of all three domains of knowledge within most programmes. It was also possible to say something about the relative importance of each of these through the amount of time allocated to the various contents. While the data produced through the survey was limited, the analysis did enable a broad mapping of the MTE landscape and revealed the positioning of different institutions with respect to the official NSE discourse of the ORF.

In order to better understand the way that these different discourses and their practices are constituted in the field we need to move to the empirical level. While the documents can tell us something about the intentions (or pretensions) of the institutions that produced them, they can not tell us much about what happens in practice or how these selections, if they were put into practice would work to specialise the conscience and consciousness of initial mathematics teachers. To get some idea of how a specific selection might constitute a legitimate text for mathematics and mathematics teaching, a move into sites of MTE practice is required. This is what I will do in the remaining chapters of this thesis. In the last section of the current chapter I introduce the third phase of the study that was described in Chapter 1. I describe the selection of the empirical sites and the processes involved in collecting evidence for the case studies. This sets the scene for what follows: in depth case studies of two institutional sites of MTE practice and the pedagogic specialisation of a selection of successful student teachers at each site.

6.1 Criteria for selecting the case study institutions

In this sub- section I discuss the criteria I used for selecting the empirical sites for case studies.

I wanted to select two sites from the across the field that would provide me with some comparative advantage for the study as a whole. As mentioned in the introduction to this thesis it was important to select institutions that would enable me to examine, not only the organisation of the knowledge discourses and practices selected into the MTE curricula, but also the way in which these organisations might work to specialise the identities of student teachers studying at the institutions. Given the context of South Africa, and particularly the differential distribution of knowledge and resources across the post-apartheid landscape, I made a decision to select institutions from widely different contexts (rural - poor and urban - wealthy) and with different histories. However, in addition I also needed to decide on other selection criteria, since I wanted to ensure that the sites selected would enable maximum insights to the field as a whole.

After considering a variety of options I made the following decisions on the criteria for selection of the cases. I would select the case study institutions on the basis of:

- (1) History: One should be a *historically disadvantaged* institution and the other *historically advantaged*.
- (2) Geographical context: One should be located in a *rural area* (ex-homeland) and the other in an *urban area* (major city).
- (3) B.Ed programmes offered: Both institutions must offer *B.Ed degrees for specialist mathematics teachers* (i.e. for SP+FET or FET). Their B.Eds must have been implemented and they must have registered students.
- (4) Incorporation of a college of education: Given the transformed context of teacher education and that the majority of institutions offering specialist B.Eds for initial mathematics teaching had incorporated a college, I decided that the institutions must be selected from those which had *incorporated at least one college of education*.
- (5) Campus: If possible, one institution should be selected on the basis of its education faculty being located on specialised education campus (an old college campus), and one on a general university campus.
- (6) Compliant: Both case study institutions must have taken their programmes through the various regulatory processes, that is, they must be *compliant*. However the nature of compliance must be different. One institution should be identified and taking an *official position*, committed to and influenced by the new official discourse of the NSE,

and one an *unofficial position* appearing to be detached from the official discourse of the NSE. The institutions would thus be positioned differently towards the ORF.

- (7) Access: In addition to the six points above, the institutions would have to agree to allow me access to their lectures, course material and students.

In making the selection I had already decided I would exclude my own institution (see discussion in Chapter 1). I also decided to exclude any distance education operations as I was most concerned with face to face contact TE.

6.2 Introduction to the cases: Rural University and City University

Using the survey results, I was able to identify a number of institutions that met the first six criteria (see Table12¹¹⁰).

Table12: Institutions that meet the criteria to be approached as case study institutions

HEI Code	HD	HA	Rural (1)/ Urban(0)	College incorporated	Offer a specialist B.Ed ¹¹¹	Compliant (1) non-compliant (0)	Official (1)/ unofficial (0)	Form: holistic (1)/ atomistic (0)	TE from Ed Campus (ex- Coll) or Gen Campus
U1	0	1	0	1	1	1	1	1	E
U2	0	1	0	1	1	1	0	1	E
U3	0	1	0	1	1	1	0	1	? (no info)
U4	0	1	1	1	1	1	1	0	G
U6	0	1	0	1	1	1	0	0	G
U14	1	0	1	1	1	1	1	1	G
U16	1	0	1	1	1	1	1	0	E+G
U19	1	0	1	1	1	1	1	1	G
T4	0	1	0	1	1	1	0	1	E
Tot	3	6	4r+5u	11	11	18	5o +4u	6h +3a	3E; 4G; 1E+G:?

I approached a selection of institutions before I was able to gain full access to suitable empirical sites. I was fortunate to gain full access to two institutions that fitted all the criteria. These institutions (U19 and U2) are named, ‘Rural University’ (RU) and City University (CU) in the remainder of the thesis. These institutions will be considered in depth in the chapters that follow. Below I give a very brief overview of how they met the selection criteria.

¹¹⁰ This table is drawn from Table 3 in Appendix C.6.

¹¹¹ In this table SP only B.Eds are not considered as specialist. This follows the analysis which shows that they are generalist rather than specialist.

Rural University:

RU is a historically disadvantaged, rural institution located near a small town. It is an ex-‘homeland’ university that served a specific ‘ethnic group’ during the apartheid years. RU incorporated two colleges of education in January 2001. Both college campuses were closed and given back to the province. All education operations at RU are now located on the general university campus. The new B.Ed (FET and Senior Phase) qualification was taken through the formal processes and approved on 29 November 2000 (DoE, 2002b, p. 27) and the first cohort of students entered the programme in 2001.

Positioning with respect to official discourse: Official (holistic)

It appears that this institution positions itself positively in relation to the policy and works within authority structures¹¹². The official discourse of the NSE is seen directly in the organisation of the curriculum. The roles in the NSE policy are clearly a major resource for the substantive selections into the curriculum. There is a clear identification with the discourse of the NSE and an attempt to put into practice the spirit of the document in a holistic way.

City University:

CU is a historically advantaged urban institution located in a major South African city. CU incorporated one college of education in January 2001. The college campus was retained after the incorporation and all teacher education activities of the institution were relocated to the education campus. The new B.Ed qualifications for secondary teaching was taken through the formal processes and approved on 12 March 2001 (DoE, 2002b, p. 33) The first cohort of students entered the new programme in January 2003.

Positioning with respect to official discourse: Unofficial – institutional

The autonomy of the institution appears to drive the organisation of the curriculum. While documents follow the form and meet requirements of regulation, their substance appears to be based on resources outside of official policy, driven by an institutional identity based in the past.

¹¹² According to the DoE officials who evaluated the programmes, they worked closely with this institution to develop their final submission.

7 Conclusion

One of the motivations for carrying out the survey was to see how the pedagogic space for teacher education theorised earlier was filled by the various HEIs educating initial mathematics teachers. A second motivation was to map the field to analyse the positioning of the HEIs, with respect to the ORF and use this. The survey has shown that the field is fairly open and that teacher educators located in the various HEIs do have considerable autonomy to generate their own qualifications. It has shown that there is a fairly wide variation across different institutions. The survey raises issues and challenges for MTE around the development of the three pedagogic discourses for mathematics teachers and teaching: M, ME and MT. On the one hand it raises issues about *what* is selected as appropriate knowledge and practices for mathematics teachers, and on the other it raises issues about *how* these are made available to student teachers. The survey, by its nature, could only give a broad picture of the field and an indication of the range of selections from mathematics, mathematics education and mathematics teaching in initial MTE B.Ed programmes. It provides a glimpse of their significance by virtue of the notional time allocated to each type of content. It raises issues about the relationship between mathematics and education departments in HEIs and their roles in MTE, and between mathematics, mathematics education, and mathematics teaching practice in the construction of mathematics teacher identities. Empirical research at sites of MTE practice is required to unravel these issues more effectively.

In addition to this an analysis of the positioning of the various institutions with respect to the official discourse of the NSE showed that institutions are differentially positioned. Some following the authority of the state, see the NSE as more or less prescriptive, and take up official positions with respect to the discourses of the ORF. The majority of institutions, however, seem to recognise the states responsibility to provide guidelines for regulating teacher education and interpret the documents as generative rather than prescriptive. These institutions have been recognised as taking unofficial positions with respect to the discourses of the ORF. Finally there are a small number of institutions that have not complied with the regulations.

Chapter 6

Methodology 1

Researching Curriculum, pedagogy and assessment practices within mathematics teacher education

Curriculum defines what counts as valid knowledge, pedagogy defines what counts as a valid transmission of knowledge, and evaluation defines what counts as a valid realisation of this knowledge on the part of the taught (Bernstein, 1977b, p. 85)

1 Introduction

In the previous chapter I mapped out specialist mathematics teacher education programmes offered at the various universities. I showed that the formal documents submitted to the DoE gave little substance about the substantive contents and pedagogy of the various HEIs' intended curricula. I provided an analysis of the overall structure of the intended curriculum for B.Ed programmes offered at 15 HEIs and considered the inclusion of different types of contents, including specialist contents, according to the classification of time, and to a lesser extent agents and spaces. I identified two critical issues for MTE from this survey of the field: firstly the place of practice teaching and its relationship to the specialist focus of the programme; and secondly the relationship between mathematics education academics and mathematicians in the education of secondary mathematics teachers. While the analysis was not able to provide any indication of the substance of the contents selected into the programmes, or insights into the pedagogic practices institutionalised, it did provide insights into the conscious positioning of institutions with respect to the ORF. Institutions were recognised as being compliant or noncompliant, and within these categories, taking official or unofficial positions with respect to policy regulations. This analysis enabled the selection of two contrasting sites of mathematics teacher education (MTE) practice as case studies for the final phase of the study.

This chapter moves the focus from the wider field of MTE to focus on specialist secondary teacher education programmes offered at the two selected HEIs. It provides an overview of the processes for collecting empirical information for the case studies and the nature of the evidence collected. It discusses the general methodological approach to the case studies as a

whole, and the specific methodology used to produce and analyse data to interrogate the MTE curriculum and pedagogic practice operating within the institutions. The purpose of this is to provide a description of the image of ‘good mathematics teacher’ and ‘good mathematics teaching’ that the institution *intends* to produce in their student teachers. That is, a description of the characteristics of a ‘good subject’ of the institution. Here ‘subject’ is used in two senses: firstly, a subject in the sense of a discipline or field of study, in this study referring to mathematics (M), mathematics education (ME) and mathematics teaching (MT)¹¹³; and secondly as a subject in the sense of a person operating subjectively within and subject to varying social, pedagogic, economic and political contexts. In other words the focus is on the pedagogic identity of the ‘good’ mathematics student teacher that the institution projects through its selection and organisation of curriculum contents. The analysis for this part of the study therefore focuses on the symbolic message systems that work to transmit the ‘legitimate texts’ for specialising the consciousness of ‘mathematics teacher’ within the context. Research question 6, as presented in Chapter 1, is under consideration here:

What images of ‘good’ mathematics teacher and ‘good’ mathematics teaching are constructed in two contrasting Higher Education Institutions?

The chapter begins with a description of the site visits and a discussion of the nature of the evidence collected for this part of the study. This is followed by explicitly describing the methodological orientation of the study, in relation to Thompson’s (1990) methodology of interpretation and Bernstein’s (1996; 2000) languages of description. This is followed by an account of the specific methodology applied in the analysis and interpretation of each of the symbolic message systems operating within the institutional context.

2 Processes for collecting empirical evidence for the case studies

In the previous chapter I described the selection of the cases: City University (CU) and Rural University (RU). In this chapter I do not provide further details of these contexts, as this is done in the chapters that follow. In this section I provide an overview of the processes involved in collecting empirical evidence for the two case studies.

¹¹³ Refer to Figure 6 in Chapter 5 where these were theorised as three specialist discourses possibly visible within any specific mathematics teacher education programme.

2.1 Access to the case study sites and some ethical considerations

As indicated in the previous chapter there were 8 institutions, coincidentally 4 rural and 4 urban, that met the criteria for selection as possible case study sites. Before settling on the two cases, I had to approach these institutions to request permission to carry out the research. I approached 6 institutions altogether before selecting the two sites described in Chapter 5. Of these 3 refused to be part of the study. Of the three that agreed two, referred to here as RU and CU, fitted the specific criteria most appropriately. Once formal permission was granted from RU and CU, site visits were organised. Each institution was visited for a period of three weeks in the second semester of 2004. The information collected from each institution is described below.

I realised, after the rejections, I was venturing into sensitive territory and that it was not a simple matter for institutions to allow me access into the heart of their practices. While researchers from education faculties routinely research teaching and go into school teachers' classrooms, it was not easy for them to consider allowing a 'researcher' into their lecture theatre and into the deep workings of their curriculum, pedagogy and assessment practices. I am deeply grateful to the mathematics teacher educators' and their institutions who allowed me into their space to carry out this research. As someone intimately involved in mathematics teacher education, working in a different HEI, and having her own very strong views (bias and focus) in relation to MTE, these institutions took a risk in allowing access. The ethical issues involved in this are therefore important to discuss.

At the most basic level, ethics requires that one strives to do no harm. From a research perspective, it was important that full disclosure was given in relation to the purpose of the study, the nature of involvement of the participants and the information that would be collected. In this study, at each site, the participants included: the institution as whole, represented by the Dean of Education/ Head of School who enabled formal access; the programme co-ordinator of the B.Ed offered at the institution who provided insights into the overall design of the four year degree; the mathematics/ mathematics education department at the institution represented by its Head of Department; all lecturers involved in the design and delivery of specialist mathematics teacher education modules or courses on the B.Ed programme; a selection of students from each of the two programmes offered at the institution, selected by their lecturers as successful mathematics student teachers who exhibited the qualities and learning they felt reflected the intentions of their programme. In each case, full disclosure was necessary. This was done both in writing and in meetings with the various

participants. Appendix D.1 a) to d) contains the various written documents provided to the participants and the formal consent forms that they were asked to sign. All participants had the right to withdraw at any time during the process. Fortunately all participants continued to participate throughout the research process. In relation to the observation of the teacher education classes, it was also necessary to inform all students of the research and to gain permission to take videos of their classroom interaction. All students in the classes concerned were informed verbally of the research by their lecturers and were given written slips requesting their permission for the researcher to take the videos and use them for research purposes (see Appendix D.1 e)).

The documents discussed in the pervious paragraph were designed to minimise the risks involved in relation to this research. Specific risks were related to the lecturers who provided information about their courses and examples of their materials and assessment items. The were being asked to expose themselves and open their intellectual property related to their teaching and course design to scrutiny by a researcher who was also a lecturer at a competing higher education institution. The risk was minimised by the formal documentation and ethical procedures undertaken in the collection of data. In particular the promise that the researcher would not utilise any of the information gathered for any purposes other than the research in question.

In relation to the selected student teachers, the interview processes asked them to reflect deeply on their paths to becoming mathematics teachers and probed their knowledge at this stage of the process. While this had the potential to have positive effects in providing them with an opportunity to reflect deeply on their learning, it also has the potential to have negative psychological effects. Firstly they were being asked to expose something of themselves and their motives to a stranger. Secondly the probing nature of the interviews required them to expose their knowledge and ignorance about specific issues related to mathematics, mathematics education and mathematics teaching, which had the potential to undermine their personal identity constructions and confidence. The risk was minimised in two ways. First complete confidentiality with respect to their lecturers' access to the information they revealed was promised. Secondly the students selected were seen as academically and professionally strong – so the risk of personal harm and undermining of confidence by exposing ignorance was minimised. In addition I worked hard on developing a relationship of trust with the student teachers. During the process, at points where uncertainty, vulnerability and the potential for personal harm became apparent, I created the opportunity to work through these

with the individual student so as to reaffirm them and build their confidence with respect to their self worth as novice mathematics teachers and as well rounded human beings.

Apart from the individuals concerned and the issues related to intellectual property, there were also other concerns specifically related to the particular political, social and historical contexts of the two case study institutions. The issues involved here relate to the concerns expressed by Lerman and Adler (2003) in the context of mathematics education research which takes place in developing contexts. Much mathematics education research is undertaken from positions which favour reform initiatives rooted within a global modernist/ post-modernist perspectives. Lerman and Adler's concern, while not expressed in this way, is related to understanding that forms of social solidarity in developing contexts are likely to be more mechanical than organic, and yet the yardstick against which practices are often compared are produced in contexts where organic solidarity is the norm, where there has been a loss of trust in traditional authority relations, and where general access to resources (both physical and epistemic) are taken for granted. Interpretive research in developing contexts therefore calls for "care and reflexivity; refined notions of consent, including participation of research subjects and continual reaffirmation of consent; and a refined notion of autonomy and privacy" (Ibid., p. 450), and the principle that evaluation of particular practice should acknowledge the context and values of the participants.

This thesis works across contexts within a developing country, and specifically across institutions that represent the rural/urban and poorly resourced/ well resourced divides. In order to deal with the ethical issues related to this, I avoided the temptation to evaluate the MTE practices found at the two sites, but rather focused on their constitution. A distance was created to ensure an ethical practice, through providing clear and detailed descriptions of the methodologies involved in producing the accounts of the cases.

In order to keep anonymity, as far as is possible given the nature of the field, a number of devices have been used throughout the thesis: (1) All lecturers have been allocated a letter and in the thesis they are all referred to using this letter. At CU the letters V, W, X, Y and Z are used. At RU A and B are used. The lecturers at CU are referred to as Mr/s V, W ... etc. and at RU as Dr A or B (since both have doctorate degrees). In all cases across both institutions all the lecturers are referred to as she, her, herself, etc. (2) The names of courses/ modules making up the curriculum at each institution have been changed. While it was not possible to use identical names for both CU and RU modules (since the curricula are differently structured),

all module names have been changed to reflect their contents. In all cases, where interviewees mention lecturers/ courses/ module names, the transcripts have been changed in accordance with the above rules. These are the only changes made in the transcripts.

2.2 The organisation and structuring of site visits

The purpose of the case studies as described in the introduction to the thesis was twofold. Firstly a focus on the curriculum offered in each of the case study institutions and the images of ‘good’ mathematics teacher and ‘good’ mathematics teaching constituted within the pedagogic context operating at the level of the MTE classroom. This relates to the pedagogic identities projected by the institution’s curriculum and pedagogic practices. Secondly, a focus on the pedagogic identities novice (student) teachers project after studying at the institution. That is on the student teachers themselves, and how they write about and speak about their specialisation as mathematics teachers after studying their MTE programme. Site visits were therefore organised to collect evidence that could be used to assist in providing two descriptions: a description of the implemented curriculum (referred to here as Description 1); and, a description of the pedagogic identities projected by student teachers selected as ‘good’ subjects of the institution (referred to here as Description 2).

The case studies, while attempting to collect as much detailed information as possible, would clearly be limited in a number of respects. Specifically, they were limited in the sense that I was only able to spend a limited amount of time at each institution. In each case three weeks were spent at the institution during which the various participants were interviewed and lectures were observed. This involved two consecutive weeks at the institution, followed by a third week in which I returned to collect outstanding documents, examples of student work, to complete lecture observations and follow up on any other outstanding aspects. While I collected a substantial amount of information, this was inevitably incomplete. It is recognised that the validity of qualitative case studies can be threatened by the length of the period over which the data is collected and observations made (see Maxwell, 1992). A longer period of observation and emersion in the practices of the institution may have enabled greater possibility of discrepancies and variations to emerge and therefore greater certainty in the descriptions of the cases. I will return to the issue of validity towards the end of the chapter after the methodology has been discussed in more detail.

The focus of the rest of this chapter is on the evidence collected and methodology for producing, analysing and interpreting data for producing Description 1. Later, in Chapter 9, this will be discussed in relation to the production of Description 2.

In order to collect information to assist in the production of Description 1, it was necessary to develop a framework for what should be collected and how this should be done. In relation to the initial theoretical basis of the work (discussed in Chapter 3), I was aware that in order to produce Description 1, I needed to focus on collecting information related to pedagogic communication operating within the institutional context through what Bernstein (1977b) had identified as the three message systems for the realisation of the “formal transmission of educational knowledge and sensitivities” (p. 85): curriculum, pedagogy and assessment (evaluation). Later in his theory Bernstein (1990; 1996; 2000) introduced the notion of the pedagogic device, which connected these three symbolic message systems into a more general theory. The operation of the pedagogic device at the level of the institution is directly related to the operation of the three message systems as is summarised in Figure 9. The site visits were organised so that information related to curriculum, pedagogy and assessment could be collected from each institution. The documentation collected (see Appendix D.1) and interview schedules (see Appendix D.2) were designed on the basis of eliciting information relating to these three message systems.

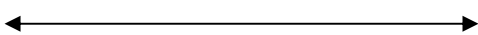
Pedagogic Device ¹¹⁴		Message system operating at the institutional level
Distributive Rules	classification principles (power) what knowledge discourses and practices are distributed to different groups in this specific institutional context: what is selected into the programme and what is the possibility of access to different forms of knowledge (mundane/ horizontal and esoteric/ vertical knowledge discourses)	curriculum
Recontextualising Rules	framing principles (control) how are these privileged selections transformed into specific pedagogic discourses for pedagogising and transmitting what counts as a legitimate text in this institution (i.e. recognition rules) and what counts as a valid transmission of such texts	pedagogy
Evaluative Rules	classification and framing what criteria for the legitimate texts are transmitted and how is access to this made possible within the pedagogic context; how are evaluative criteria for the acquisition of recognition and realisation rules of the legitimate texts transmitted to potential acquirers (student teachers)	evaluation (assessment)

Figure 9: The pedagogic device and three message systems for pedagogic communication

¹¹⁴ See Figure 2 in Chapter 3 for a full picture of the pedagogic device.

3 Nature of evidence collected at empirical sites

In this section I elaborate briefly on the nature of evidence that was collected and used for producing data for the analysis and interpretation of the three symbolic message systems under consideration in this chapter and Chapters 7 and 8 of the thesis. Four types of evidence relevant to the institutional analysis were collected from each site: documents, video records, interviews, and field notes.

3.1 Documents

A relatively wide range of different documentary evidence was collected from each of the sites. This evidence provided material for the analysis of the curriculum and assessment practices. The documents collected included:

1. Official formal documents related to the overall structure of the curriculum offered at the institution. This included pamphlets advertising the programmes on offer, the general university/ faculty calendar and prospectus, as well as specific documents relating to the design of the Bachelor of Education degree provided by the institution. This provided information that could be used to assist with describing the principles underlying the curriculum design and the various types of knowledge and practices selected into the FET/SP mathematics teacher education programmes under consideration.
2. Documents relating to the specialist mathematics/ mathematics education/ mathematics teaching courses offered through the programme. This material was provided by the lecturers concerned with teaching the various modules/ courses and was variable across different lecturers, within and across institutions. It includes examples of: module outlines with various details (some include dates and times, assessment criteria and expectations of students, while others simply give an outline of topics); lecturer notes (also variable, some include full explanations and exercises and could be considered as pedagogic texts rather than simple notes/ practice exercises); photocopied articles that were supplied to students and sections of books used by students as 'text books'. The amount of this kind of material collected was determined mainly by what the mathematics teacher educators at the institutions chose to provide. These documents provide information that could assist with the description of the specialist contents of the teacher education programme.
3. Assessment items relating to the specialist courses/ modules. These were also provided by the lecturers concerned. Items relating to every module in the specialist programme (whether focussed on M, ME or MT) were requested. What was provided once again varied considerably across different lecturers and institutions. The material collected included a wide range of different formal assessment items including examples of a range

3.2 Video records

At each institution a limited number of teacher education lectures were observed. One class given by each lecturer involved in teaching specialist FET mathematics related modules was observed and video-recorded. These records form the basis for the production of data used to assist with the descriptions of pedagogic practice operating within each institution.

3.3 Interviews

A number of different open-ended interviews were held that are relevant to this part of the study.

- 1 At each institution an interview was held with the overall Bachelor of Education programme co-ordinator (see Appendix D.2 a) for the interview schedule). The focus of these interviews was to probe the processes, at the institutional level for the production of the new curriculum and the overall design of the programme. These interviews were audio recorded but not transcribed. They were only considered as sources of information for confirmation purposes, and not for producing data.
- 2 All the lecturers involved in teaching the specialist mathematics/ mathematics education courses to FET/SP student teachers were interviewed (see Appendix D.2 b) for the interview schedule). The interviews focused on probing the principles the lecturers believed they used for selecting contents into each module, applied in their own pedagogic practices within their lecturer theatres, and in their assessment practices. They were requested to provide descriptions of the characteristics of teachers they would like to produce through their programme. They were also probed on their position with respect to official knowledge (specifically from the NCSM and the NSE). These interviews were all audio-taped and transcribed and sifted to provide data used to assist in the production of thick descriptions of the implemented mathematics teacher education curriculum in practice.
- 3 Group interviews were held with the student teachers selected as good subjects¹¹⁵ (see Appendix D.2 c) for the interview schedule). The focus of the first group interview was on the overall design of the programme as these subjects experienced it. This probed their

¹¹⁵ Individual interviews were also held with the selected student teachers. However these provided information for Description 2 and are discussed in detail in Chapter 9 rather than here. There was also a final group presentation, which is also described in Chapter 9.

ideas about the various modules (both general and mathematically related) and their experiences as student teachers at the institution as a whole. The group interview was video-recorded and transcribed. The information provided here was used to confirm/question/ or illuminate the analysis and interpretations produced in relation to the overall programme design, focus of specialist courses as provided by lecturers, and descriptions of pedagogic practice through other data sources.

3.4 Field notes

At each institution I kept a journal in which field notes were recorded on a daily basis over the duration of the site visit. After each group interview and lecturer interview I recorded impressions and initial interpretations of what had been said in the interviews. During the lecture observations some notes were also taken and immediately after the observation details and reflections that appeared relevant at the time were recorded. General reflections and observations of the institutional context and practices were also recorded.

4 The general methodological framework for producing and interpreting data

Two aspects are discussed in this section. First, an approach to interpretation of symbolic systems that draws on Thompson's(1990) *depth hermeneutics*, and secondly a general methodological orientation to producing data, based on Bernstein's (1996; 2000), Dowling (1993) and Brown and Dowling's (1998) discussion of *languages of description*.

4.1 A methodology of interpretation

The focus of this part of the research is on curriculum, pedagogy and assessment, which are produced by institutions in the PRF. The empirical evidence that will form the basis for the production of data is therefore populated with texts that can be described as symbolic forms. Thompson (1990, p. 272) argues that in social inquiry, the "object of analysis is a meaningful symbolic construction which calls for interpretation". Therefore the *process of interpretation* is a central concern for any research that involves the analysis of symbolic forms.

The focus of this section is on the nature of the empirical objects that are to be interpreted and a framework for the interpretation. In the next section I will suggest that meaningful interpretation needs to be produced through the use of an external language of description.

Thompson makes the point that symbolic forms are embedded in social and historical contexts and are internally structured in a variety of ways. So, an analysis of their social contextualisation and internal structural features are both important. From his perspective the study of symbolic forms is fundamentally and inescapably a matter of *understanding and interpretation*. He suggests a framework of *depth hermeneutics* to help facilitate this.

The social-historical world is not just an ‘object domain’, which is there to be observed, it is also a ‘subject domain’, constituted in part by subjects who are routinely involved in understanding themselves and others, and interpreting actions and events which take place around them. Understanding is seen as a fundamental characteristic of human activity – something we do all the time. This means that interpretation is multi-layered – when we analyse a symbolic form we offer an interpretation of an interpretation. In a sense it is a re-interpretation of a pre-interpreted domain.

Hermeneutics suggests that the object domain of social inquiry (objects of our study) is also a subject domain in its own right (made up of self-reflective individuals trying to make sense of their world). This means it is possible the subject-object domain of the study could appropriate the results of the inquiry. That is, there is the potential for feedback to and appropriation by ‘the objects’ of the study. This is not necessarily a problem for research – but it should be kept in mind as a possibility. It could mean that as research is carried out so the subjects, in the subject-object domain being studied, could ‘take up’ some of the ideas created by the study and so themselves change the empirical setting and in some ways deflect the original inquiry.

Hermeneutics further suggests that the subjects who make up the social world are always embedded in historical traditions. As Thompson describes it human existence is always historical, and new experiences are always assimilated into the residues of what is past, and so in seeking to understand what is new we always and necessarily build on what is present. However, we need to also be aware that residues of the past may also serve to conceal, obscure or disguise the present.

The depth hermeneutic approach, outlined below, provides an intellectual template for analysing symbolic forms systematically and appropriately, by integrating a variety of types of analysis.

The approach involves two steps:

1. The object (subject-object domain) of the interpretation is a 'pre-interpreted' domain. Therefore the approach acknowledges and takes account of the ways in which the subjects who comprise the subject-object domain interpret symbolic forms. Thus the hermeneutics of everyday life is the starting point of a depth hermeneutics approach. That is, an account of the ways in which symbolic forms are interpreted and understood by the individuals who produce and receive them in the course of their everyday lives. This is an 'ethnographic' moment in the research process and a preliminary study to the depth hermeneutic approach. Through a variety of methods (interviews, participant observation, etc) we can reconstruct the way in which symbolic forms are interpreted and understood in a variety of social-life contexts by the very people who produce them. This produces what Thompson refers to as 'an interpretation of doxa' (i.e. a description of the context of daily life and the ways in which individuals situated within these contexts interpret and understand the symbolic forms that they produce and receive). In this study the interviews are the main source of data which is used to produce the interpretation of the doxa. In relation to the institutional context of each case, which is the subject of the following two chapters, the first level of interpretation is produced through descriptions of the curriculum which provides a context for the rest of the chapter.
2. The second level of the depth hermeneutics approach is a broad framework that consists of three main phases (processes). These are not necessarily sequential, but should rather be seen as 3 distinct dimensions of a complex process. They are: social-historical analysis; formal or discursive analysis; and, interpretation/ re-interpretation.

Social-historical analysis

This analysis aims to reconstruct the social and historical conditions of the production, circulation and reception of symbolic forms. A variety of dimensions could be explored to reconstruct these conditions, for example, the spatial-temporal setting, the fields of interaction, social institutions, social structure, and technical media of transmission. These all represent different ways of trying to grasp the social contextualisation of symbolic forms.

Formal discursive analysis

This analysis is concerned with the internal organisation of the symbolic form, with their structural features, patterns and relations. A variety of theoretical frameworks could be

used to illuminate this, for example: semiotic analysis, discourse analysis, narrative analysis, argument analysis etc.

Interpretation/ re-interpretation

This phase of interpretation is facilitated by, but distinct from the phase of formal discursive analysis. Interpretation proceeds by synthesis, by creative construction of possible meaning. The methods of social-historical analysis and discursive analysis can be used to mediate the process of interpretation, but the process itself goes beyond these methods. For Thompson the process of interpretation is simultaneously a process of re-interpretation of the pre-interpreted domain. This means that it is quite possible for the depth hermeneutics approach to project an interpretation that is quite different from the meaning constructed by the subjects who make up the social –historical world of the study (doxa). For Thompson it is this possibility of conflict of interpretations, a divergence between lay interpretation and depth interpretation, of interpretation and re-interpretation that creates the methodological space for “*the critical potential of interpretation*” (Ibid. p.290).

In this study, the analysis of the pedagogic space at each institution does not rely on an historical account, however the study is historically and geographically located in relation to the analysis that was provided previously in considering teacher education in general and in the South African context. In the analysis of the identities of the institutions’ good pedagogic subjects however, the historical is present in narratives of the teachers’ careers. The study does provide an account of the social conditions for the production (design of the curriculum), circulation (pedagogic modes and assessment operating in the context), and reception (specialisation of consciousness of the pedagogic subjects) of symbolic forms within the context. Formal discursive analysis is central to the production of interpretations in this study, and this is strongly influenced by an approach to analysis informed by the theory of languages of description, which is the focus of the next section. The interpretation/re-interpretation is the final stage in which the various analyses are brought together and rubbed up against one another, and the pre-interpreted domain, to produce a final interpretation. In this study this is produced in Chapter 12 where the various analyses that make up the study are used to produce a final account of the relations internal to each case and across the cases.

4.2 General comments on the production of data from the evidence

The first comment is that the empirical evidence collected from the sites of practice described earlier in this chapter provides a variety of basic texts that will be used to produce *an account* of curriculum, pedagogy and assessment operating within each institutional context. They are not in and of themselves data; however they do provide sources for producing the data that must then be analysed and interpreted to construct the account.

The next point, as Brown and Dowling (1998, p. 89) so clearly put it, “the text very definitely does not tell its own story. Rather its descriptions must be *biased* according to an explicit and coherent theoretical framework”. In other words, what is produced through the research process is always *an account* that is constructed from selections of texts produced at the empirical level and orientated (or biased) through a theoretical gaze. If the theoretical gaze is not made explicit and the languages of description for producing the data are not coherently structured, then the reliability of the findings may be compromised. In the following sections of this chapter (and later in Chapter 9¹¹⁶), I provide an explicit account of the way in which theoretical and conceptual resources have been recruited into this study and used to produce the data.

For Brown and Dowling the *theoretical field* in which the study is located refers to the various theoretical referents used to produce the theoretical orientation for the study. The principle orientation of this study is found in Bernstein’s theory of the pedagogic device, and, of horizontal and vertical knowledge discourses which were a central focus of Chapter 3 where the regulation of teacher education and the design and organisation of teacher education curricula were theorised. The *empirical field* is populated by all texts available from which the data will be produced. The texts in this study refer to all empirical material (information) collected from the case study sites, including the various documents, video records, audio-tapes, transcripts and field notes. Of major importance in ensuring the reliability of research findings is the processes through which the theoretical and the empirical fields are considered in relation to one another.

Bernstein describes this relationship in terms of *languages of description*, which he defines in the following way:

¹¹⁶ This is a second methodology chapter where I focus on producing an account of the pedagogic identities of each institutions good subjects.

Briefly, a language of description is a translation device whereby one language is transformed into another. We can distinguish between internal and external languages of description. (...) A language of description constructs what is to count as an empirical referent, how such referents relate to each other to produce a specific text, and translate these referential relations into theoretical objects or potential theoretical objects. In other words the external language of description (L^2) is the means by which the internal language (L^1) is activated as a reading device or vice versa. A language of description from this point of view, consists of rules for the unambiguous recognition of what is to count as a relevant empirical relation, and rules (realisation rules) for reading the manifest contingent enactments of those empirical relations. (Bernstein, 1996, pp. 135 - 137)

In this study, the internal language of description for the analysis discussed in this chapter is derived mainly from Bernstein (1996; 1999; 2000) and Hegel as recontextualised by Davis (2001; 2005). Later on further theoretical referents derived from Lacan (2002) are introduced to enable the analysis of student identities (see Chapter 9). The selection of the theoretical ideas which are used to inform the production of the internal language is “done in “dialogue” with the empirical specificity of the object(s) of research” (Davis, 2005, p. 106). The internal language has to be transformed into an external language in order to “construct what is to count as empirical relations and translate those into conceptual relations” (Bernstein, 1996, p. 136).

Dowling’s (1993) explanation of the idea of an internal and external language of description, and the relationship between these is, is represented diagrammatically in Figure 10, shown on the next page.

This diagram is helpful for explaining the construction of an external language of description. Once the internal language has been constructed it is used to construct a series of theoretical propositions about relations that may be found within the empirical field with respect to specific types of empirical objects. These propositions are produced through a process of iterative movements backwards and forwards between the internal language and the empirical texts. On the basis of this work an external language is produced which, depending on the nature of the empirical field, may be constituted by a model together with recognition rules for the identification of data, and realisation rules for the interpretation of this data. The recognition rules form the basis for selecting what counts as data for interpretation and thus provide a theoretically biased selection of some aspects from the empirical field. The significance of this is that the external language cannot exhaust the empirical field; it cannot fully capture the specificity of the empirical.

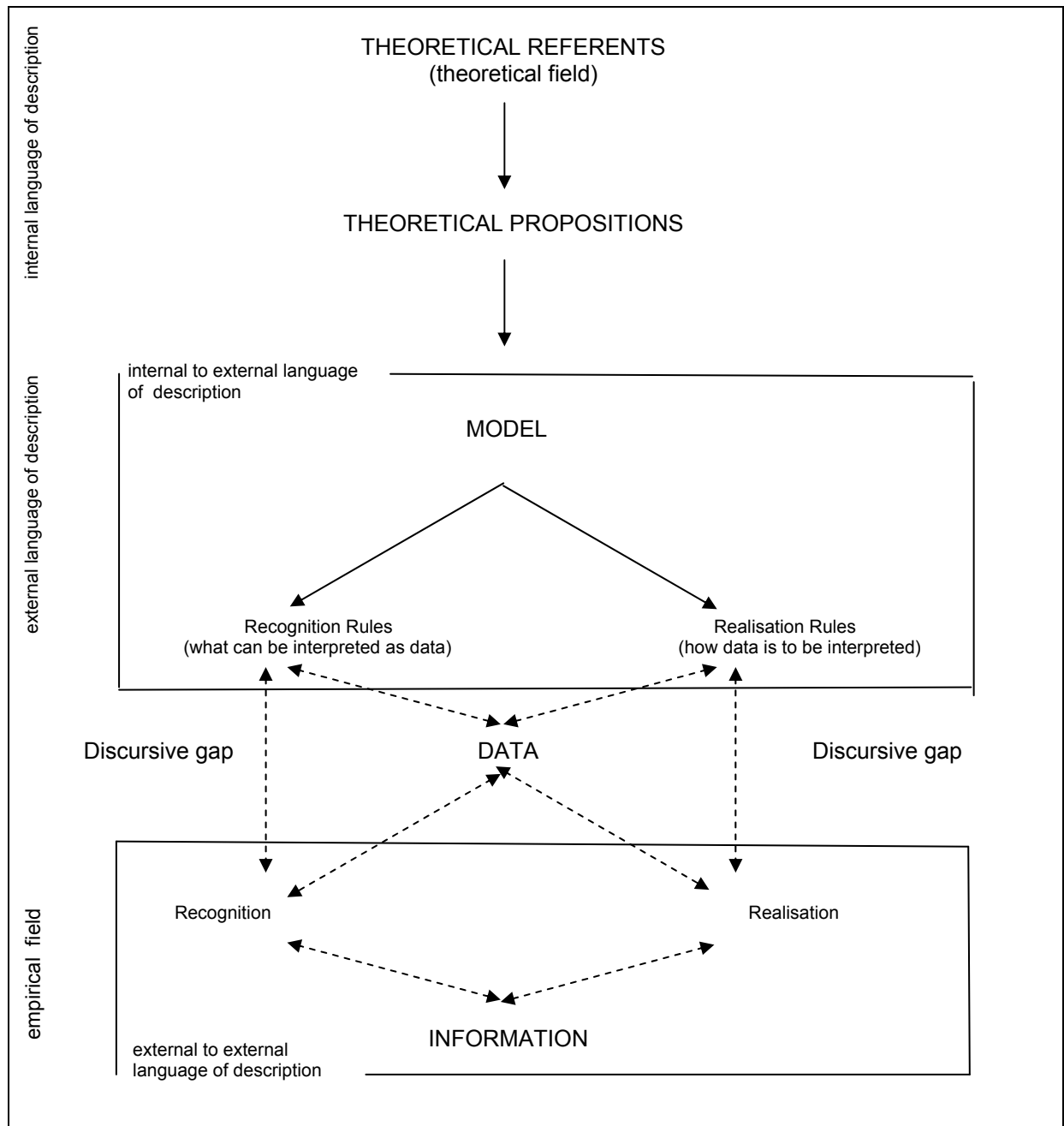


Figure 10: Diagrammatic representation of a language of description (adapted from Dowling, 1993, p. 88, as presented in Davis, 2005, p. 107)

In relation to the data produced through the model the empirical field represents a material surplus. Data therefore is not located in the empirical field, but rather in what has been termed the discursive gap (Bernstein, 2000; Brown & Dowling, 1998). Brown and Dowling describe this as a methodological space that exists between what is inside the external language of description, that is, the model and its rules, and that which is outside of it, that is, texts in the empirical field. The discursive gap signals that in as much as the empirical cannot be fully described, it can only be grasped and interpreted through a theoretical gaze. It also signals that

the empirical field is implicated in developing theory since the model itself is tested by the empirical in its construction.

5 Producing the data for the analysis and interpretation of the symbolic message systems within the institutional context

I begin by giving an outline of the approach to the first level of interpretation (of the doxa), as described above, which provides the context for the rest of the analysis. In the sections that follow I describe the approach taken for the discursive analysis of each aspect in focus: curriculum, pedagogy and assessment.

5.1 The interpretation of the doxa: the pre-interpreted domain.

This is produced through a description of the context of each case and the content of the design of the curriculum in terms of the formal documentation that was produced at the institutional level in response to the new regulations for teacher education, and the material collected from the institution in relation to the overall design and operation of the B.Ed programme. The account provides a view of the overall structure of contents in the curriculum and some insights into the institutional positioning with respect to teacher education generally and forms a basis for the more in depth analyses that follow.

5.2 Curriculum

The main theoretical orientation to this part of the study is heavily informed by a theoretical orientation framed through Bernstein's (1996; 2000) theory of pedagogy, symbolic control and identity, and the models for analysing the production of curricula in the PRF through the survey discussed in Chapter 5, in particular the model of specialist knowledge discourses (M, ME and MT), produced earlier in this thesis (see Figure 6 Chapter 5).

The methodology is informed by Thompson as discussed in the previous section, and involves systematically working through layers from unpacking the specialist contents of the curriculum and considering the relations between the different discourses made visible (classification and external framing of forms of M, ME and MT), the agents involved in teaching these courses (classification of agents), and the space and time in which these are transmitted and circulate (classification of space and time). The next move is to consider an initial analysis of the internal framing relations, that is, the discursive relations of selection, sequencing, pacing and criteria, and the social relations which govern regulation of learning in

the mathematics teacher education context, from texts (interviews) produced by the recontextualising agents (lecturers) operating in the context. By considering these relations and account of some of the features that structure pedagogic discourse within the institutional context (aspects of the distributive, recontextualising and evaluative rules at work) can be illuminated. This account produced at this stage will be fairly descriptive focusing on the contents and the visible forms within the empirical texts, and thus provide a thick interpretation of the pedagogic context. This will then be tested and deepened by the formal discursive analysis of pedagogic practice in MTE classrooms, and of assessment items used to evaluate student teachers across a variety of course contents.

5.3 Analysing and interpreting pedagogic practice

The empirical objects for this aspect of the study are comprised of the video records of lectures observed together with field notes taken during the observations and immediately afterwards. These are to be used as one of bases for providing an interpretation of the pedagogic mode in operation within the context. The focus is on getting a glimpse of *how* access to legitimate texts is constituted through pedagogic communication within the context of teacher education classrooms in each institution.

In producing this analysis I extend the language of description to enable a closer examination of the way in which pedagogic discourse operates within the context through evaluation. New theoretical referents are recruited from Hegel as recontextualised by Davis (2001; 2005) and used in the QUANTUM methodology to analyse video records of pedagogy in teacher education classrooms (Davis et al., 2007; Davis et al., 2003).

At each case study institution one specific video record was selected for in-depth analysis. The rule for selection was determined by the local context and the recognition given to the particular lecturer, by the student teachers in the sample, as providing a ‘role-model’¹¹⁷ for their own images of ideal pedagogic practice. In both cases this was also the head of the mathematics/mathematics education for the undergraduate programme and so in some senses represented the leadership for the specialisation of mathematics teachers within the institution. For each video, the interactional practice (see Bernstein, 1996, pp. 31 - 33) was analysed across the temporal duration of the lecture period. This enabled an analysis of the transmission-acquisition process and a description of the way in which meaning of the legitimate text is (re)produced within this specific pedagogic context. It is recognised that this

¹¹⁷ What is meant by ‘role model’ varies significantly across the two cases, as is established in Chapters 10 and 11.

analysis provides only *one* glimpse of pedagogic practice at the institution, nevertheless it is considered a significant glimpse, as it provides a window into what may be seen as the favoured practice (by the good subjects) across the modules, and gives insight into the way in which evaluation operates within the specific pedagogic context of a particular aspect of the curriculum.

5.3.1 Evaluative judgement within interactional practice

The interactional practice (IP) is defined by classification and framing procedures operating in the pedagogic context and acting selectively on the recognition rules and on the realisation rules¹¹⁸. At the level of the acquirer, the recognition and realisation rules enable the ‘what and how’ for constructing the expected legitimate text. Within the IP a text is anything within the context that attracts evaluation. Figure 11 provides a diagrammatic representation of IP in any pedagogic context.

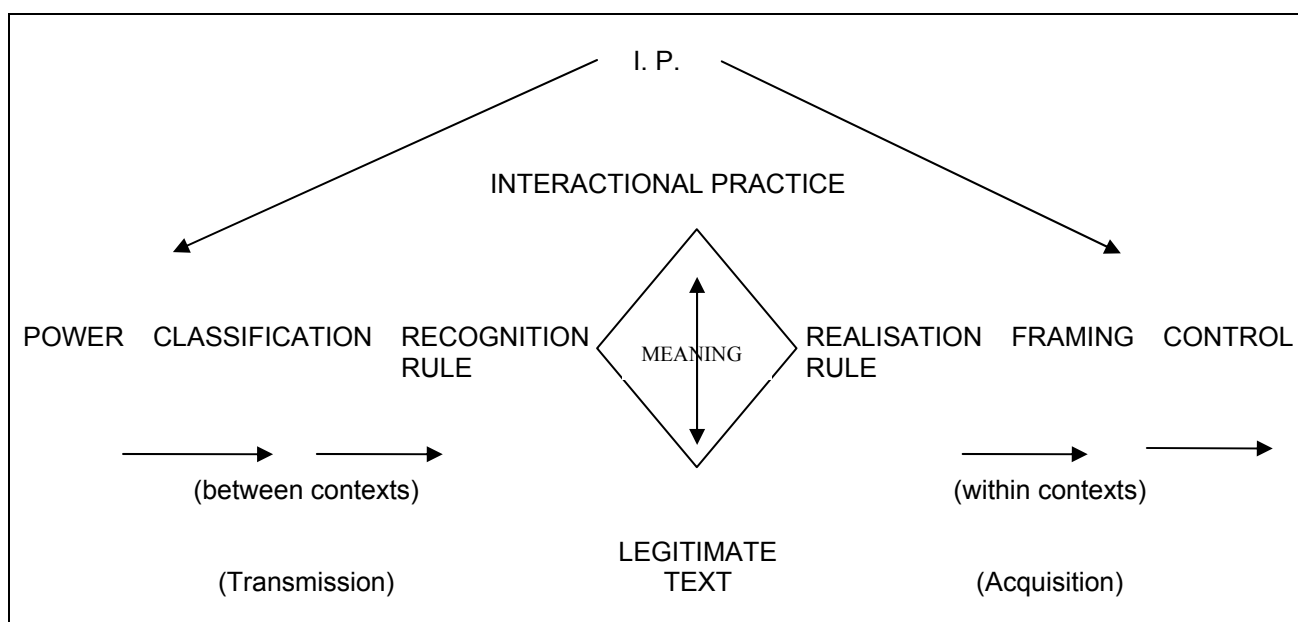


Figure 11: Pedagogic context (as described in Bernstein, 1996, p. 31)

The IP within the pedagogic context of the lecture is mapped out by breaking it up into *evaluative events* over its duration. This is done by applying the understanding that fixing any particular meaning within a pedagogic context occurs through the operation of the evaluative rule (criteria for recognition and realisation of the legitimate text operating within the context). Bernstein himself gives us little to enable a purchase on how evaluation operates in the pedagogic context, except to insist that pedagogic discourse is condensed within evaluation: “Evaluation condenses into itself the pedagogic code and its classification and framing

¹¹⁸ The internal language of description related to these theoretical referents was discussed in detail in Chapter 3.

procedures” (Ibid. p 33). The notions of recognition and realisation rules are too abstract to be useful for producing data and interpreting how meaning is fixed at the level of practice.

In order to unpack the way that evaluation operates within the context additional theoretical referents need to be recruited. Here I turn to the methodology developed for the video analysis in the QUANTUM project (Davis et al., 2003), which is adapted from Davis’ work on evaluative judgement (Davis, 2001, 2005). Davis adapts aspects of Hegel’s ‘Science of Logic’ to produce a methodology for unpacking the evaluative event through four moments of pedagogic judgement recognisable over a temporal segment of classroom interaction: existence (E), reflection (R), necessity (N), and notion (C). These moments of judgement are theoretically¹¹⁹ necessary in order to fix the meaning (if only temporarily) of the concept/ notion/ idea/ behaviour that is the focus of pedagogic acquisition/ transmission within the pedagogic context. In any evaluative event focussed on a specific object of acquisition, the operation of evaluation across these moments enables us to identify the way in which the meaning of the legitimate text is (re)produced, by identifying the grounds on which meaning of any particular notion is communicated through the movement of judgements from existence through reflection and necessity, if they exist.

Thus any particular evaluative event in the IP is recognised first by the announcement (E) of an object of acquisition (whether it is a concept, an idea, a practice, a behaviour etc – i.e. in Bernstein’s terms, a text that attracts evaluation).

The initial encounter with a notion is one of *immediacy*; it is simply a “that”, an empty signifier: a verbal or written mark, or gesture. The relations between the specific notion and other notions are not yet established, so that what we might call the “understanding” of the notion is not yet apparent because of the absence of predication; or, more accurately, the absence of appropriate predication. (Davis et al., 2003, p. 7)

This announcement in its immediacy *stands in the place* of the object to be acquired (in its full meaning), that is, it simply signals the existence (E) of *what* (knowledge that) is still to be acquired, it is “the representation of the missing representation” (Ibid., p. 10). In other words by making the announcement of existence, the notion to be acquired is simply indexed, but its substantive meaning is only accessible to subjects who are already ‘in the criteria’ (Shalem & Slonimsky, 1999), i.e. who can recognise the specificity of the context they are in and realise

¹¹⁹ This does not mean that in the empirical domain of pedagogic practice that they are generally observed. Many examples of ‘teaching’ only announce existence assuming the notion can be transferred through the announcement, but do not provide the possibility of reflection and necessity. This can be associated with a caricature of ‘traditional’ teaching.

(legitimately reproduce) the pedagogic text. “In this way the missing representation that would index the notion in its necessity is, at the moment of immediacy, *represented by something other than itself*” (Davis et al., 2003, p. 10).

In order to begin a process of (re)producing¹²⁰ meaning in the pedagogic context a process of reflection (R) is entered into. Here a field of possible meanings for the missing representation is generated, and this includes possible explanations of *what it is* and *what it is not*. Thus in the moment of *reflection* an attempt is made “to predicate the notion, to transform it from a mere “that” into something more discursively substantial. [...] The attempt at predication opens up a space of *possibility* in which an increasingly comprehensible correspondence between subject and predicate(s) is generated” (Davis et al., 2003, p. 8).

For meaning to be coherently fixed, even momentarily, there needs to be a closing down of the space of possibility, that is “the work of predication must be halted, and it is this arresting of continued predication that shifts the judgement from reflection into *necessity*” (Ibid). A *necessary* relation between subject and predicate(s) becomes established, and the notion begins to hold substantive meaning and “no longer collapses into a mere “that” ” (Ibid). We note that “the notion in its necessity, which recovers the representation that was missing at the moment of immediacy, is a *negation* of the representation of the missing representation” (Ibid. p 9). In other words, what ever was originally presented to signal the existence (stand in the place of) what is to be acquired (a substantive meaning or criteria which establishes the notion), is now discarded, since its (contingent) meaning has been established through a process which has generated possible meanings and then through a process of closure which settles on some criteria which attaches some¹²¹ meaning to the notion.

The movement of the judgement from immediacy to necessity is itself dependent on the generation of coherence from the chaos of contingently occurring events and phenomena. In other words, the arrival at the moment of necessity is generated from within—and dependent on—*contingency*. With the judgement of the notion we are evaluating the extent to which some or other phenomenon corresponds to its notion. (Ibid, p. 9)

¹²⁰ In general the pedagogic context is in a recontextualising field rather than a field of knowledge production, however often in the context of constructivism (specifically pedagogic constructivism) there is some effort to act as if it is being produced (constructed) anew.

¹²¹ The nature of this (e.g. whether they are principled criteria in relation to the field of knowledge or metaphorical and weakly related to the discursive field) will depend on the particular relations and context operating at the pedagogic level. That a moment of necessity is empirically observed does not necessary mean that the meaning that is ‘fixed’ is principled.

The moment of necessity is generated by a series of contingent events through which the notion may be recognised – examples (accepted as instances of the notion) and non-examples (rejected/ negated as not representing the notion). The moment of necessity, while it creates contingent possibilities for establishing the meaning of the notion, does not signal the arrival of the notion. This is because to arrive at the notion, judgement needs to move to the conditions that fill out its meaning (the criteria for it to be ‘counted’ as that – i.e., recognised); and to judgement of the adequacy of the new representation (produced through necessity) of the notion itself. In other words, “the judgement is now concerned not with filling out of the notion, but rather the adequacy of the object itself. Is this object “good” or “bad”, “elegant” or “clumsy” ...?” (Davis, 2005, p. 92). The arrival of the notion (recognising it) is dependent on “retroactively transcoding a series of contingent events into its necessary conditions” (Ibid. p. 93), and at the same time, within the pedagogic context its realisation is also contingent; it is evidenced in its reproduction by the pedagogic subject.

The judgement of the notion is necessitated by the contingency of the activity of the pedagogic subject—the very activity which was retroactively transcribed into a necessary condition. *This* is why the judgement acquires an additional, fourth moment, beyond the triad of *immediacy-reflection-necessity*: the pedagogic subject is a point of self-relating negativity disturbing the smooth operation of knowledge (mathematics, teaching), thus necessitating the operation of pedagogic judgement bound to a symbolic mandate. (Davis et al., 2003, p. 10)

In other words, notions, as elements of discursive fields (e.g. mathematics/ mathematics teaching) have an existence outside of specific pedagogic contexts that determine their legitimate operation internal to that field¹²². The pedagogic subject, the acquirer in the context of the IP, is only able to demonstrate the acquisition of the notion through its legitimate reproduction, but as this subject subjectively interacts in the pedagogic context he/she always represents a point of “self-relating negativity” which has the potential to disrupt the process of transcoding, creating illegitimate realisations (in terms of the rules internal to the operation of knowledge). Therefore, in the pedagogic context to arrive at the notion, it is necessary for pedagogic judgement of the realisation to be “bound to a symbolic mandate”; to the judgement of the realisation by reference to the field of knowledge itself. In the IP, the symbolic mandate

¹²² The strength of the evaluative rule that determines this legitimacy will differ in relation to the field itself. Where there is a strong grammar internal to the field itself, such as in mathematics, this can be unambiguously established. However, where the grammar is weak (such as in mathematics teaching) the grounds for establishing what is legitimate to the field shift and are often ideological (a new scripture).

for judgement of the notion is conferred on the teacher/lecturer who must evaluate the realisation against legitimate realisations produced within the knowledge field¹²³.

5.3.2 A model for analysing pedagogic evaluation in a mathematics teacher education class

Before giving an example from the empirical field of this study to illustrate how the four moments of pedagogic judgement (E, R, N, C) are recognised in the MTE context and used to read data, we need to translate the theoretical ideas related above into a model. In order to examine how evaluation is operating within an IP, we need to unambiguously recognise objects (notions) to be acquired, and to identify the movement through the four moments of judgement (if they exist). The first point to notice is in the IP there is no possibility of recognising C – the judgement of the notion. To do that we would have to examine texts reproduced by the pedagogic subjects and evaluated by the teacher. What we can get a grasp of is whether the IP moves through moments of judgement or not, and if it does how these are constituted. It is through this that an interpretation of the pedagogic mode in operation and the rules of classification and framing at work can be produced. This can be grasped, to some extent by considering *how* the moment of necessity (if it exists) is grounded or legitimated.

Recognising the object of acquisition in an evaluative event

The first step for observing evaluative judgement in any IP is to identify the object(s) of acquisition. In working with the concepts discussed above to produce a methodology for analysing evaluative events of IPs in video records of MTE in the QUANTUM project, we found there was always a tension between at least two objects of acquisition: notions of mathematics (M) and notions of teaching (T)¹²⁴. It is expected that this is likely in any teacher education context where there are a number of different knowledge discourses to be acquired and the internal grammar of these fields varies considerably from very strong (e.g. instances of ‘pure mathematics’), to very weak (e.g. instances of teaching as grounded in ‘experience’). The analytic space for identifying the objects of acquisition of any particular ‘evaluative event’ is constituted by recognising aspects of M and T, and then considering which is the *primary* object of acquisition in the particular event, and which object is secondary (in the

¹²³ This underlines an obvious point; if the teacher/ lecturer does not have access to the criteria operating internal to the field of knowledge then they will be unable to assist learners to the point of ‘understanding’ in relation to the field itself.

¹²⁴ Here what was identified earlier as ME and MT are examples of fields in which M and T come together – in ME with a focus on the discursive field constituted through research into mathematics learning/teaching and in MT with a focus on the field of professional practice in which mathematics is taught. The boundary conditions between the two are not clearly demarcated within the fields, so rules of recognising one or the other as empirically distinct are weak. In this model we simply consider the fields of M and T which can easily be demarcated.

background/ assumed as known). That which is primary is marked with a capitalised letter (M/T) and that which is secondary is marked with a small letter (m/t). While the empirical field for the QUANTUM project produced instances where M and T were always in tension, this is not necessarily the case in teacher education. For example it may be possible to find a case where a teacher is learning pure mathematics (in-and-for-itself) within a university disciplinary department, alongside other students learning it for other purposes. Here it is likely that M would be the only object of acquisition. It may also be the case in a mathematics ‘methods’ classroom, that at a particular moment the focus of attention is on ‘the most appropriate number of learners in a group for effective communication’, in which case mathematics may not be brought into the context, or assumed, at all. The possibilities constituted within the space created by the tension between M and T is indicated in Figure 12.

	M	m
T	MT	mT
t	Mt	mt

Figure 12: An analytic space for recognising objects of acquisition in MTE.

MT would be a case where M and T are *both* primary objects. It is unlikely that such a case would emerge empirically – usually one or other would be in focus. To imagine this occurring we would need to consider the possibility of an instance where there is simultaneously a strong focus on a mathematics education text *and* on a particular mathematical object, for example, the ME text would have to be discursively interrogated both for its potential to assist the pedagogic subject (student teacher) to understand/learn a particular mathematical idea, and at the *same time* to produce a principled position in relation to the methods of mathematics education/research. It is also unlikely that we would find serious instances of mt, although we might imagine instances of MTE where the focus is on some professional/ bureaucratic task, where there are no specific M or T object in focus to be acquired but there is an *assumption* that what is required of the teacher in terms of M and T is already so well known or so obvious that it requires no evaluation.

Recognising an event and its sub-events

The beginning of an evaluative event can be recognised in terms of the announcement of the existence of an object in its immediacy, and the end (or sometimes a pause in the judgement of evaluation and a move into a new evaluative event) by the announcement of a *new* object to be acquired. In general the evaluative event may proceed over a long period of time and can be

considered as made up of a number of *sub-events*, each one contributing to the primary object and moving through the moments of judgement.

For example, in the Curriculum 103 lecture at CU, over the duration of 1 ½ hours, five main events¹²⁵ were recognised. The first event was clearly a continuation from an announcement of existence in a previous lecture, and in itself represents a sub-event. However since there was no access to that interaction, and for simplicities sake, it is named here as Event 1. This event moves through four sub-events, named Event 1.1, 1.2 ... and so on. In each case, while the overarching object of acquisition remains the same (in this specific instance, an orientation to solving and evaluating ‘word problems’ algebraically through ‘unpacking’ a specific example - M), the interaction moves through a number of different specific objects which together assist with the move towards necessity in relation to the main object.

In this case Event 1 moves through the following sub-events:

- Event 1.1 There is an announcement of existence through projecting a specific word problem from the OHP and requesting students’ solutions for it (the problem had clearly been given to students in the previous lecture and they were expected to come to the class with the solution). A number of solutions are produced and students must consider which, if any are correct and why this is so.
- Event 1.2 One student’s full working of the problem is selected and written on the chalk board and is considered by the whole class. The first focus is on the *algebraic correctness* of the first part of the solution. The class is asked to evaluate this.
- Event 1.3 The focus is still on the solution written on the board, but now the focus moves to the process of *translation from a ‘word problem’ to a symbolic representation* of the problem. In this particular sub-event, the focus is on the meaning of the first line of the solution and the *translation from words to algebraic expressions* that will later be used to formulate an equation.
- Event 1.4 The focus is still on the solution written on the board and the process of *translation from a ‘word problem’ to a symbolic representation* of the problem, but in this sub-event the focus moves to the *formulation of an equation* that can be used to solve the problem, and on evaluating *whether this represents the problem accurately or not*. The student’s formulation is

¹²⁵ For a full description of all events and their coding, including transcripts see Appendix E.2.

discussed and negated and replaced by other formulations which are judged as correct.

Event 1.5 The focus moves to *different (equally correct) representations* of the problem and at this point the problem is solved and the meaning of the translation and solution is fixed for this particular problem.

In terms of the sequence of sub-events in the overall IP of this lecture, Event 1 was punctuated by the announcement of Event 2 in between Events 1.4 and 1.5. In the interaction it *seemed* at first that Event 1 was disposed of, however, one of the students in the class interrupted the process (a result of weakened internal pedagogic framing which is a feature of this specific practice) to make a further comment on the previous discussion, and so Event 1 was returned to and brought to a more satisfactory close. This illustrates the point that an event/sub-event may be punctuated by other events. If an entire series of lectures from this practice were to be examined through the model, it would be likely that we would see movements backwards and forwards between sub-events as meanings were reflected upon (and either negated or legitimated on different grounds), necessity of sub-events was contingently reached (or not), and the meaning of the overarching object of the main event was slowly elaborated.

Recognising the movements in pedagogic judgement

Within the QUANTUM project as we developed this methodology, we found, empirically that an evaluative event would not always move through to reflection and necessity, although generally some form of reflection would start with the announcement of existence. We also found in the pedagogic process that *any* attempt to fix meaning would appeal to some ground or another. The grounds that were appealed to varied considerably with the different objects of acquisition (M/T/Mt/mT), and ranged across, for example discursive (symbolic) resources including the discipline of mathematics and the field of mathematics education research, experiential knowledge (gained from practice), everyday local understandings of the world, metaphors and analogies, the authority of a text/ individual (e.g. lecturer), school curriculum knowledge and so on. We called these appeals *legitimizing appeals* and identified them as ways in which to recognise the *move towards* necessity in the evaluative event, that is, as instances of reflection. If the reflection in the event moved to a point where meaning appeared to be fixed, and there was some kind of agreement over meaning of the object of acquisition, then we would recognise that a moment of contingent necessity had been reached within the context.

The rules described above, as produced through the QUANTUM project are diagrammatically represented in Figure13. This now provides a model for reading the IP in a MTE class.

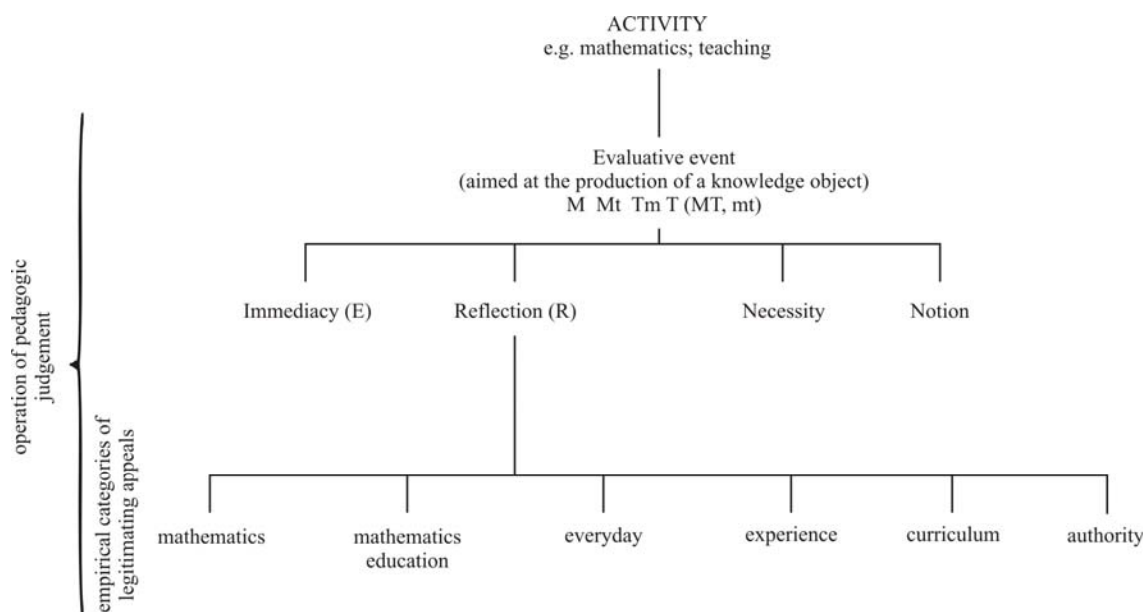


Figure 13: Analytic space for identifying moments of judgement and legitimating appeals (Davis, Adler, & Parker, 2006, p. 2)

A table is used for recording the analysis (See Table13 for an example showing the results of the analysis of Event 1).

In what follows I give an example of a section of transcript from CU and show how it is analysed to produce and record data using the tool. In the following chapters data from each case will be presented and an interpretation produced.

5.3.3 An Example of MTE practice from CU

The example of Event 1, outlined above is used to illustrate the movement of evaluation through pedagogic judgements.

The judgement of Existence

In the example of evaluative Event 1.1 the event is announced through showing a word problem on the OHP (see Plate 1: Word problem given at the beginning of the lecture.). At this stage it is merely a problem. The problem is an announcement of the object to be acquired in its immediacy - it stands in the place of what is to be acquired, namely, an *orientation to solving mathematical word problems algebraically*.

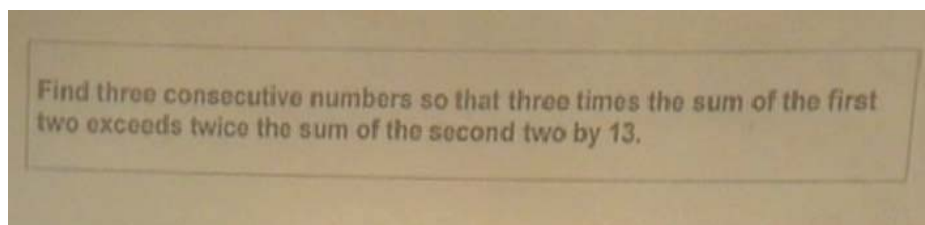


Plate 1: Word problem given at the beginning of the lecture.

The Judgement of Reflection

In the second sub-event (E 1.2) a student's solution to the problem was written on the board (see Plate 2). During reflection aimed at evaluating the algebraic correctness of the first part of the solution, the link between the line 1 and line 2 was questioned. The lecturer bracketed it off, and now returns to it, using it to announce a new focus, which marks the beginning of Event 1.3. Here the object moves from evaluating the algebraic correctness of a particular argument to *the translation from words to symbols*, in the form of expressions and equations.

The lecturer asks the student to explain:

- L: Ok so that part is correct. So Precious, what we are not clear on is how you ... just explain to us what line 1 means in relation to the problem and how you went from line 1 to line 2.

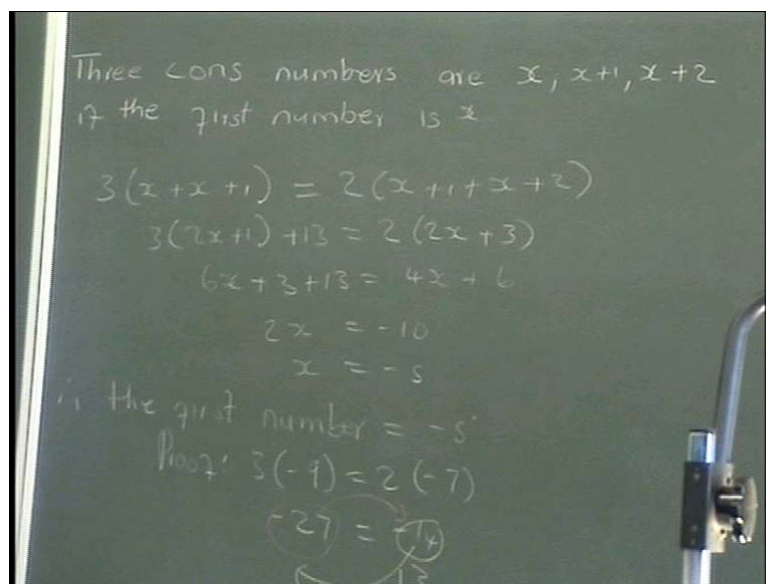


Plate 2: Precious' solution

The student tries to explain what she was doing. The lecturer listens as she explains and probes her thinking. He concludes:

- L: so you are saying [pointing to first line] that's number one, the first number and second number add them together and multiply by 3.
Precious: yes

- L: and then you said that's the second number and the third number [underling in yellow on the board – see Plate], right. Add them together and multiply by 2. And you are saying that those two are equal?

$$3(x + x + 1) = 2(x + 1 + x + 2)$$

$$3(2x + 1) + 13 = 2(2x + 3)$$

Plate 3: Lecturer focuses on the translation from word to symbols

- Precious: yes
 L: then you said ...
 Precious: that one exceeds that one by thirteen
 L: this one [L points to $3(2x + 1)$] exceeds that one [L points to $2(2x + 3)$] by thirteen, so you put the 13 in here [L points to the 13].
 L: Comments? Let's focus on the first line.

We see here the beginning of reflection on the translation of the problem from words to algebraic symbols. The lecturer probes the student to reveal her thinking, and so puts this up for discussion with the whole class. The discussion proceeds with different students considering the meaning and reflecting back on the word problem. Throughout, the lecturer keeps the focus on unpacking the thinking involved in translating from the word problem to the algebraic expressions used to produce the equation she used to solve the problem. During this Precious' translation is corrected (aspects are negated), and the link between line 1 and line 2 in the argument is clarified, and the moves to the next sub-event (E 1.4) which evaluates whether line 2 is a valid translation or not is signalled:

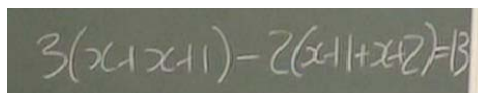
- L: So they are just two expressions. They are not equal. [L rubs off the equal sign in the first line]. So that is one way of representing one phrase [points to $3(x + x + 1)$] and that's an algebraic way [points to $2(x + 1 + x + 2)$] of representing another phrase. And now we are trying to set up the relationship between this one and this one [points to the first and then to the second]. So that's why you bring in the equals because it has got something to do with the thirteen [pointing to the second line]. Ok. I think what you [Precious] were meaning was right. But what you wrote mathematically in terms of the symbols was wrong. Ok so I'm taking out the equals and I'm assuming that you are trying to express two different ideas. Now is this thing [pointing to line 2] valid? So is that equation expressing the relationship that is in here? [L points to the problem statement on the OHP]

The judgement of reflection is recognised in the process of posing different possibilities and appealing to mathematical meaning in order to accept or negate a suggestion. In this particular example *all* legitimating appeals are made to mathematics.

The Judgement of Necessity

Having moved from 1.1 though to 1.4, where the translation had been discussed, and some different ways of translating the problem from words into an equation which represents the relationship in symbolic form had been presented, further possibilities are added, that is the judgement of reflection is continued. This is recognised as Event 1.5.

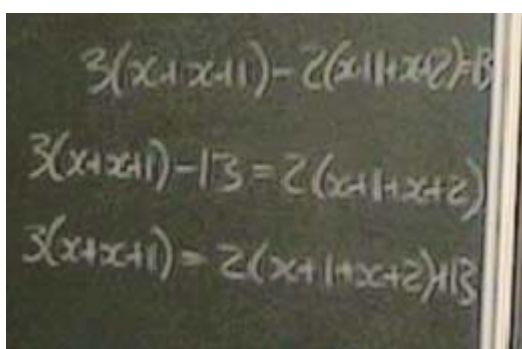
Nicole: Another way you can think about it is as a subtraction sum. They are saying that the 3 times 2 x plus 1 exceeds the two, twice two x plus 3, obviously the three times 2 x + 1 is the bigger one, so you take your bigger one minus the smaller one [L listening and writing up on the board: see Plate] and the difference between them is 13. And then you can see that if you take your second number over to the right hand side you will get 2 times two x plus 3 plus 13.



$$3(x+1) - 2(x+1+x+2) = 13$$

Plate 4: equation describing the word problem in terms of a subtraction

- L: [looking at class] Follow? So we can interpret this as saying, take the smaller one from the larger one, the gap is 13. So there are at least 3 ways that we can write this thing. [points to new equation written on the board]
- L: Ok. That is subtraction to get 13. This one is balancing, so we are dropping the bigger one by 13 to make it equal to the smaller one [writing second equation on the board: see Plate]. The other way is what Nathi was saying, [writing third on the board] add 13. So in other words we increase the smaller one so that it is the same size as the bigger one.



$$\begin{aligned} 3(x+1) - 2(x+1+x+2) &= 13 \\ 3(x+1) - 13 &= 2(x+1+x+2) \\ 3(x+1) &= 2(x+1+x+2) + 13 \end{aligned}$$

Plate 5: three different equations for solving the problem

The discussion is continues until everybody agrees. They then all confirm which of the original solutions put up on the board in Event 1.1 was correct.

The Event 1 ends here, having moved from 1.1 to 1.5. At this point the problem is solved¹²⁶ and the meaning is *contingently fixed*. The ‘notion’ conveyed includes: doing such word problems is a process that involves translation from words to symbols and doing this successfully depends on carrying mathematical meaning from the words into the symbolic representation; there are different (equally correct) ways in which the meaning can be expressed; all correct ways of expressing this meaning will result in the same correct solution; the grounds for making decisions and legitimating a text (in this case a particular expression) as correct are to be found in the mathematical meaning itself.

In terms of the methodology the overall coding for Event 1 is as follows:

1. *Primary object to be acquired:*

M an orientation to solving and evaluating word problems

2. *Secondary object/s (assumed or implicit):*

¹²⁶ Note that the process does not include the normal checking of a solution against the original problem which would be typical of this kind of problem, and would generally be expected.

- m: Background knowledge of mathematics, e.g. knowledge of correct algebraic methods and the logic of algebraic expressions.
- t: There is an implicit message about mathematics teaching: we are doing this because you will become teachers, this is an example of teaching that is being put up here, we are unpacking an M problem and its solution which is an essential skill for the work of mathematics teaching

3. *Form of interaction:*

Student presentation of solution; whole class discussion; lecturer questioning; small group discussion

4. *Pedagogic judgements:*

- E – yes (the announcement of the problem)
- R – yes (movement through the various sub-events, legitimating appeals made to mathematics at all times and mathematically incorrect expressions/translations/solutions are negated)
- N – yes, contingent (the problem is solved and it illustrates the idea, necessity is reached with respect to this problem)

The results of the analysis of Event 1 are summarised in Table 13.

Table 13: Table recording results of analysis of evaluative Event 1 (Curriculum 103; City University)

		KNOWLEDGE OBJECT(S)																		
		MATHEMATICS									TEACHING									
		Legitimizing appeal									Legitimizing appeal									
Event	Major object	M	E	R	Maths	M.Ed	Ev.day	Auth.	N	m	T	E	R	Maths	M.Ed	Exp.	Curr.	Auth.	N.	t
1.1	correctness of specific solutions to word problem	1	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
1.2	algebraic correctness of the argument leading to a solution	1	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
1.3	translation from words to expressions	1	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
1.4	formulating equation to represent problem	1	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
1.5	Producing different correct representations and a final solution	1	1	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1
1	Orientation to solving and evaluating M word problems	1	1	1	5	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1

Note that each sub-event is coded by analysing the event for E, R, and N, and for each pedagogic judgement recognised 1 is placed in the corresponding cell. If not, a 0 is written in the cell. If there is reflection and a move towards necessity, then the grounds for the legitimating appeal is considered and the corresponding cells filled. In the final summary of the event, the columns indicating the legitimating appeals are summed (shown in bold type face in the table). This gives an indication both of the spread of appeals across the event as well as the density of appeals made.

5.3.4 Patterns in classroom interaction

In addition to considering the evaluative events over the duration of the IP, a second aspect of the interaction with respect to each identified event/sub-event is also recorded. The purpose of this is to make visible the movements between different patterns of classroom interaction that create distinct discursive formations. The analysis of evaluative events provides some purchase on how meaning in the pedagogic context is contingently fixed (and so some access to the recognition rules for the legitimate text). On the other hand, the patterns of interaction between lecturer and students and between students during the unfolding of a particular evaluative event, gives a view of the way access to this meaning is regulated, i.e., the social relations within the classroom.

In relation to the empirical field a number of different discursive forms may be recognised within an IP:

- lecture/ expository teaching (where the lecturer presents ideas, examples, and so on, explaining ideas and showing procedures or methods that would lead to reproductions of the legitimate text);
- lecturer controlled questioning and answer sessions (where the lecturer elicits answers to specific questions in order to evaluate specific texts);
- whole class discussions (where there is interaction amongst students and the lecturer which focuses on a specific idea/ example etc, where varied input is welcomed from all parties, and ideas are developed);
- small group discussions/ work (where students sit in small groups and discuss ideas/ examples amongst themselves; where students work together on a problem);
- individual student work (where students sit on their own and independently work on a problem/ reproduction);
- student presentations (where students address the whole class and present a specific piece of work, e.g. writing a solution on the board and explaining it to all);

- lecturer questions (where the lecturer interacts with students on an individual or small group or whole group basis, asking questions, not to elicit answers, but to get them to consider possibilities/ evaluate their own thinking and promote discussion)
- non-trivial student questioning (where students independently ask probing questions of the lecturer, without the questions being elicited by the lecturer – these are not simple questions for purposes of clarification).

These are self explanatory and easily distinguished in practice. The purpose of distinguishing between these forms is to provide additional depth to the interpretation of the pedagogic mode operating in the context. Each evaluative event is examined for the form of interaction, and the table as shown above is extended on the right to accommodate these records (See Table 5 in Appendix E.2 for an example)

5.3.5 Interpreting the results

The data produced enables us to consider the movement of pedagogic practice through a specific temporal duration. By considering the patterns in the evaluative events and discursive movements at the classroom level we will be able to interpret how the pedagogic discourse (instructional discourse/ regulative discourse) operates to constitute meaning in the classroom context.

5.4 Analysing and interpreting formal assessments

The empirical field is constituted by the examples of formal assessments provided by the lecturers at the various institutions. Examples of formal assessments are analysed. It is here that the evaluative rule in operation will be at its most condensed. All examples contained in the archive are considered in the analysis in order to provide as full a picture as possible of the way in which the legitimate texts for the various modules are constituted. It is recognised that this analysis cannot be complete since the empirical objects are a particular selection of assessments and do not represent the totality of the assessments used over the duration of the B.Ed. (The texts are limited by what was provided by the lecturers)

Once again a methodology for analysing the assessment tasks needs to be elaborated. The purpose of this is to analyse the range of formal evaluations across the different modules in order to obtain data that will enable me to describe the way in which these reproduce specialised forms of knowledge, in this instance, forms that might be recognised as mathematics, mathematics education and mathematics teaching. This can then be linked to the

possibilities for the specialisation of consciousness within the pedagogic subjects who study at each institution.

5.4.1 Producing an analytic space for categorising assessment tasks

Adler and Davis (2006) emphasise that there is a specificity to the way in which teachers need to hold and use mathematics in order to teach mathematics well, and they support Ball and Bass' (2000) argument that this way of knowing and using mathematics differs from the way mathematicians hold and use mathematics. In particular, they identify 'unpacking' or 'decompressing' mathematics as a critical element of knowing and doing mathematics in and for teaching¹²⁷. While recognising that the notion of 'unpacking' is very broad, still at the level of metaphor and needs to be elaborated itself to become more useful, they use it as a basis for developing a tool for analysing formal assessment tasks in a range of in-service teacher education programmes. They see their analysis as having the potential to reveal, at least partially, the selection of mathematical and teaching competences privileged by the teacher education programmes in their study. In this section I use the methodology described by Adler and Davis as the basis for examining the formal assessment tasks in my sample.

The general methodology developed by Adler and Davis for the analysis of assessment tasks draws on Bernstein's sociology of pedagogy, and in particular his insight that the pedagogic device condenses in evaluation. They note that notions such as "evaluative events, criteria for legitimate knowledge displays, and recognition and realisation rules at work in pedagogic practice are all abstract notions that require elaboration and/or grounding in the empirical if they are to be put to work to turn information into data" (Adler & Davis, 2006, p. 282). Here I work with the general methodology they present to turn the information relating to the assessment items collected in my archive into data.

I accept that for a specialised knowledge form to be reproduced there must be some degree of internal coherence and consistency that is characteristic of the established patterns of reasoning and logic internal to that knowledge discourse. The way in which coherence and consistency is established in mathematics and mathematics teaching¹²⁸ differ, and in particular, the difference between the established discipline of mathematics and the relatively unstable fields of mathematics education and mathematics teaching is to be found in the

¹²⁷ Refer to Chapter 2 where these ideas were discussed in some detail.

¹²⁸ This is used here to include what I previously identified as mathematics education – the academic field based on knowledge produced in the research field – and mathematics teaching – the field of professional practice, including research into practice as well as other forms of bureaucratic, practical, experiential, and local knowledge(s).

internal grammar of these discourses. Mathematics, as was argued earlier¹²⁹, has a strong internal grammar that enables the unambiguous evaluation of texts offered as mathematical knowledge. In Mathematics teaching, the grounds for evaluation are more ambiguous since the field is “populated by academic, professional, bureaucratic, political and even popular discourses” (Adler & Davis, p. 284) as well as local experience. However, regardless of these differences, justifications for coherent and consistent reproductions of knowledge, whether mathematical or educational, can be structured in a mode that conforms to the formal features of chains of syllogistic reasoning. This is the analytic resource used to distinguish between types of assessment as either requiring ‘unpacking’ or ‘compression’ – that is whether or not explicit coherent chains of reasoning are demanded by the task.

The basic procedure involves first distinguishing what are the primary and secondary objects of acquisition in the task (mathematics and/ or teaching), and secondly, whether or not the response demanded by the task requires the meaningful production of chains of syllogistic reasoning relevant to the knowledge to be reproduced. In this way Adler and Davis generated a two dimensional analytic space for categorising tasks to enable an initial description of formal assessment tasks in their archive. They first identified the primary and secondary objects of the tasks, labelling these by a capital M or T and the secondary object (where it appears) by a lower case m or t. Where a task explicitly demanded an understanding of syllogistic chains, that is some “unpacking” of knowledge relevant to the task, they indicated this by a U^+ . If no such reasoning was demanded they labelled the task U^- . The analytic space so generated is reproduced diagrammatically in Figure 14.

		What			
		M	m	T	t
How	U^+	M U^+	m U^+	T U^+	t U^+
	U^-	M U^-	m U^-	T U^-	t U^-

Figure 14: Analytic space for the description of tasks (after, Adler & Davis, 2006, p. 284)

While this typology worked for the QUANTUM study I needed to adapt it slightly for my purposes. I wanted to be able to see what knowledge discourses formed the grounding for any justification produced in response to a task. I recognised that while any justification of mathematical objects (M/m) would be unambiguous in their requirements, in the sense that all cases of M/m would be based within a discipline with a strong internal grammar and could be

¹²⁹ See the discussion in Chapter 3 focusing on Bernstein’s (1999) notion of horizontal and vertical knowledge discourses.

evaluated against well established practices for what counts as legitimate reasoning within the domain, this would not be the case for mathematics teaching (T/t) objects where the grounds (that is the authority on which the legitimating appeals are based) could be very diffuse. For my purposes the typology does not sufficiently discriminate between different types of T/ t tasks. For Adler and Davis all teaching/ pedagogic tasks of the type TU^+ and tU^+ represent assessment tasks where the response requires understanding to be “unpacked”. For me the problem also includes whether the T/t in each case is grounded in horizontal discourses based on experience, practical know how, local knowledge etc, or other more vertical forms of knowledge produced in the discursive/ official fields of ME or MT (academic knowledge/ professional/ curriculum knowledge). Thus I adapted their typology by splitting the T/t depending on the grounding expected for carrying out the task. So for example while all TU^+ tasks require reasoned activity (explaining why and providing some chain of argument), the reasoning could be symbolically grounded in a field of (mathematics/ professional) educational research (T_k/ t_k) or on experiential/ practical reasoning based on local knowledge (T_e/ t_e). I therefore expanded the analytic space to include these forms, as shown diagrammatically in Figure 15. While it is recognised that this is still very broad, it was one way to enable the recognition of whether and how resources from the broad field of mathematics education were demanded in the expected reproduction of legitimate texts within the formal assessment tasks found within a particular module (pedagogic context).

		What					
		M	m	T_k	t_k	T_e	t_e
	How						
	U^+	MU^+	mU^+	T_kU^+	t_kU^+	T_eU^+	t_eU^+
	U^-	MU^-	mU^-	T_kU^-	t_kU^-	T_eU^-	t_eU^-

Figure 15: Analytic space for the description of tasks (elaboration of Adler & Davis, 2006, p. 284)

In working with the assessment items in the archive it was easy to identify those tasks which focused on a single object and then to categorise it in terms of the demands for unpacking as described above. In the cases where two objects were present, I needed to determine, following Adler and Davis’ methodology, which of the objects was primary and which secondary. I was able to judge when a teaching object was present by recognising within the task the appearance of a virtual or actual pedagogic subject, for example, a fictional learner to which something or another must be explained.

Given the above possibilities it is clear that a particular task could occupy more than one cell in the analytic space shown in Figure 15. Where a task has two objects, it occupies the cell indexed by its primary objects as well as its secondary object. For example where the primary

object is mathematics (M) and this requires the (re)production of a chain of syllogistic argument the task occupies the cell MU^+ , at the same time this task may have as its secondary object teaching ($t_{k/e}$) where a specific pedagogic argument is also required and it therefore also occupies the cell $t_{k/e}U^+$. The task is then categorised as a $MU^+t_{k/e}U^+$ type task.

At this point it is noted that the notation is becoming cumbersome. While the symbol $U^{+/-}$ was originally used by Adler and Davis to signify the original metaphor of ‘unpacking’ as connected to providing a chain of reasoning, this is no longer necessary. The U in the notation can be dropped without changing the meaning of the notation. Applying this simplified notation to the example above, a task that has primary object M and secondary object $t_{k/e}$ where both objects require the production of a chain of syllogistic reasoning would be represented by the symbol $M^+ t_k^+$ or $M^+ t_e^+$, depending on the grounding of the pedagogic argument. In addition we note if the secondary object is t, and *no* argument is required, then no grounding is necessary for t. In other words it is unnecessary in these cases to use a subscript of k/e to signify the type of grounding. Thus a task that has as its primary object M requiring the production of a reasoned argument, and secondary object t which does not require the production of an argument, would be represented by the symbol $M^+ t^-$. Thus the categories referred to before as $M^+ t_k^-$ and $M^+ t_e^-$ collapse into one category, $M^+ t^-$.

A further collapse in notation is produced when it is recognised that if the primary object is T and *no* pedagogical argument is demanded in the production of the required text, then *no* grounding for the argument would be required. Once again the k/e in the subscript could be dropped. Thus a task that has as its primary object T and secondary object m, where neither objects require the production of a reasoned argument, would be referenced by T^-m^- . Similarly a task that is *only* focused on one object T, but no reasoned pedagogical argument is demanded, would simply be categorised as T^- . From this point on the simplified notation will be used.

Figure 16 shows the range of possibilities available for categorising assessment tasks.

Thus the process for working through the assessment tasks to systematically produce the data follows the procedure: (i) for the specific task identify the primary ($M/T_{k/e}$) and secondary (m/t) objects; (ii) with respect to each of the objects identify whether elaboration of a reasoned argument is explicitly demanded (+) or not (-).

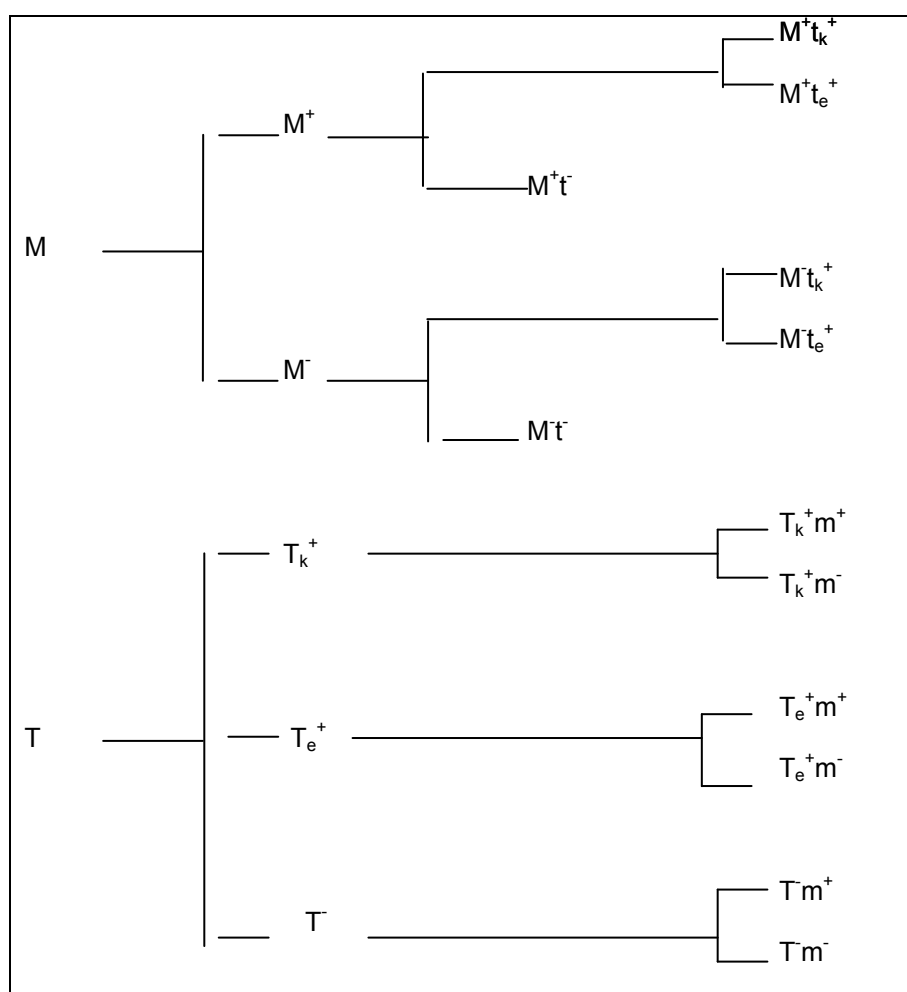


Figure 16: Possibilities available for categorising tasks (elaboration of Adler & Davis, 2006, p. 285)

5.4.2 Recognising different categories of formal assessment tasks

As was the case with Adler and Davis' study, the items in the sample collected from CU and RU did not include examples of all possible types of tasks shown in the model. In this section I use a selection of examples from the empirical field to illustrate the recognition rules for different possible categories produced by the model. The full the analysis and interpretation for each case are presented in the following chapters.

1) *Tasks of the type M^+ and M^-*

Following Adler and Davis, tasks of the type M^+ are recognised as those tasks that are focussed explicitly on mathematics *and* demand a display of understanding of the mathematical grounds/ reasoning/ argument/ practice that is the basis for a legitimate mathematical (re)production. These tasks demand some kind of 'unpacking' as described earlier, in order to produce a legitimate response. That is, they require chains of syllogistic reasoning.

Figure 17 is an example of an M^+ assessment task from the Mathematics for Teaching module at CU. This task is unambiguously recognised through the demand in part b) for an explanation to be given which requires the student to produce a reasoned argument.

4)	The function $p(x)$ is defined as follows:
	$p(x) = \begin{cases} -x^2 - 5, & x < 2 \\ 2, & x = 2 \\ x^3 + t, & x > 2 \end{cases}$
a)	determine the value of t so that $\lim_{x \rightarrow 2} p(x)$ exists.
b)	Explain why $p(x)$ will never be a continuous function, regardless of the value of t

Figure 17: An M^+ type task from Maths for Teaching 103 module offered at CU (final examination)

Note that in this particular example, the formulation of the task orientates the student towards what is required in 4b). The task is structured with an intermediate step (a) which provides the first part of the argument that will be needed to provide the explanation (b). A fully ‘compressed’ form of the question would simply ask the student to answer (b) and expect the student to recognise the specificity of what is required to produce a legitimate answer. The student is given some help here to orientate them to the requirements and help them recognise the context – that is if we want to examine the continuity of a function we need to consider the limit at all possible points of discontinuity.

If 4a) was given here on its own, that is, if 4b) were excluded from this task, then the task would be recognised as an M^- type. The student is required to produce the solution which could be done on the basis of following a fairly standard procedure.

2) Tasks of the type T_k^+ , T_e^+ and T^-

Tasks of the type T^+ demand reasoned discussions of pedagogic strategies *without* reference to *specific* mathematical knowledge. The example provided in Figure 18 is recognised as a T_k^+ task, since it requires the production of pedagogical arguments ($^+$) based on evidence grounded within an academic/ discursive/ symbolic resource ($_k$) (in this case a specific reading based on research from the field of mathematics education). In this specific example, a particular article is used as the basis for the production of a pedagogic text about mathematics teaching.

T_e^+ tasks would be recognisable as grounded in practice and experience. For example a task asking: ‘Reflect on examples from your own practice to argue for or against group work as a

method of teaching', would be identified as a T_eU^+ . No such tasks were found in the archive from CU or RU.

T^- type tasks would be those "calling for the recall of pedagogic strategies without reference to mathematics. For example, "List five features of group work" (Adler & Davis, 2006, p. 286). As with Adler and Davis' study, there were no tasks of this type found in the archive from CU.

QUESTION 1
 This question refers to the article **Never say anything a kid can say** by Steven Reinhart, *Mathematics Teaching in the Middle School*, 5 (8), April 2000.

- 1) The author claims he has two purposes for asking good questions (p480a par 3). Write down his 2 purposes. (2)
- 2) The author distinguishes between *product* questions and *process* questions (p480a par 4). Explain what he means by *product* and *process* questions. Give examples to illustrate the differences. (4)
- 3) The author refers to *wait time* (p480b para 2)
 - a) What does he mean by *wait time*? (1)
 - b) Why does he consider *wait time* an important issue in his teaching (2)

.....

[comprehension exercise continues]

.....
- 7) The author's general message is that he never tells his students, and that they must learn from each other. Discuss 2 advantages and 2 disadvantages of this approach. (4)

Figure 18: A T_k^+ type task from Curriculum 103 (June Exam)

3) Tasks of type $M^+t_k^+$, $M^+t_e^+$ and M^+t^-

$M^+t_k^+$ and $M^+t_e^+$ type tasks are recognised as tasks that have a clear mathematical object that is primary and a teaching object that is secondary, and both of these demand explicit reasoning of mathematical solutions and pedagogic steps. It is noted that while it is possible to imagine such tasks, none were found empirically at CU or RU.

On the other hand in M^+t^- tasks the primary object is mathematical and this requires a display of reasoning that would unpack the meaning of the mathematics. The task also posits a virtual pedagogic subject and activity, however this is simply a resource for generating the required demonstration of mathematical reasoning and so an understanding of the mathematical object and no explicit pedagogic argument is required. In these cases there is no need to distinguish between the t objects since in all cases the virtual pedagogic subject/ activity needs no explanation and is simply a device to unpack the mathematical reasoning. While no tasks of

this type were recognised at RU, a number were found empirically at CU. Figure19 gives an example of such a task.

h)	A fellow student believes that $x^2 + (y - 3)^2 = 10$ is the equation of the circle with diameter EB. Show him that this is incorrect using at least two different explanations.

Figure19: An M^+t^- type task from Maths for Teaching 104 (Tutorial 1) (CU)

In Figure 19 we see the student is introduced not as a pedagogic subject that requires serious attention but rather as a virtual subject to which the mathematical explanations are to be addresses. The work to be done is purely mathematical, and demands the student to produce two explanations, which of necessity will require the production of arguments which ‘unpack’ the meaning of the given equation.

4) Tasks of the type $M^+t_k^+$, $M^+t_e^+$ and M^+t^-

In tasks of the types $M^+t_k^+$ and $M^+t_e^+$ the mathematical object is primary, but requires a procedural response rather than the production of a principled argument. As described previously the pedagogic object could be conceived of as demanding a reasoned response that is grounded in one of two different ways denoted by t_k or t_e . I did not find any tasks of this type in the archive of RU or CU. The example in Figure 20, from CU was considered as being close to this type – however in the final analysis it was decided that it represents a M^+t^- type task. I have inserted this task here to emphasise the difference between $M^+t_{k/e}U^+$ and M^+t^- type tasks.

The task in Figure 20 is seen as being primarily mathematical – there is a mathematical word problem that is to be solved and this is the primary focus of the task. The work to be done is to ‘do the problem’, an instruction that does not necessarily imply the production of a reasoned argument, that is an M^- task. In order to do the task the student is asked to identify the ‘important words and phrases’ used in the task, presumably words and phrases that can be recognised as providing clues for the mathematical work to be done in solving the problem. However, the student is *not required to provide any justification* for identifying these as important words. In addition the virtual pedagogic subject (the learner) is to be considered as one who might find some of the language difficult. The pedagogic task is to identify the words that the virtual subject might find difficult, which could be considered to be a merely procedural task. It does not necessarily demand a pedagogic argument and is therefore seen as a t^- task.

Task 1
 The following extract comes from Laridon, P. et.al. (1996) *Classroom Mathematics Standard 10/ Grade 12/ Level 12*. Johannesburg: Heinemann

The sum of the first five terms of the finite arithmetic series is 40. The 5th and last term is 14. Determine a and d , the first term and the common difference.

- 1) Identify all important words and phrases in the problem statement.
- 2) Identify aspects of language that learners may find difficult.
- 3) Do the problem.

Figure 20: An M^+t type task from Curriculum 103 (Mathematical Language Task) (CU)

For this task to be considered a $M^+t_{k/e}$ type task, question 2) in the task would need to be adapted. For example, if question 2) read “refer to X (some or other mathematics education resource) to identify aspects of the language that learners may find difficult. Explain how this language could interfere with learners’ ability to solve the problem. Suggest alternative wording that would be more appropriate. Justify your answer”, it would be transformed into a M^+t_k task. To change it into a M^+t_e task a similar rewording could be used, but in this case the use of a mathematics education resource would not be demanded – it would expect the argument to be based on general knowledge of language use and experience of learners.

5) Tasks of the type $T_k^+m^+$, $T_e^+m^+$, $T_k^+m^-$ and $T_e^+m^-$

In tasks of the type $T_k^+m^+$ and $T_e^+m^+$ the primary object is pedagogical and the secondary is mathematical. Both objects however demand the production of reasoned argument. Figure 21 and Figure 22 respectively provide examples of tasks of each of these types. Both these come from CU. No such tasks were found in the RU archive.

In Figure 21 the primary object is recognised as T_k^+ since the problem is primarily concerned with a virtual pedagogic subject and with working with error analysis which is a focus found within the field of mathematics education. However mathematics must be drawn on to recognise the error and to give an interpretation of its source. The secondary object, m^+ , is focussed on using a geometric approach to help the pedagogic subject correct the error. The specific resource being used to do this is a math teaching resource (algebra tiles) and also incorporates the idea of multiple representations. In this example both the pedagogic and the mathematical require the production of a reasoned argument. The pedagogic argument is seen to be based within the field of mathematics education, drawing on discursive resources

focusing on error analysis and on teaching resources (algebra tiles) unlikely to be found in a purely mathematical context. The task is classified as type $T_k^+m^+$.

QUESTION 2

1) A Grade 9 learner is asked to simplify: $(x + 5)^2$
 She writes $(x + 5)^2 = x^2 + 25$

a) Describe the error she has made (1)

b) Give a possible source of the error (1)

c) Use a geometric approach (e.g. algebra tiles) to help the learner correct her error. Give the geometric representation and explain carefully how it links to the algebraic solution. (5)

2)

Figure 21: A $T_k^+m^+$ type task from Curriculum 103 (June Exam)

A $T_k^+m^+$ task would focus on a pedagogical object that would require the production of a reasoned argument grounded in some or other discursive resource. Such a task would also have a mathematical focus, which simultaneously required the production of a chain of mathematical reasoning.

A $T_k^+m^-$ task would have a similar focus on a pedagogical object requiring a reasoned discursive argument, but in this case the mathematical focus would not require the production of a reasoned mathematical argument. No such tasks were found in the archive of CU or RU.

The task in Figure 22 is of type $T_e^+m^-$. A pedagogic argument is demanded but the requirement is that it be based on the student teacher's experience and opinion. The marking memo for this task indicates that the T decisions are not expected to be based on any discursive resource e.g. resources on assessment in mathematics from within the field of mathematics education, or education more broadly, but rather on what the student thinks based on their experience and unpacking of the mathematics in the learner solutions. While mathematics is clearly a necessary resource for producing the task, no specific mathematical explanation or argument is required here. The task is therefore categorised as type $T_e^+m^-$.

QUESTION 3

A Grade 9 class were given the following question in a test:

Solve for x: $x(x + 4) - x = (x + 2)(x - 5)$ (4 marks)

The following memo is provided. Mark allocations are indicated with ticks ()

$$x(x + 4) - x = (x + 2)(x - 5) \quad \checkmark$$

$$x^2 + 4x - x = x^2 - 3x - 10$$

$$3x = -3x - 10$$

$$6x = -10 \quad \checkmark$$

$$x = -5/3 \quad \checkmark$$

- 1) Give your opinion on the following:
 - a) The number of marks allocated for the question (1)
 - b) Whether you agree with what the marks are allocated for (2)
- 2) The solutions of 3 learners are given in Appendix A.
 - a) Mark each learner's solution. Show clearly what you are giving marks for. (6)
 - b) Justify your mark allocation for each learner. (6)

[15]

Figure 22: A $T_e^+m^-$ type task from Curriculum 103 (June Exam)

It is easy to imagine adapting this task in order to transform it into a $T_k^+m^-$ type. For example if in addition to question 2) (or in place of it), the students were asked something like: 'Examine the 3 learner solutions for errors. Draw on readings done in your course to name the categories of errors you identify. For each type recognised, explain a possible cause and provide a strategy for assisting the learner to correct the error'.

We could also imagine adapting the task in Figure 22 so that it is transformed into a task of the type $T_{k/e}^+m^+$. For example, if the teacher were asked, to provide the pedagogical argument (grounded in experience (e), or, a specific discursive resource (k)) and then to provide a full mathematical argument for the solution given, or to produce arguments for additional alternative solutions.

6) Tasks of the type Tm^+ and Tm^-

No examples of tasks of type Tm^+ were found in the archive of CU or RU. Such a task would have as its primary object a pedagogical focus that did not require the production of a reasoned pedagogical argument, for example the requirement to produce some or other pedagogic resource without having to provide the reasoning behind its construction, and as its secondary object, some mathematics that does require the production of a mathematically principled argument.

Tasks of the type T_m^- would be characterised by the primary pedagogical object requiring a response that does not demand the production of any reasoned pedagogic arguments. The secondary object would be mathematical and would also require no reasoned mathematical argument. Figure 23 is recognised as an example of a T_m^- type task. The task is an assignment from a RU module in which students are asked to plan a lesson. No specific details of requirements for the production of the task are provided. The task is presented in a very compact form, and there is an assumption that the students know what is required in the production of such a calculus lesson. This has been identified as a $T_e^- m^-$ type task since there is no evidence that any specific discursive resources were required to produce the plan. Mathematics is visible in the task since the focus is on a calculus lesson, and it is assumed that knowledge of calculus will be drawn on to produce the plan. However there is no demand for a pedagogic or mathematical explanation or argument in the production of the lesson.

<u>Assignment Task 1</u> Produce a detailed plan for a Grade 12 Calculus lesson.

Figure 23: An example of a T_m^- type task (Assignment: Calculus B) from RU

6 Issues of reliability and validity in this research

Reliability, as was indicated earlier is related to the explicit nature of the languages of description used in the production of data and the iterative processes set up between the empirical and theoretical fields in the development of the external language of description, which work to ensure reliability and reduce the risks of inconsistency and dishonesty. The validity of qualitative interpretive research, on the other hand, can be thought of in relation to the types of understanding that are employed producing the account.

Maxwell (1992) suggests that all qualitative research produces *an account* of an empirical field, and that it would be wrong to assume that there would be “only one correct, “objective” account”. He adopts a realistic approach to validity, suggesting that “*understanding* is a more fundamental concept for qualitative research than validity” (p. 281) and that the types of validity relevant to qualitative research provide a typology of “the kinds of understanding that accounts can embody” (Ibid., p. 284). Broadly he identifies three types of internal validity: descriptive, interpretive and theoretical validity, and two aspects related to external validity: generalizability, and evaluative validity.

Here I briefly discuss the internal validity implications of descriptive, interpretive and theoretical validity in my study. Descriptive validity refers to the factual accuracy of the account. In relation to this study, descriptive validity is dependent, at the most basic level, on an accurate recording of empirical information. To reduce the risk to descriptive validity all individual interviews were audio recorded, and group interviews video recorded, and these were transcribed. Transcriptions were checked for accuracy. In addition all MTE classroom observations were video recorded and the audio tracts transcribed, and checked. Field notes were written up systematically at the time of the site visits. All printed material and student writing was labelled and systematically organised in files so as to ensure accuracy in linking material to courses and institutions. All information for each case was stored in separate boxes and worked with at separate times. These procedures were employed to ensure that, as far as was possible, accurate and full information was used as the basis for data production and thus to ensure: “a valid description of the physical objects, events, and the behaviours in the setting of the study” (Ibid., p. 288).

The methodological approach based on Thompson’s (1990) depth hermeneutics discussed earlier in the chapter provides a control over what Maxwell refers to as interpretive validity. In particular, the rich descriptions of the doxa or the pre-interpreted domain provide the basis for interpretive validity. Here the focus is on the participants’ perspectives. The account of the first level of interpretation given in the thesis uses, as far as is possible, the participants’ own words and concepts. This enables thick and rich descriptions which assist in providing a basis for interpretive validity. However, as was explained earlier, the open and explicit description of the external languages of description used to produce data for analysis and interpretation, provide a mechanism for ensuring interpretive and theoretical validity.

One threat to internal validity inherent in the accounts given in this thesis, relate to the limitations of the empirical information collected for the case studies. In each case, the account is of a slice of time (a three week period in the second half of 2004), and the information collected was what was provided by the participants at that time. The most limiting aspect was the videos of MTE classroom practice, which while providing some insight into pedagogic practice in operation, were in-and-of themselves very limited. However, the layered approach taken, and the number of different aspects analysed and then reinterpreted provide a basis for strengthening the credibility of the account. This is similar to a process of triangulation that would be common in more positivist accounts. A second threat

mentioned by Maxwell is that of researcher bias. This threat is kept at a minimum by the explicit description of and use of the internal and external languages of description.

In relation to external validity the case studies presented in this research are not claimed to be generalizable to other cases or to the field as a whole. However, the cases are used to illuminate aspects of MTE that may be found in the field and aspects from these accounts are reflected back onto the field as a whole. The research also makes no evaluative claims with respect to the cases. There is no attempt to evaluate the MTE practices constituted within the two case study institution. They are not compared in order to highlight what is ‘good’ or ‘bad’, ‘worthwhile’ or ‘of no use’. Rather the case studies are described and the practices interpreted in order to understand the constitution of pedagogic discourses and practices and to understand how specific discourses and practices might work to specialise the consciousness and conscience of the institution’s student teachers differently.

7 Conclusion

In this chapter I described the methodological orientation for this part of the research project. In the following two chapters I use this approach to analyse and describe the three symbolic message systems (curriculum, pedagogy and assessment) operating at the institutional level at each case study site. The languages of description provide the discursive resources for interpreting the constitution of the ‘*what*’ and ‘*how*’ of the pedagogic context at each site. The general methodological approach derived from Thompson’s (1990) methodology of interpretation is used to structure the analysis and interpretation. This leads to a systematic unpeeling of layers which moves from a first level of analysis in which the doxa (pre-interpreted domain) is presented and interpreted using a Bernsteinian gaze, providing a thick and broad description of the curriculum. The second level is a discursive analyses of pedagogy and assessment in which evaluation operating in the context is interrogated. The final interpretation reflexively considers all three analyses to provide an overall interpretation of the operation of the three message systems and hence a distilled description of the ‘good subject’ (in the sense of the subject of mathematics and the pedagogic subject of mathematics teacher education) by each institution. Later in (Chapter 12) a cross-case analysis provides further insights into the possible spaces opened and closed for the specialisation of consciousness and conscience within these institutional settings. The comparative advantage produced through the selection of the two empirical sites enables some general comments to be made with respect to the design of initial mathematics teacher education curricula and the organisation of knowledge(s) and practice(s) within these settings.

Chapter 7

The Case of City University

... in terms of what I am trying to convey to them I realise that I am trying to share myself, and that's the most I can do. [...] In a sense I am trying to ooze my experience and my knowledge out to them, rather than here is your book I can make it more explicit.
(Mr/s Y; GVT2-CU)

1 Introduction

In the previous chapter I explicitly introduced the methodological approach to be taken in producing an account of the curriculum, pedagogy and assessment practices at each case study institution, and described the nature of the evidence that was collected for this purpose.

In this chapter I consider the case of City University (CU). In line with the methodology I provide an account of the selections of knowledge and practices into, and the organisation of these, within CU's initial mathematics teacher education curriculum. This is produced through an analysis and interpretation of the three message systems of curriculum, pedagogy and assessment operating within, and constituting the pedagogic space of CU. The account is used to interpret the features of 'good mathematics', 'good mathematics teacher' and 'good mathematics teaching' that the institution hopes to produce. That is it produces a description of the characteristics of a 'good subject' of mathematics teacher education (MTE) projected from the institution. Here 'subject' is used in two senses: firstly, a subject in the sense of a discipline or field of study, in this study referring to mathematics (M), mathematics education (ME) and mathematics teaching (MT); and secondly as a subject in the sense of a person operating within and subject to varying social, economic and political contexts. In other words the focus is on the specialised pedagogic identities of 'good' mathematics student teacher that the institution projects through its selection and organisation of curriculum contents.

Later the findings of this chapter and of Chapter 10, which focuses on the identities of the pedagogic subjects specialised as (novice) mathematics teachers through their studies at this institution, are rubbed up against one another to produce an interpretation/re-interpretation of the case of City University. This account will then be considered in relation to a similar analysis of Rural University, to produce a further interpretation/re-interpretation and from this analysis produce a series of comments and questions to and for the field of MTE.

I begin the chapter with an interpretation of the doxa produced through presenting an account of the institutional context and the overall design of the B.Ed degree. This is used as a basis for identifying the basic organisational structure of contents (knowledge and practices) in the MTE curriculum offered at the institution. In Section 3.1, I present an analysis of selections into the specialist mathematics modules and an interpretation of the legitimate texts for M, ME and MT produced through these selections. This is followed in Section 3.2 by an analysis of an example of pedagogic interaction in a MTE classroom, and in 3.3 by an analysis of examples of formal assessments selected from a range of specialist modules across the curriculum. The analyses of curriculum, pedagogic interaction and assessment are then rubbed up against one another and interpreted to produce an account of the (projected) characteristics of the institution's 'good' subjects (disciplines and persons).

2 The institutional context and the overall design of the Bachelor of Education programme at City University.

City University (CU) is located in a major urban centre in South Africa. It was a historically advantaged English medium institution that served a predominantly white population during the apartheid era. Today it serves diverse groups of students who have a wide range of different home languages and ethnic origins. The institution has residences, but the majority of students live in accommodation off campus. CU is a relatively well resourced institution networked into the global society with access to international and national intellectual capital.

This institution incorporated a College of Education in 2001. The College campus was situated on a site geographically distinct from the general City University campus. The College was governed by the provincial education department under the House of Assembly (the ex-white education system) and was seen by its staff as a centre of excellence in teacher education. It had close ties with City University, and in particular its three year Secondary Diploma in Education and four year Higher Diploma in Secondary Education (4 year diploma), as well as its Bachelor of Primary Education (B Prim Ed) degree, were accredited through the university¹³⁰.

¹³⁰ It is noted that this was not unique to this institution. Colleges of Education were only permitted to provide diploma qualifications for primary teachers under the previous legislation. However there was a need to provide secondary diplomas particularly for mathematics and science teachers since insufficient numbers were being produced through the University system. In many cases Colleges of Education had close ties with a University located close by, which enabled them to offer such secondary qualifications accredited under the university's legislative authority. A similar arrangement was held with respect to the B Prim Ed degree. Colleges were not permitted to provide degree qualifications for primary teachers, yet there were students who wanted to become primary teachers and wanted to read a degree rather than a diploma. These degrees were offered in conjunction with a University.

After the incorporation the College campus was retained by the university as a specialised education campus. The majority¹³¹ of ex-college staff became permanently employed by the university and all students and programmes were taken over. All education activity at CU was relocated from the main university campus to the College campus and academics that had traditionally operated from the general City University campus moved to the College campus.

After the incorporation, the ex-University based School of Education (School) and the ex-College of Education (College) continued to operate side by side, relatively independently. The School took responsibility for the post graduate programmes, that is, the PGCE, honours, masters and PhD programmes, which were its traditional focus. The College took responsibility for the initial teacher education programmes, in particular the new B.Ed programme. Academics in the School had little input into the design of the new undergraduate B.Ed curriculum which was the domain of the College.

The College at CU continued to offer their old qualifications, the Higher Diploma in Education (HDE) and the Bachelor of Primary Education (B. Prim Ed) in 2001 and 2002 while the new Bachelor of Education (B.Ed) degree programmes were developed. The final intake for the old qualifications took place in 2002, and the new B.Ed programmes were introduced for the first time in 2003. Under the new policy regulations this was the last possible date for the phasing out of the old programme and introducing new programmes. This supports the conclusion, reached in the selection of case studies for this research, that this institution positions itself as relatively independent from the ORF and while meeting the formal regulatory requirements of the state with respect to qualifications for educators, is driven by institutional concerns rather than official policy.

Traditionally students who studied to be teachers through the College were not required to have a matriculation exemption¹³² for entry, whereas those who studied through the university were. The College staff were concerned about this¹³³ and so in their formal documentation submitted to the DoE put forward the entry requirement as a “level 4 senior certificate or an

¹³¹ Some staff took voluntary severance packages from the provincial DoE and some were reabsorbed into provinces.

¹³² Matriculation exemption refers to the endorsement given by the matriculation board to students who have achieved a certain combination of subjects at predetermined levels in the senior certificate (school leaving) examinations. This involves achieving passes in at least four approved subjects on higher grade. A matriculation certificate with exemption is a basic requirement for entry into a university degree.

¹³³ Interview with the deputy head of the college in September 2004.

equivalent University approved qualification”, with the suggestion that “learning support, in the form of a special curriculum, is provided to learners who do not have the appropriate level 4 credits to proceed immediately with the standard B.Ed learning programme”¹³⁴ (CU, 2001, p. 2). However in the rules for the B.Ed it is clearly stated that “the normal requirement is matriculation with exemption” with the proviso that “a candidate may be considered for admission provided s/he has passed a minimum of three subjects (including English) on higher grade and has, in addition, demonstrated, in a selection process approved by Senate, that s/he is suitable for admission” (CU, 2003, p. 27). The pamphlet for entrants into the teaching profession suggests that such students without exemption may be considered with a minimum of 12 points¹³⁵, provided they successfully complete an access test approved by the Senate. The entry requirement for the programme is therefore very low and this is related to the need to enable the traditional College cliental entry into teaching, and as is suggested later, contributes to a deficit view of students as requiring considerable support and input from lecturers on the programme.

This is accentuated in the case of the students who enter into mathematics teaching. For entry into the Senior Phase & FET mathematics specialisation a student would normally be expected to achieve at least a C on Standard Grade (SG)¹³⁶. However, in the selection process, students with SG passes lower than this may be admitted. The head of the mathematics division at the college, Mr/s X, indicated that they are a little flexible,

... because a standard grade 60 for someone from a rural area is worth way more than 60% from the private school down the road. So sometimes we go below 60% for black students who haven't been to ex-model C schools, for example. For Indian students and white students who have had a decent high school education, we are pretty tough. Because if you couldn't do matric maths with all the support you had, then how are you going to do it here? The cut off may be a little low. (IAT-X1)

The normal entry into the main stream mathematics programmes at CU is a C on the higher grade, or under special circumstances a SG A. The students who are selected into the mathematics specialisation in the B.Ed would therefore not normally be admitted straight into a mathematics programme at CU.

The number of students in the B.Ed FET mathematics specialisation at CU was relatively low in 2004. Only 12 students took mathematics as their first specialisation in the 2nd year of study

¹³⁴ It is noted that while there were suggestions by the lecturers that students had low levels of entry, there was no indication in any of the documentation or in discussion with lecturers that there was any special provision for academic development for students who had especially low levels of entry.

¹³⁵ Matriculation points refer to a calculation done by most universities in order to rank entrants and make selections into degree programmes. 12 points would be extremely low. Normal entry into a degree programme at CU would be significantly higher, varying between 34 to 40 points depending on the qualification.

¹³⁶ This is a mark between 60% and 70 %.

and there were about 30 in the first year of study (which included all FET students whether they intended to take mathematics as a first subject or second subject in 2005). The low numbers of students in the specialisation increases pressure on entrance requirements and influences selection processes. In general students with high higher grade passes in mathematics at matric level do not choose to enter into mathematics teaching degrees, so the problems associated with low entrance requirements are not easily solved.

2.1 How City University meets the formal state requirements in their design of the B.Ed degree

The formal documentation required in terms of the Criteria (DoE, 2000a) were submitted to the Department of Education by CU in January 2001 and the B.Ed programmes described in the documentation were approved as programmes for employment in education in March 2001 (DoE, 2002b). The qualification and its programmes had been taken through the processes of interim registration with SAQA and accreditation with the CHE under the Interim Joint Committee (of SAQA, CHE and DOE) by November 2002. The documentation submitted provides a generic description of the B.Ed degree with six different possible specialisations. The documentation meets all the formal requirements of the official discourse. It is written in the format required by the Criteria and in the language of the Norms and Standards, providing exit level outcomes in terms of the teacher roles and applied competences (foundational, practical, reflexive and applied). Table 14 provides a summary of the information contained in the formal documents submitted to the DoE.

Table 14: Summary of B.Ed Curriculum design information submitted to the DoE for purposes of recognition and evaluation of qualifications for employment in Education

University	City University	Comment
Name of the recognised qualification	B.Ed	
Specialist Phase Focus	General Education: Foundation Phase; General Education: Intermediate Phase; General Education: Senior Phase; Further Education; Intermediate and Senior Phase; Senior Phase and Further Education	The document covers a range of possible combinations. Thus this is seen as a general education qualification with different learning programmes leading to specific specialisation.
Minimum credits required	480, with at least 96C at level 6 or higher, and at least 108 C at level 5 or higher.	This is the minimum mentioned in the NSE and Criteria.
Choice of specialisations possible for the Senior Phase and FET	No restrictions for FET subject specialisations mentioned; Suggests that at FET students would normally be expected to study two approved subjects for teaching, but that it may be possible to focus on at least one; for a senior phase qualification students must take at least 24 credits in Mathematical Literacy, Mathematics and Mathematical Sciences, Natural Sciences, or Technology.	This follows the minimums as stated in the NSE. The mention of Mathematical Literacy, Mathematics and Mathematical Sciences indicates the old lexicon of the original C2005 GET curriculum.
Integration of generic roles into the specialist role	The specialist role is explicitly put at the centre of the programme throughout the documentation; The integrated teaching competences are all described in terms of the specialist role. Other roles are described as	While the centrality of the specialist role is clear, the relations between modules core (generalist) and elective (specialist) contents is not clear. The integration seems to be

	contextual and supporting.	expected to occur in practice.
No of Credits for the specialist role in the whole programme (this includes all specialist phase, learning area and subject related credits)	240 Credits (132 at level 5 or higher, and 108 at level 6 or higher)	This is higher than the minimum 204C mentioned in the NSE.
Maximum no of Credits for a FET subject specialisation (e.g. Mathematics) – includes the disciplinary basis, methodology and pedagogic theory	For a single subject B.Ed (FET) the maximum would be 204C (108 C at level 5 or higher and 96 C at level 6 or higher). If two subject specialisations are taken for an SP and FET programme, then the maximum number of credits in one subject would be 120 C (66 at level 5 and 54 at level 6)	It is not clear how a single subject specialisation would be made available in practice, but it is possible in terms of the formal documentation.
% of programme focussed on Maths specialist role	In a single subject FET programme: 42.5% of the total credits; In a two subject SP +FET/ FET programme: 25% of the total credits	The fact that no information is given relating to the specifics of the specialisation is possibly a function of the design as a general degree rather than as a named degree. It also signals that the documentation simply provides a shell with no clear indication of how the specialisation will be given substantial meaning.
Credits allocated to Mathematics (raw no; % of total maths specialist credits)	Not visible in the documentation: no indication is given of any specific modules; all description is in generic terms.	
Focus of Mathematics modules	No information made available	
Indication that Maths Education and Maths Teaching are focussed on independently.	No information made available	
Credits allocated to Mathematics Education and Mathematics teaching (raw no; % of total Maths specialist credits)	No information made available	
Focus of ME/MT modules	No information made available	
Relationship between Maths, Maths Education and Maths Teaching.	No information made available	The lack of substantial description behind the generic exit level outcomes provided in the documentation supports the same conclusion suggested in the comment on the specialist modules (electives)
Credits allocated to Core modules (raw C; % of whole degree)	180 (108 C at NQF level 5 and 72 at NQF level 6) (37.5% of total credits)	
Focus of Core modules	No indication given of any content of foci	
Relationship between the core modules and the specialist modules	No information given	
Credits allocated to fundamental modules	60C at NQF level 5	
Focus of fundamental modules	No indication is given of any contents of these modules.	What constitutes 'fundamental' learning is not visible.
Credits allocated to Practice teaching	Applied and integrated teaching competence focused on the specialist role is highlighted in the document, but it is not visible in terms of credit allocation.	The description implies that practice will take place in schools and that it will be specialised. Otherwise no specific detail is provided.
Assessment of practice teaching	No clear indication as to how practice teaching is assessed from the formal documents.	
Conditions in terms of completion of the degree related to the assessment of practice teaching.	Nothing is mentioned about how the assessment of practice teaching contributes to the student evaluation in terms of earning credits towards the degree. It is not mentioned whether success in the practice teaching element is essential for achieving the award of the degree or not.	

(Source: original documents submitted to the DoE in January 2001 and provided by the DoE in 2003; evaluation documents provided by the DoE in 2003)

It appears from Table 14 that the overall design of the programmes leading to the B.Ed qualification is generic. The learning programmes approved through the formal process are cover a wide range of specific, yet underdetermined, purposes. They follow the form of what is required by the regulations in terms of mentioning lists of exit level outcomes and applied and integrated competences in very general terms, but have no substance in terms of specific credit allocations to actual contents, practices or purposes. That is, no specific curriculum

appears to give meaning and substance to the shell presented in the formal documentation. This is supported by the later investigation on site which showed that the actual curriculum contents (courses and their modules¹³⁷) designed to fit into this shell took little cognisance of the various outcomes and competences mentioned herein.

The overall design can be summarised as a programme for initial teachers, across all phases, learning areas and subject/discipline specialisations, comprised of an unspecified number of courses that are taken over 4 years of study. The total credits allocated to the courses making up the degree programme are 480C, with 180 of these pegged at NQF level 6 or higher. The courses making up the programme are defined in terms of fundamental, core and elective components¹³⁸. The elective components are the specialisation modules that should be selected in terms of the overall purpose of the qualification. Specific credit values for the specialist role are mentioned that follow the minimum details contained in the Norms and Standards. The exit level outcomes are written in generic terms with no specific details given in relation to how the credits will be allocated to specific modules, nor what the rules of combination for these will be. This confirms the finding in Chapter 3 that the regulatory framework for teacher education is open to interpretation and the requirements in terms of formal documentation merely expect institutions to submit a particular bureaucratic form, but leave the substance open to generation at the institutional level. CU has clearly submitted its documentation in a form that was acceptable and met the requirements, but it is a form without substance. In order to get to a description of the substance that underlies this form, a closer examination of the teacher education practice instituted at CU is necessary.

In the next section I examine the implemented curriculum in terms of its overall design. This description is produced from the formal rules and prospectus obtained from CU in 2003, and supported by information from interviews with the head of mathematics in the College, Mr/s X, and other lecturers who taught the specialist mathematics modules for the FET/ Senior Phase qualification, Mr/s Y and Mr/s Z¹³⁹.

¹³⁷ Here course is used to describe a particular focus of study and module to describe the minimum sized 'chunks' of learning that make up any course. So for example the Teaching Experience course at CU is made up of six Teaching Experience modules (101, 102, 103, 104, 105 and 106) each carrying a credit value of 12 C (120 nsh). The Teaching Experience course is made up of 6 x 12C (72 C) or 720 notional study hours (nsh), or 15% of the total credits in the degree programme.

¹³⁸ This is terminology associated with the SAQA requirements for qualifications rather than the NSE or the Criteria which do not mention these.

¹³⁹ Altogether there were 5 lecturers involved in teaching mathematics modules at CU. The rules for the use of place holders to refer to the lecturers was described in the previous chapter in the section dealing with the ethics of this research. Mr/s X is the head of mathematics in the college sector at CU and provided a wealth of information. Mr/s V and W teach the general mathematics modules taught to all B.Ed students. They were not

2.2 The formal requirements for the B.Ed curriculum for FET or Senior Phase and FET mathematics teachers at CU

Table 15 gives an overview of the whole B.Ed curriculum showing the organisation of modules over the four years of study for students who elect to take Mathematics as their first specialisation for the purpose of teaching in the Senior Phase and FET (Grades 7 – 12).

Table 15: The Bachelor of Education Curriculum (Senior Phase & FET)¹⁴⁰

Year	Semester 1 Module	NQF level	C	Semester 2 Module	NQF level	C
1	English in Education 101	5	12	English in Education 102	5	12
	Mathematics for Life	5	12	Education Studies 101	5	12
	Curriculum 101	5	12	Teaching Experience 101	5	12
	Mathematics for Teaching 101	5	12	Mathematics for Teaching 102	5	12
	2 nd Subject for Teaching 101	5	12	2nd Subject for Teaching 102	5	12
2	Afrikaans / IsiZulu in Education 101	5	12	Afrikaans / IsiZulu in Education 102	5	12
	General Mathematics in Teaching	5	12	Life Studies in Education	5	12
	Curriculum (Senior + FET) 102	5	12	Teaching Experience 102	5	12
	Education Studies 102	5	12	Curriculum (Senior + FET) 103	6	12
	Mathematics for Teaching 103	6	12	Mathematics for Teaching 104	6	12
3	Info and Communications Technology 101	6	12	Education Studies 104	6	12
	Education Studies 103	6	12	Teaching Experience 104	6	12
	Teaching Experience 103	6	12	Curriculum (Senior + FET) 104	6	12
	2 nd Subject for Teaching 103	6	12	2nd Subject for Teaching 104	6	12
	Applied mathematics 101	5	12	Mathematics for Teaching 105	6	12
4	Education Studies 105	6	12	Education Studies 106	6	12
	The School in Context 101	6	12	The School in Context 102	6	12
	Teaching Experience 105	6	12	Teaching Experience 106	6	12
	Education Project	6	12	Curriculum (Senior + FET) 105	6	12
	Applied Mathematics 102	5	12	Mathematics for Teaching 106	6	12

(Source: documentation on the rules and B.Ed curriculum obtained from CU in 2003; interviews with B.Ed lecturers.)

Notes on the modules reflected in the table:

1. Students take five 12 C modules per semester (120 C per year) for 4 years, making a total of 480 C in the degree programme. Modules that run over a semester are allocated 8 lecture periods per week (one single, two doubles and a triple). Modules which run over the whole year are allocated 3 lecture periods per week (one single and one double). All contact lecture periods are 55 min long. This translates into contact time of 32 to 35 periods (or hours) per

interviewed during the research process however there are occasions where they are mentioned by students during the interviews. Mr/s Y and Z teach specialist modules and were interviewed during the research process.

¹⁴⁰ The original names of all the modules have been changed. This is in order to ensure that, as far as is possible, the institution is not clearly recognisable. The module names used here are consistently used throughout the thesis.

week during each semester¹⁴¹ (This level of contact was confirmed by B.Ed students in the group interview). This level of contact time is very high and directly effects the way in which students experience the curriculum, as will be revealed later in this chapter. The choice to use the full allocation of 8 lecture periods per week, which appears to be the norm for most of the semester long modules, may be related to the perception that students require major teaching input as a result of the low levels of expectation related to the entry requirements mentioned earlier. Later in the discussion of time and space in the curriculum I will return to this issue in more detail.

2. *Mathematics for Life and General Mathematics for Teaching* are two compulsory modules for all B.Ed students irrespective of their phase specialisation. These modules are taught to relatively large numbers of students (according to Mr/s X about 90 students in 2004).
3. *Curriculum 101* is a general course for all B.Ed students. *Curriculum (Senior & FET) 102* is a generic module for all students specialising in the Senior Phase and FET. *Curriculum (Senior & FET) 103* and *105* are specialised courses in the 1st subject specialisation (in this case mathematics). *Curriculum (Senior & FET) 104* is a specialised course in the 2nd subject specialisation¹⁴². All *Curriculum* modules run across the whole year and are allocated 3 lectures per week.
4. *Teaching Experience* modules are divided between the 1st and 2nd subject specialisation. Each year the student spends at least 6 weeks out in schools gaining experience in teaching, and three weeks are allocated to each subject specialisation. It appears that in practice there is no possibility of a single FET specialisation as was suggested in the formal documents discussed in the previous section. The first school experience takes place in March/ April, and the second in July/ August. In 1st and 2nd year there is one 12 credit module (over six weeks) allocated to *Teaching Experience* (three weeks for each subject specialisation). In 3rd and 4th year there are two 12 C modules (each over 3 weeks) allocated to teaching in schools. It is assumed that the demands in second and third year are much higher than in first and second year. In discussion with the head of department of mathematics (interview with Mr/s X) it appeared that the requirements for each year were not well defined and that in every 3 week teaching practice period students were evaluated three times by a specialist lecturer. Exactly what the difference is between the 12C six weeks *Teaching Experience* module and the 12 C three week module is not clear, but is under discussion in the Mathematics department. All teaching practice is assessed in terms of the specialist role. The total credits allocated to *Teaching Experience* is 72C (36C per specialisation)
5. The NQF level allocated to specific modules is questionable and the meaning of the level is not transparent. For example, the second year *Mathematics for Teaching 103* module focuses on the study of Calculus. Here it indicates that the level of study is NQF level 6. It is difficult to be clear over what this level would mean in the context of the B.Ed as compared with a BSc. for example. In discussion with Mr/s X it is evident that the focus of this course is on a form of mathematics for teaching (*MfT*) which attempts to attack a limited selection from the field of Calculus in some depth. This would be a limited selection of content traditionally covered in a university level Mathematics 1 course, which would be defined as NQF level 5 in the BSc. Overall it is not clear why this specific module is pegged at level 6 and not at level 5, nor what the level means in any substantive way. It appears that nominally, the first two modules in any course are pegged at NQF level 5, and subsequent modules at level 6 throughout the curriculum. However this does not appear to have any link to any specific version of the SAQA level descriptors¹⁴³.
6. A student is able to take the mathematics specialisation with a choice from a range of other subjects as a second teaching subject (restricted by time table constraints). Students who specialise in mathematics as their second subject do not study the *Mathematics for Teaching 105* and *106* modules nor the *Applied Mathematics* modules. They also study only one 12 credit *Curriculum* module in mathematics education (the same as the second year *Curriculum 103* module, but do it in their third year of study)

¹⁴¹ Example: In first year students take four full semester modules per semester: $4 \times 8 = 32$ lecturers, plus the *Curriculum 101* which is 3 lecturers per week for the whole year. i.e. 35 contact periods per week. The other credits are made up by *Teaching Experience* which is completed off campus.

¹⁴² It is noted that in the case of students who take mathematics as their second subject specialisation, *Curriculum 104* is exactly the same as the *Curriculum 103* module (taken by the students who take mathematics as their first specialisation). Mr/s X expressed some concern about this as these students go out as qualified mathematics teachers having studied only half the teaching modules and significantly less mathematics modules.

¹⁴³ It is noted here that while there have been draft level descriptors for some time, no final versions have ever been published. This appeared to be one of the problems with the evaluation of education qualifications more generally.

7. Overall the student who specialises in mathematics as a first subject will take eight modules in Mathematics for the Senior Phase & FET (Maths for Teaching 101, 102, 103, 104, 105 and 106, and Applied Maths 101 and 102). That is a total of 96C (48C at NQF level 5). In addition to this they also take the compulsory mathematics modules (with all other B.Ed students), Mathematics for Life and General Mathematical for Teaching, that is, 24C at NQF level 5. They will take the specialist Curriculum courses for FET and Senior phase Mathematics (Curriculum 103 in second year and 105 in fourth year), that is 24C at NQF level 6. Altogether the number of credits allocated to mathematics and mathematics education in various forms are $96C + 24C + 24C = 144C$. Of these 72 are pegged at NQF level 5 and 72 at NQF level 6. This is 30% of the total credits allocated to the whole degree (480 C). If one includes the specialist Practice Teaching credits (36C)¹⁴⁴, the total number of credits allocated to the mathematics as a first subject specialisation is 180C, or 37.5% of the total credits in the degree programme. This is very high in relation to other programmes surveyed in Phase 2 of the study. A student who is taking mathematics as a second specialisation will do significantly less specialist modules in their degree.

The overall design of the curriculum is an interpretation that meets more than the minimum requirements indicated in the NSE with respect to the specialist role. We see that the naming of the modules does not appear to refer directly to the discourse of the NSE. While the total credits in the implemented curriculum do match the number of credits suggested in the formal documentation submitted to the DoE, there is not a clear match to and identification of fundamental, core and elective modules.

However, as we take a closer look at the modules themselves we begin to see a number of domains of knowledge and practice clearly visible in this curriculum. In general terms the curriculum could be conceived as being organised around a number of types of knowledge contents recognisable in terms of the fundamental; core and elective distinction made in the original design:

Fundamental modules:

- 1) A minimum level of proficiency in language and mathematics for the study of education (English in Education and studies in a second language; Mathematics for Life and General Mathematics for Teaching);

Core:

- 2) Life studies in education
- 3) Information and communications technology
- 4) The study of education
- 5) The school in context
- 6) General pedagogic principles and practice (Curriculum 101 and 102);

¹⁴⁴ It is noted that in general across the field these credits are counted towards the specialist role in order to meet the minimums stipulated in the NSE.

Elective:

- 7) Specialist Mathematics subject knowledge (Mathematics for Teaching 101 to 106 and Applied Mathematics 101 and 102) and specialist pedagogic principles and practices related to mathematics teaching (Curriculum 103 and 105 and Practice Teaching)
- 8) Specialist knowledge in a second subject (101 to 106) together with its pedagogic principles and practices (Curriculum 104 and Practice Teaching).

On closer scrutiny the NSE has clearly influenced the inclusion of some aspects of this curriculum, even if it is not explicitly stated and the lecturers do not seem to be aware of this. In terms of the fundamental and core modules, this is seen, for example in relation to Life Studies in Education (with a focus on the Pastoral Role). While I do not consider this influence in detail here, it is apparent that the development of competences related to all the roles are integrated into this curriculum. This is summarised in Table 16.

Table 16: The NSE Roles in the organisation of the CU B.Ed curriculum

NSE Role & competences	Modules in the B.Ed
Mediator of learning	specialist modules/ curriculum modules/ teaching experience
Designer and interpreted of learning programmes and materials	specialist modules/ curriculum modules/ teaching experience
Researcher/ scholar/ life-long learner	Research project specifically, but also in Education Studies modules
Manager/ leader	The School in Context/ Curriculum modules
Pastoral role	Life studies in education in particular
Assessor role	Curriculum modules and some Education Studies
Specialist role	all electives and practice teaching

The various aspects of this curriculum can be described in terms of the discussion on the design of teacher education curricula and knowledge structures in teacher education presented earlier in Chapter 2. In particular, the curriculum is seen to have a structure that fits fairly comfortably with a description of different types of knowledge as identified by Shulman (1986b; 1987a) and Grossman (1990). This is shown diagrammatically in Figure 24. How these different aspects are related to one another is not visible at this stage. The relations between the general aspects of the curriculum and the specialist knowledge discourses would be an interesting aspect to consider. However, in the context of this study, there is insufficient time and space to focus on this aspect of the curriculum and it is not considered. Therefore next step is to look more closely at the specialist knowledge and the way in which it is classified and framed (in Bernstein's language) in the curriculum, which is the main focus of this part of the study.

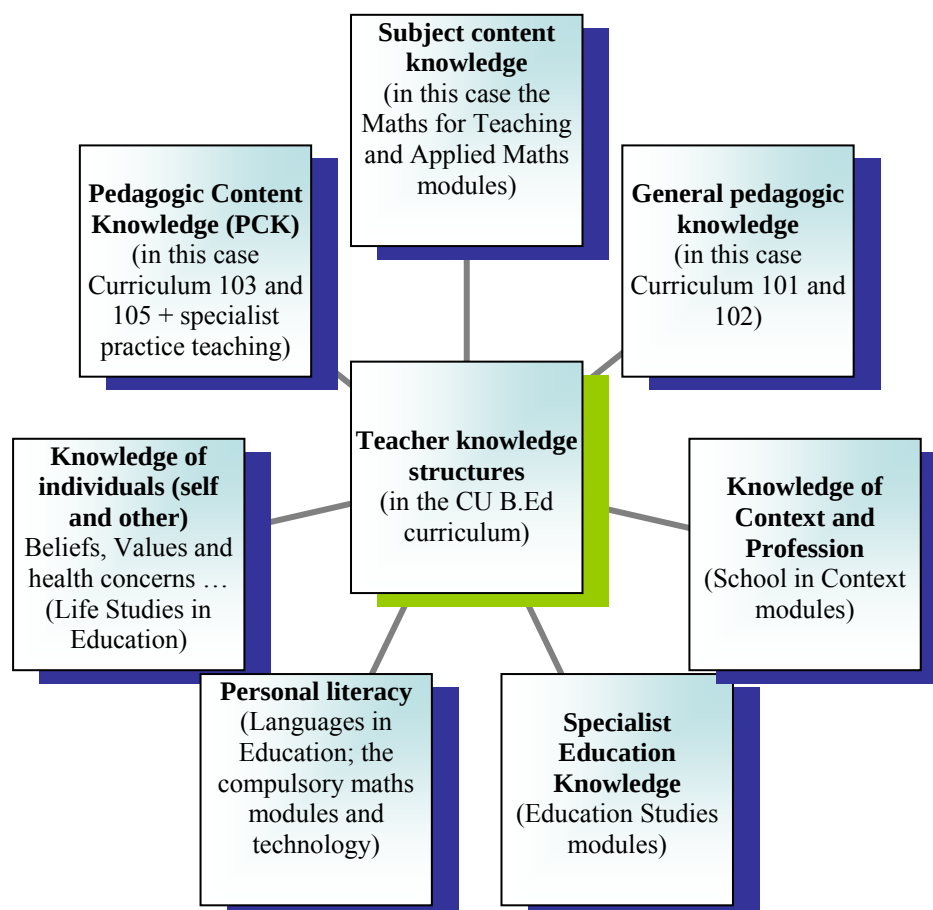


Figure 24: Knowledge structure of the B.Ed curriculum at City University

In terms of the model of specialist knowledge discourses presented earlier¹⁴⁵, mathematics as a subject (M) and mathematics teaching (MT) as a practice are clearly visible. However how these are related to one another and whether and how ME and MT as discursive fields of knowledge (produced through research) are related to these is not yet visible. Further scrutiny of the specialist modules in the curriculum is required in order to recognise how M, ME and MT come together within this MTE curriculum.

The relationships between (classification) and within (framing) the different specialist components in the curriculum are not visible from the documentation considered thus far. In the next sections I take an in-depth look at the specialist modules for the SP + FET/ FET where mathematics teaching is a first subject specialisation. I also consider the specialised identities projected through these selections.

¹⁴⁵ See Chapter 5, Figure 6.

3 Images of ‘good’ subjects projected from Mathematics Teacher Education at CU

In order to reveal the pedagogic discourses operating within this context and to unpack the pedagogic identities projected from this base it is necessary to move beyond paper descriptions given in Section 2 above to interrogate the ‘what and how’ of the implemented curriculum. This is done by drawing on evidence from interviews with lecturers and students, course material, observations of classes and examples of assessments. A major aim of this is to describe the construction of the legitimate text for mathematics (M), mathematics education (ME) and mathematics teaching (MT) within the pedagogic context at CU. That is, official knowledge(s) of the institution with respect to these discourses, and from this, the possible pedagogic identities of mathematician, mathematics education specialist and mathematics teacher projected.

One of the complications with the case of CU is the fact that the B.Ed curriculum was only in its second year of operation when the data was collected. As was mentioned earlier, the College section continued to offer the old Higher Diploma in Education (HDE) until 2002, and the first intake into the B.Ed only occurred in January 2003. While this was the case, B.Ed mathematics related modules, and probably other courses as well, were being developed and tested with the HDE student group before 2003. So, while the degree was only in its second year of operation, when I undertook the site visits, many of the modules for the various specialist courses were being implemented and tested with the existing third and fourth year students. For example, the head of the mathematics department at the College, Mr/s X, clearly indicates

The functions and algebra course, the very first one in first year. I designed on my own. I have played with it a bit in my first year here. The year before the B.Ed was implemented. So I took that as a bit of a trial run. I had a small group. (IAT-X1).

Table 17 gives an overview of specialist modules in the B.Ed and their stage of development when the evidence was collected. While it is recognised that the HDE group is not identical to the B.Ed group, there are many similarities in their experiences of the specialist mathematics curriculum. They are taught by the same lecturers and the courses they are took were being developed and tried out for use in the B.Ed. The discussion that follows therefore includes all the modules that had been developed for the whole B.Ed curriculum by the end of 2004, whether they were taught to the B.Ed or the HDE students. Interviews with the lecturers teaching these courses and with students in the 2nd year B.Ed and the 4th year HDE groups are used to help provide the description.

Table 17: Sequence of modules for SP&FET Mathematics first subject specialisation in the CU B.Ed: their focus and stage of development in October 2004.

Year of study	Semester 1		Semester 2	
	Module	Stage of development in 2004	Module	Stage of development in 2004
1	Maths for Teaching 101: Functions and Algebra	First developed in 2002 and tested on the HDE student group. Implemented in the B.Ed in 2003 and 2004	Maths for Teaching 102: Geometry and Trigonometry	Developed and implemented in 2003 and 2004 with the B.Ed students
	Teaching Experience 101 : Block 1	This is a traditional (half) module for all HDE and B.Ed students		
2	Maths for Teaching 103: Calculus	Developed and tested with the 2002 and 2003 HDE group, implemented in the B.Ed in 2004	Maths for Teaching 104: Linear Algebra	Developed in 2003 and implemented in the B.Ed in 2004. Also taught to the HDE 3 rd year group in 2003 and 2004.
			Teaching Experience B: Block 2	Traditional (half) module
	Curriculum 103 (year long module): a range of pedagogic issues and practices specific to mathematics teaching and learning			Developed and taught in 2004
3	Applied Maths 101: Statistics and Probability	Developed and tested with the HDE groups in 2003 and 2004	Maths for Teaching 105: Mathematical Modelling	Still to be developed for use in 2005
	Teaching Experience 103 : Block 1	Traditional (full module)		
4	Applied Maths 102 : Financial Maths	Developed with the HDE group in 2003 and 2004	Maths for Teaching 106: Mathematical Connections	Still to be developed for use in 2006
			Teaching Experience 106: Block 1	Traditional (full module)
	Curriculum 105 (year long module)			Still to be developed

(Source: Interviews with Mr/s X; CU Syllabuses for degrees, diplomas and certificates)

3.1 Specialist knowledge(s) and practices in the CU curriculum

There are three specialist university based courses in the B.Ed curriculum (Mathematics for Teaching, Applied Mathematics and Curriculum) as well as a practical Teaching Experience course (made up of four distinct practice teaching blocks mostly carried out in schools, each of three weeks duration in which mathematics teaching is the focus of practice and assessment).

The specific focus in this section is to provide a description of legitimate texts for M, ME and MT produced through the selections of various contents, contexts and practice into these courses in the B.Ed curriculum. It is not possible here to systematically consider every module of every course in the curriculum, however it is possible, as a first level description, to give

broad brush strokes of each course so as to provide: a view of how distribution rules are working within this institution, an interpretation of the basis on which selections are made into the curriculum, the social regulation of legitimate communication constituted through this, and the boundary conditions between them.

This initial description will be built using information provided by the lecturers during individual interviews (doxa). This is supported by students' comments given during group interviews, held at the beginning of the research process in which the overall contents and structure of the B.Ed curriculum was discussed, and during the individual interviews. When appropriate, I also draw on examples of course material provided by the lecturers concerned.

3.1.1 The organisation and selection of mathematically related contents and practices in the curriculum

From what has been presented in the chapter so far, it appears that M may be mainly produced through the *Maths for Teaching* and *Applied Maths* courses, and that ME and MT may be mostly produced through the *Curriculum* and *Teaching Experience* courses. Principles for the selection of contents into these various courses and the relations between (that is, classification) and within (that, is framing) of their contents and contexts are however not at all visible from what has been presented so far. A closer look at descriptions of these courses and their implementation in practice is now required.

1) Mathematics Courses

In the descriptions of the *Mathematics for Teaching* and the *Applied Mathematics* modules contained in CU's 2003 Rules and Syllabuses booklet, a clear signal is provided that these modules are *intended* to integrate aspects of M, ME and MT.

For example, *Mathematics for Teaching 101* is described as:

Algebra, function and introductory calculus, including quadratic, absolute value, exponential and logarithmic functions. Transformations of functions. Introductory limit concepts. Associated algebraic concepts. Development of fundamental skills in teaching and learning mathematics, with particular reference to pattern, algebra and function: planning appropriate mathematics learning experiences; selecting and designing appropriate resources; introductory knowledge of theories of teaching and learning mathematics (CU, 2003, p. 72)

Mathematics for Teaching 103, is described as:

Calculus with applications: introductory concepts in calculus including limits and continuity, Calculus B. Applications of these concepts including maximizing quantities, area, solids of revolution. Further development of skills in teaching and learning mathematics: planning appropriate mathematical learning experiences, selecting and designing appropriate resources; comparative evaluation of different learning materials; application of theories of teaching and learning mathematics; issues in assessment of mathematical comprehension and skills (Ibid.)

And *Applied Mathematics 102*, is described as:

Financial mathematics: introductory concepts in mathematics of finance including compound growth, depreciation, investments, loans, cost and revenue. Development of fundamental skills in teaching and learning mathematics with particular reference to financial and economic issues: planning appropriate mathematical learning experiences; selecting and designing appropriate resources; introductory knowledge of theories of learning mathematics and mathematical literacy (Ibid.)

All the *Maths for Teaching* and *Applied Maths* modules are described in similar ways, beginning with some details of the mathematical topics to be covered and ending with a description that indicates the modules will also deal with the development of practical skills for teaching and learning mathematics as well as some knowledge of mathematics education theory.

However it appears that these descriptions, while bearing some connection to the modules implemented in terms of identifying the broad topic focus, do not necessarily describe what happens in practice. When discussing the overall structure of the B.Ed and the maths and maths education modules in the curriculum the student teachers clearly indicated that in the maths modules they ‘do maths’.

For example, Nicole, a successful 2nd year B.Ed student teacher, suggests

In the maths courses we do maths. In the Curriculum course we do all kinds of things, like we are given learner’s work to analyse and we’ll take a section like exponents and we look at it. Where the misconceptions come up, where they come up, why they happen, how can we deal with it with our learners, how to assess and deal with errors in learners work. (Nicole, GVT1-CU-B.Ed)

Emanuel, also a successful 2nd year student teacher, agrees with her.

That mathematics classes focus on mathematics rather than mathematics teaching or ‘method’ is also supported by Sonny, a successful fourth year HDE student teacher, who says

In mathematics they don’t prepare you for teaching mathematics as such. Its only the methods that does that and there is less time for that. The focus is on doing mathematics itself. (Sonny, GVT1-CU-H.D.E)

Karyn, also a successful fourth year HDE student teacher agrees, but adds:

With [Mr/s X], I really enjoy her teaching. And for me the boundaries are blurred all the time. Even the stuff we were doing today in financial maths. Its, ja, it is our own learning and our own growth, but the skills we are learning definitely overlaps into methodology and I’m definitely going to use those techniques in my teaching [...] its modelling all the time. (Karyn, GVT1-CU-H.D.E)

So while Karyn agrees that in the maths class they focus on maths and their own learning of mathematical content she also recognises that modelling of teaching is going on, and this clearly links to a form of learning MT for her. It appears from later discussion that this form of modelling is a type of discussion based teaching that is found in the mathematics classes of

two of the specialist lecturers (Mr/s X and Mr/s Y), but not always in the third (Mr/s Z) who is described as having a more traditional approach.

The *Mathematics for Teaching* and *Applied Mathematics* courses, while having formal descriptions which suggest that there is an explicit focus on M, ME and MT, are recognised by the student teachers as being focussed on mostly M itself and not having an explicit focus on ME and MT, however, a form of ME/MT is recognised up front by at least one of the students as integrated into the M focus implicitly though the modelling of a particular way of organising mathematics teaching and learning. In later interviews with all students this was reinforced – Mr/s X provided a model for how mathematics ought to be taught that they all identify with and would ideally like to emulate.

This view that maths and applied maths modules focus on M and not explicitly on ME or MT is supported by Mr/s X in her description of the process of developing and trying out ideas in the Functions and Algebra module (Maths for Teaching 101). She says:

The big thing at that stage, so this was 2002 early 2003, was to get them **to see that we can learn old maths in new ways**. So there is lots of maths that we have done at school, so for example linear function, quadratic function, log, exponential, absolute value, square root functions – those kind of six are the ones that are covered in the course. [...] So we know the stuff about the parabola, **but why?** And we know the stuff about the cubic, or whatever it is, but why? And, so that was one level. Explore stuff. **Maths is not just about doing procedures. We can explore things.** And ask a question and find a way of exploring it. [...] (IAT-X1)

Mr/s X explains that at first she attempted to integrate issues from the new curriculum related to teaching algebra in the senior phase into the module, but found that this had consequences which were not helpful for enabling the students to access the mathematics more deeply. As Mr/s X explains it,

[...] what happened to a large extent was that the marks in the methods stuff were quite high, because we wanted to encourage, and we wanted them to just make an effort, and that tended to get them through the maths course. Which in one sense wasn't a bad thing but in another sense it hid the fact that some of the maths stuff wasn't that strong. [...] I [...] took out, I did very little methodology stuff. **We did nothing explicit. I don't think we looked at the new curriculum statement. I kind of shifted in my thinking to mathematics for teaching**, as opposed to maths method. So this is appropriate mathematics for teachers, **it's not necessarily about how to teach maths but this is the maths they need to know**. And I mean, what is bizarre for me, is it took a colleague in science to say that what you are doing is okay. Having done all the Deborah Ball thinking, and all those discussions of feeling guilty, and I'm not convinced it's completely okay. But I'm getting more comfortable with it. There **was also a guilt sense, in that you are sending students out on teaching prac, and they are going to get whacked if they haven't got some sense of doing, teaching maths in the classroom**. [...] But I think I'm shifting more and more to say, we don't need to do method here. (IAT-X1)

Here we see that while the syllabus descriptions may indicate an integrated approach to the learning of mathematics, the lecturer has, after piloting the module on the HDE students and the first year B.Ed, decided to focus on what she is calling “mathematics for teaching” (*MfT*).

So while initially there was an intention that maths and ‘maths methods’ should be integrated in the *Maths for Teaching* modules, this has been replaced by an understanding that supports the view that teachers should rather be taught “the mathematics they need to know” for teaching in these modules. This is a particular selection of maths that teachers should know that does not include an explicit introduction to teaching methodology or to selections from the field of mathematics education. The students’ sense that they do “maths in maths” is therefore supported by their lecturer. How they learn this maths and are taught this maths seems to be the way that images of good mathematics teaching/learning practices may be implicitly conveyed. The lecturer explicitly mentions the work of Deborah Ball¹⁴⁶ as an inspiration for this approach. Her position is therefore underpinned by particular research in the field of mathematics teacher education. That there are dilemmas in making these choices is also clearly articulated; Mr/s X expresses this in terms of feelings of guilt. By neglecting to focus on aspects of teaching and learning mathematics in the first year, student teachers go out into schools in their first year of practice with no specific skills to help them cope with teaching in practice.

The notion of *MfT* being described by Mr/s X implies a serious concern with content that is relevant to teaching. The selections into the mathematics teacher education curriculum from the discipline of mathematics should be driven by what *teachers need to know*. Decisions made about what is selected into the curriculum appear to be consciously considered in the process of developing the modules, and it seems that there is a conscious understanding that the principles underpinning the selection of contents and practice into the mathematics and applied mathematics modules are being driven to a large extent by what are seen as the needs of mathematics teaching in the South African context – in particular the demands of the new curriculum and a recognition of the poor preparation of students (prospective teachers coming into the programme) through the schooling system. This became even more evident during a section of the interview discussing the calculus module (*Maths for Teaching 103*), discussed below.

Mr/s X had already indicated that for her one of the drivers for including certain contents, for example radian measure in the first year geometry/trigonometry module, and, at least on paper, introductory calculus concepts in the first year functions module, was pressure and expectations from other academics outside of the College maths department.

¹⁴⁶ Ball’s work was discussed earlier in Chapter 2 (see Ball, 2000; Ball & Bass, 2000; Ball et al., 2004; Ball, Lubienski, & Mewborn, 2001).

- Mr/s X: [...]So there were pragmatic reasons as well as, um, I just think that that is where it [radian measure] should be, because there is still a thing in my head around, what's the status of these courses in the eyes of other maths people.
- Di: The mathematicians?
- Mr/s X: Ja, Ja. And even, scientists in general. You don't teach calculus in first year? You know, kind of like, there is something wrong with you! I mean the head of the college is a physicist, well I mean a physics educator, and we had long ding dongs about not having calculus in first year. So actually the first year course, the name of the course is 'Functions, Algebra and Introductory Calculus'. And, it was a political move. ... I was hoping to get to the idea of limit. And I realised in the first year it was not going to happen, and this year I didn't even try. And so I'm not going to change the name of the course. (IAT-X1)

Here we see that while there is an awareness of the expectations and pressure from academics outside of the College mathematics department (mathematicians and scientists in general) that there should be certain contents included in first year university mathematics courses for them to be considered legitimate in the university community, it is clearly asserted that the final decisions over selection will be made by lecturers on the basis of their own professional judgements¹⁴⁷.

As a department that was focused on developing teachers the College mathematics department was not going to be driven by these external expectations, but rather by a reading of what is needed by teachers. At the same time, there is acknowledgement that these external academic judgements on the college mathematics curriculum do have some weight, and so for expedient political reasons certain descriptions would remain in the formal syllabus even through these are never taught in practice¹⁴⁸. The following exchange reveals some of what drives the selection,

- Di: Is one course in calculus enough?
- Mr/s X: No its not. So one of the things the modelling course will include is some calculus [...]. But at the same time if you give more calculus you give less of something else. So it's a continual payoff. **And the reality is they are not going to teach much calculus at high school.** So I think you have to be really careful about saying, you know, calculus is *the* thing, but hello, they are not going to teach the stuff and if we are not going to get them to be able to understand and teach modelling properly or stats properly then we have got a problem.
- Di: So what is really driving your selection of these things? What is really driving your selection of what you choose to do?

¹⁴⁷ This is not to say that the lecturers are not subject to structuring by distribution rules operating in society more widely but rather to say that they have relative autonomy over their selections and made decisions based on other pressures circulating in society – they are not framed by the expectations of what *university mathematics* courses ought to be. There is a general implication that mathematicians do not know what is good for mathematics teachers. This conforms with a general attitude across the field of MTE recognised in the survey described in Chapter 5.

¹⁴⁸ During the lecturer interviews it became apparent that a fairly large amount of content mentioned in the various course outlines (specifically mentioned in discussions over the Functions and Algebra, Calculus, and Statistics modules) was never attended to in practice. This seems to be related to the commitment to the specific pedagogic discourse, specifically the regulative discourse under which social relations in the mathematics classroom are conducted, and the resultant time pressure experienced. This will be elaborated later in the discussion on framing relations and time and space in the curriculum.

Mr/s X: **The key thing is what is in the school curriculum. Then in the big scheme of things, I mean, and what is going on in the rest of the world.** [...] We believe that we are making broad enough strategic choices, to prepare them adequately. Um, but I mean its unlikely that there is going to be, [...] a whole chunk of new calculus added to the school curriculum. The modelling stuff is key. And some of **it is about the thinking. It's not just the content, its how you do this stuff in a different way.** [...] (IAT-X1)

Here we see the main drivers of the selection: what contents are *relevant* to what teachers exiting the B.Ed will be expected to teach in schools – based on a reading and interpretation of what is in the new school curriculum (NCSM) and what selections for the discipline of mathematics would be of most use to enable a teacher to teach this better. However the selection is not entirely determined by these interpretations from the ORF, since it is also connected to the lecturer's reading of the field of mathematics education more widely – what is going on in the rest of the world - and particularly by a distribution rule that emphasises doing “this stuff in a different way”. What this “different way” is needs to be examined more closely to reveal the dominant discourses that may be regulating the selection.

Theoretically, in Bernstein's terms, control over selection of content refers to the framing relations that structure the curriculum.

What is revealed by the discussion so far is that the external framing relations (F^e , i.e., external control) over selection and sequencing of contents by mathematicians/ other scientists at CU located outside of the college mathematics department, is relatively weak. However, external framing exerted by the ORF through the national curriculum is relatively strong. F^e is also relatively strong in relation to specific discursive influences from the field of mathematics education. This is recognised in the way in which Mr/s X (and Mr/s Y but not Mr/s Z) talks about her decisions over selection and in discussion about specific things she chooses to do in various courses.

In considering the knowledge and practices selected into the curriculum it is evident that at CU, while Maths for Teaching and Applied Maths modules may be focussed primarily on M with little explicit integration of ME or MT, the selections are regulated by discourses quite different from what would be expected in a traditional university mathematics department. That is, what comes to be constituted as M in this context (MfT) is regulated fairly strongly by discourses circulating in the field of ME¹⁴⁹. It is also evident that access to and use of a well

¹⁴⁹ e.g. Ball and Bass's idea of “unpacking” as key mathematical work in teaching; an emphasis on multiple representations, which is found in writing across field (Ball et al., 2004; Reys et al., 1992) and rooted in the Lesh Translation Model described in (described in Lesh, 2003; Lesh, Cramer, Doerr, Post, & Zawojewski, 2003) and

resourced computer LAN and software has also influenced some of the practices that are selected into the M based modules in the curriculum. There is extensive use of such technological tools in the delivery of the mathematics modules (specifically those run by Mr/s X and Y), from the first module and throughout the four years of study. This is used as a tool for exploration of mathematics ideas, to develop different ways of mathematical thinking and for exploring applications and mathematical modelling. The following interview transcript, which follows the suggestion that mathematics must be done in a “different way”, supports this, as well as numerous class work tasks, tutorials and assignments.

Di: How does the use of technology, such as excel and sketchpad help with the development of thinking?

Mr/s X: Yes. And it's got nothing to do with whether its available in schools or not. **It's for their thinking not for their teaching.** I mean there are some courses where I explicitly deal with being able to set up the formulas and all those kind of things, and others where you just use it. But it's about new tools to think with, and why not use them? If they are not available in schools that's OK! In five years time maybe they will be and otherwise we are keeping our teachers in the ghetto, in terms of available technology. One of the things with the calculus course, **theoretical stuff that I choose to put in there, and I should have made more of a meal of it was the concept image, concept definition stuff, and the process object stuff.** Where I felt it was appropriate. So we actually took a double fairly early in the course to talk about concept image and concept definition, once they had done work on limits [...] **Definitions are a big deal.** Unless it is connected to other stuff and those connections are correct and there are several of them and all that stuff, there has got to be some web going on here. [...] the other thing we did spend a lot of time focussing on was, so here is **the formal definition.** Straight out the text, either copied or just written up. **How do we unpack it** and what does it mean. Which is a big step from the first year course. So this is formal notation. **Formal compressed stuff, and how do we unpack it?** To write it in words and how do we take that to explain it, link it to diagrammatic stuff. So in fact, the other thing which I haven't said, is one of the key things for me was **the multiple representations stuff**¹⁵⁰, always. So what does the graph look like, numeric, algebraic, all the time. And it's interesting in their portfolio and reflection stuff at the end of the calculus course, some of them said the most important thing they learnt was to unpack notations, although some of them still can't do it that well. But, that is what they felt was one of the key things in the course And for me it was about access to text as well. Because, I mean we know what maths texts are like, you know. And how do you, how can they go further now, because we haven't done enough calculus but it means that hopefully they are in a position where they could actually do something on their own. As opposed **to be helpless because they have got no one to help them**¹⁵¹ **unpack** the [...] and just to see the value. So we give kids this thing even at school level, Sigma notation for example [...] One of the things for the calculus course for me was about thinking this, these are just more tools to analyse functions. And I think in a sense that is a helpful approach to calculus at school level. Because, the formal stuff, maybe its just because I don't know enough about it, but to say where does that thing turn and where is there a point of inflection, how do we know and da, da ,da, da. We can do that numerically on sketch pad, by checking gradient and stuff like that, but then we can go and confirm and it looks like its got a tweak, is that a problem cause of the pixels on the screen, you know. **So we spent lots of time exploring and of course we never got to [...] consolidating the stuff.** Pulling it together and spending time practicing some of the procedural stuff, just getting more fluent with it ... (IAT-X1)

integrated into the NCSM (DoE, 2003)); Tall and Vinner's (1982) notions of concept image, concept definition, etc; van Hiele's theory of the levels of geometric thinking (Crowley, 1987); general social constructivist problem-based teaching methodologies; and discussion-based classrooms (Boaler, 2002a; Boaler & Greeno, 2000); to name a few that are visible in Mr/s X's talk.

¹⁵⁰ According to Mr/s X the idea of multiple representations (as exemplified by the Lesh Translation model, although not named in this way) run right through *all* courses and is a key aspect of *MfT*. Definitions and unpacking definitions is also very important (again a reference to the influence of Ball and Bass).

¹⁵¹ This idea of students being helpless if they are not taken through the work here, is connected to the 'deficit' view of students (not unrealistic) – but we also see later that (possibly) it is the most disadvantaged students that feel this helplessness most acutely (See Sonny's Story in Chapter 10).

Two things become apparent throughout the interviews with Mr/s X. The M modules focus on this *different way of teaching*, in particular using technological resources as thinking tools, working on developing conceptual understanding and on “unpacking”, rather than focusing on “this formal compressed stuff” (an explicit reference to Ball and Bass). How teachers need to know mathematics is to be able to unpack it. Secondly, that the ‘coverage’ is reduced as a result, the pace is slow (weak internal framing with respect to selection and pace), and procedural fluency is neglected¹⁵². One of the effects of this is that there is very little that focuses on more advanced aspects of mathematics (for example, group theory). Mr/s X is very clear that these are tensions and that they have to make hard selection choices and that in the end,

there is a whole lot of maths that they won’t know almost exists. Whereas, supposedly, those of us who have maths majors do know it exists. But what I can remember about it is probably dangerous anyway. So does it matter, you know? (IAT-X1)

After considering the materials collected for, and the discussions with the various lecturers about, each of the Maths for Teaching / Applied Maths modules that had already been developed at CU, it became clear that in all but one module (Maths for Teaching 102: Geometry and Trigonometry) there is no explicit reference to discursive fields of mathematics education/ mathematics teaching or of mathematics teaching as a field of practice. The focus is on the student teachers’ personal development and understanding of mathematics selected on the basis of an interpretation of what mathematics students need to know for teaching. While there is a recognition that the student teachers need to be introduced to some post secondary mathematics, the selection of this material takes into consideration what will provide depth for them in relation to the contents of the new school curriculum, and also includes a considerable amount of school mathematics. In considering the contents of the modules (as provided in the archive of material collected on site – see Appendix E.1 Table 4) it appears that there is as much of a focus on relearning old school mathematics in new ways (for example, work on: functions and algebra; geometry and trigonometry) as there is on learning new school mathematics in new ways (for example, work on: statistics and probability; financial mathematics; mathematical modelling) and on learning post secondary mathematics in ways different from a traditional post secondary mathematics course (for example aspects of: the calculus; linear algebra), and on linking all of these (in the mathematical connections module). There appears to be a major concern with seeing mathematics differently (from what would be considered as traditional school experiences/ or what is characterised as traditional university

¹⁵² In schools this is a critical problem – slow pace and lack of fluency in doing mathematics (for example see, Davis & Johnson, 2007).

practices), and with learning processes and practices that will enable the teachers to think about and do mathematics in this new way.

The mathematics that student teachers at CU are exposed to as is described above by Mr/s X is a form of *MfT*, but in discussion with students and the other lecturers it became evident that approaches used by the different lecturers are not all the same and so how *MfT* is constituted is not necessarily the same across all modules.

In the first year Geometry and Trigonometry module, ME and MT are explicitly introduced. The work in geometry that is done does not only focus on the students own geometric development and understanding but also on their understanding of how Geometry is learnt, specifically working with the van Hiele theory and on practical work, such as the use of patty paper, that can be transferred from the teacher education classroom to the school mathematics classroom. Mr/s Y reiterates:

That course has a two pronged aim, one being to give students the opportunity to revisit their school mathematics and actually make sense of it. Most of our students, if not all, have only standard grade mathematics with quite a low grade, so you know to give it at a higher grade level at least, but then also to up it a bit. And the other aim is to introduce a new approach to them. You know to focus again on things like habits of mind, ways of thinking geometrically, what's the field of geometry about, rather than just this is the school mathematics now you get another chance to do it. (IAT-Y)

This is the only Maths specific module in which a ME 'theory' appears to be explicitly taught. However in discussion with Mr/s Y it became apparent that the van Hiele theory influenced her approach to mathematics teacher education in important ways, it is not merely a theory for students to become acquainted with as they learn to teach geometry. This gives some insight into what Mr/s Y considers to be important in the selection into mathematics teacher education curricula and how she sees *MfT* being constituted. In particular Mr/s Y gave some insight into the theoretical 'maps' that underpin her own practice as a mathematics teacher and teacher educator. She suggested that:

I have a few maps. One is **problem-centred learning**, as a map which is developed along **constructivist principles**, but what it basically says is, you need a problem. People only think when there is something to think about. So problematise everything. You know, rather than saying this is so, saying what can we get if we look at it this way? It also says that you need, to think properly to sort things out for yourself, you need an audience. You need somebody to listen to you. And it says there should be a **culture in the classroom** that allows, or that says, we are **listening to each other**, so that we all can learn. [...] And then obviously there should be numerical knowledge, **you need the tools of the trade**, and those should be at you fingertips, **with understanding obviously**. [...] And it is your basic things like being able to do the basic calculations to work with percentages, to understand ratios and that kind of thing. [...] But then the other map that I find that I use even more is **levels of mathematical thinking**, that I find I am always going back to **the van Hiele levels theory**, I just find it very applicable everywhere. That on a basic level you take things at face value, then on the next level you are able to access the properties, on the next level you are able to reason about the relationships between properties, at the next level you are able to organise these properties into causal chains and so on. (IAT-Y)

It appears that for Mr/s Y this theoretical orientation is not so much explicitly taught, but rather modelled in her teaching. In discussing her approach to teaching the statistics module (Applied Maths 101) she explains,

... I, take seriously the problematisation story and I prefer to throw them into the swimming pool, you know go under water, hold your breath, look around, where's a branch you can grab onto and surface. I don't itemise and say what could be the simplest part and then lead them on. **I want them to see the big picture.** So, if there was **social knowledge** to convey, like terminology and so on, I did that directly, but for the rest I confronted the students with problems. Here it is, you do that one, you do that one, then you discuss [...] **It took very long, very, very long.** And the aim there wasn't so much group work as, sort it out. What do you think? **Does your way of thinking resonate with anybody else's?** And then where there were procedures that developed from that, you know I would pull together and say okay, now let's look at this. But that was the main way in which it went. Based on that they would get homework or individual work tasks which would just be the typical practice task. But the classes usually, I felt that in the class **they must learn something they hadn't learn before, so they must struggle.** Almost the picture, you know, **Vygotsky talks about the Zone of Proximal Development,** I just toss them outside that (laughs). Make sure they understand the situation and toss them way outside, not way outside, but just outside, where they don't know what to do, and they say but I want to know this. What can I do? And then we discuss that. (IAT-Y)

In reflecting on her involvement in the research process Mr/s Y and on the issues relating to what she tries to teach in her work with the student teachers she suggests,

... its necessary to ask yourself these kind of questions – we don't find the time to do it. I realised after reflecting on the interviews and the questions you asked, how different it is (being a teacher educator) from teaching in a school where you have a fixed curriculum. We have a little more freedom here. In our unit we are trying to get to grips with what is the place of everything in the maths that we are teaching. And I noticed that in this complex situation, I approached it as, I don't know what to make explicit. There are a few things that I can make explicit to students, like the van Hiele theory, the principles of problem types when you deal with functions... blab la bla .things like that. We can make that explicit to students. But **in terms of what I am trying to convey to them I realise that I am trying to share myself, and that's the most I can do. [...]** In a sense I am trying to ooze my experience and my knowledge out to them, rather than here is your book I can make it more explicit. **Much of my knowledge and my role here is implicit. And maybe it's a start. But maybe there is some experience or something that I relay to learners and I see them as apprentices under me, and I try to share myself.** (Mr/s Y; GVT2-CU)

We see from this that the approach described by Mr/s Y in the mathematics/ applied mathematics modules that she teaches, while not exactly the same, appears to fit fairly well with that described by Mr/s X. The focus is generally on the conceptual understanding of mathematical ideas and the development of mathematical reasoning within a classroom climate that fosters discussion. There is also a clear recognition by both these lecturers that in their own teaching they are implicitly modelling ways of teaching. While they may be working explicitly with different discursive resources from the field of mathematics education to frame their approaches, both could probably be described broadly in terms of social constructivist teaching methodologies that favour pedagogic constructivism¹⁵³, and are driven by similar concerns about access and ways of regulating mathematical thinking in the teacher education classroom through discussion and fostering a classroom discourse that enables this.

¹⁵³ For a good description of pedagogic constructivism, which focuses on developing conceptual understanding of mathematics using a broadly constructivist pedagogy, refer to Davis (2005).

The third lecturer involved in the mathematics specific modules is Mr/s Z. Students considered her to have a more traditional approach to teaching mathematics than Mr/s X and Y. In the modules taught by Mr/s Z, the focus is always on maths, although she is attempting to change the way in which she teaches to fall in line with the current philosophy of the mathematics department. At the beginning of the interview she indicated that she might not be the right person to speak to about mathematics teacher education as she only teaches the maths courses. She clearly sees herself in terms of what might be considered a more traditional view of mathematics, in particular what was taught in the college before it became part of the university and before the development around the new B.Ed curriculum began. She does not see what she does in terms of a form of *MfT*, it is simply maths.

In the interview speaking about the Linear Algebra module she indicates there are “Two aspects of it. You got vectors, so, the representation of vectors geometrically. What does it mean? And how can we represent that. And the matrix part of it is about solving problems, solving simultaneous equations. That’s the main focus” (IAT-Z). When asked directly if the mathematics modules she teaches are connected to what they do in mathematics education or mathematics teaching courses she says:

No. I mean, look, when will they use matrices in school? They are not going to use it, calculus yes. But it’s not to that extent, but at least they will use it if they do the grade 12s. But I’m not sure of how much of it, in stats I’m not sure what the syllabus is like for school, and financial maths. Some of these things is for the students own growth its not for, to help them teach better. Its for mathematical background and their own growth. Which they need to be able to say, Ok, this is where we can be able to use this or what. We’re extending their knowledge. (IAT-Z)

For Mr/s Z the maths that is done is for the personal growth of the teachers. They are learning mathematics for themselves and this has little to do with learning to teach mathematics. Mrs Z mentioned the need to change on a number of occasions in the interview. When asked directly how she feels about the changes she replied:

Mr/s Z: I think change is good. People don’t accept it in a hurry. But you have to move with the trend. Things are changing so much that if you don’t change you get frustrated. You must move with the change. And I think change is good.

D: What has changed?

Mr/s Z: They need calculus. They need it for the physics and chemistry. So they do need it. We have to have it. And we are doing linear Algebra. So that is also still in. and they are still doing applied maths which we have done in the past. They are doing things a little differently. They may be doing things in a different way than we were doing it in the past, but we are still doing some of those basic things.

D: What do you mean you are doing things differently from the way in which it was done in the past?

Mr/s Z: I think I am looking at things differently. I am now asking the students to do a lot of things, probing things from them instead of just going there and saying, ok now this is what we want to do. I have changed my approach myself, personally, because I think that is better. And they are going to have to

learn to do that themselves. So if I do it, then they know that look. So they get also the feel of how to go about doing it¹⁵⁴.

D: Why do you think its better?

Mr/s Z: Because at least you are probing the children to think. You're making thinkers out of them and not just somebody who is now just taking whatever you say. Okay they do ask you sometimes questions, and maybe you can't quite answer them, but that's fine. (IAT-Z)

So for Mr/s Z while some of the selections into the curriculum have changed, the focus for her is still mathematics for its own sake, and for the 'personal growth' of the students rather than for the purpose of their mathematics teaching. She clearly does not consider mathematics education at all in her selection of what to teach. When selection was discussed in the interview she indicated that what she used to teach before was determined by the courses she took over when she arrived at the college many years before, and what she does now is a decision of the mathematics department. The materials she is using for the linear algebra course have been developed by an outside consultant and have not really been influenced by her¹⁵⁵. Much of the mathematics she used to teach in the old days, such as number theory, graph theory, group theory and so on is 'out' now, while other things are 'in'. She does not see herself as a decision maker, but recognises that she has to change with the times – and for her that is changing her methods of delivery from a lecture style to involve more discussion and group work.

Throughout the various discussions with the lecturers and students in the interview situations it became clear that the lecturers in the mathematics department interacted on a regular basis over the curriculum and what was being taught in the mathematics modules. There was a lot of co-operation with respect to delivery of modules and lecturers did sometimes teach modules together as well, both in terms of sharing loads, observing one another and team teaching. However the department itself is lead fairly strongly by Mr/s X. While there is discussion and negotiation, she makes the final decisions and keeps in touch with how things are developing. So Mr/s Y might argue a point but then accepts the decision taken, and Mr/s Z accepts that she must change and tries to implement the changes required of her. Mr/s X keeps a pulse on what is going on. As Mr/s Y describes it,

[Mr/s X] is very good in that way. She eavesdrops on all our [lectures], she knows whats going on you know and she asks us questions about it, which is nice. We all have an ear on what is going on in the others class. There is a lot of cooperation. We all give each other the articles that we found you know, [...] the sharing is great. (IAT-Y)

¹⁵⁴ Here it appears that she believes she is modelling a new practice for the student teachers – they will learn how to do it through the experience of learning that way. This supports the earlier suggestion that there is a conscious choice in the maths department to model practice: to 'walk the talk' and not only 'talk the talk'.

¹⁵⁵ This is unlike the case of Mr/s X and Y, both of whom have developed the courses they teach and have also developed the materials that they use.

It appears that the department itself is not a stereotypical academic department where all members are more or less left to make their own curriculum decisions. In this department there appears to be an attempt at developing a coherent approach to teaching mathematics and making selections into the programme. At the same time it seems that all the stories point to the dominant influence of Mr/s X, and in this sense it appears that her practices and decisions could be described as the privileged position in the department.

At this point I will move on to consider the other courses in the curriculum – Curriculum and then Teaching Experience.

2) Curriculum Course

The *Curriculum (Senior & FET) 103* and *105* are the modules where we could expect to find ME and MT explicitly dealt with. As indicated above, only the 103 module was implemented in 2004, with the 105 module still to be developed for implementation in 2006. In the rule book these modules are described in generic terms. *Curriculum (Senior & FET) 103* is described as:

Application of principles examined in Curriculum 102 to a learning area that includes the teaching subjects selected in terms of Rule 4.1d, including key content and concepts relevant to the whole learning area; the teacher as designer of learning programmes and materials; learning area manager; learning area specialist. (CU, 2003, p. 59)

And *Curriculum (Senior & FET) 105*, as:

Study of methodological issues relevant to the FET subject specialist in a subject selected in terms of Rule 4.2d, including learning programme and material selection, design and development; subject management; managing of learning outside the classroom; assessment techniques and methods relevant to FET (NQF 4) outcomes. (Ibid., p. 60)

These descriptions are clearly related to the roles of the teachers as described in the NSE, the 103 module focusing on the Senior Phase specialist and the 105 module on the FET specialist. The description of the 103 module refers to the general *Curriculum 102* module, which is described in the syllabus as:

Exploration of current curriculum issues and applications relevant to teaching methodology, with focus on the senior phase; the teacher as learning mediator and interpreter of learning programmes; assessment techniques and methods appropriate to GETC outcomes. (Ibid., p. 59)

These descriptions seem to focus on curriculum knowledge, teaching and the practical skills connected to managing learning and teaching in school. It is not clear from this how Mathematics Education as a field of study in its own right is included.

Again it is necessary to consider what students and lecturers reveal in the interview situation to get a better idea of the actual focus of these modules. As indicated before only Curriculum 103

module had been developed when the information was collected. Fourth year students taking the HDE did not take Curriculum as a separate course of study. For them the mathematics courses were all year long courses that were split into two sections. One lecture per week throughout the year was allocated to mathematics 'methods' with four periods allocated to mathematics. In that model the mathematics method component was seen as an add-on that was often ignored if there were time constraints for completing the mathematics sections. Mathematics education, it seems, was not a priority in the HDE curriculum.

Having established in the previous sub-section that despite the formal module descriptions pointing to the integration of mathematics education and mathematics teaching into the mathematics specialist modules, this was largely not the case. All but one of the modules focused exclusively on selections, albeit those seen as relevant for teachers, from the domain of mathematics. It appears therefore if there is to be a specialisation of consciousness related to specialised fields of mathematics education and/ or mathematics teaching, the space for this would be within the Curriculum or the Teaching Experience modules. The extent to which the Curriculum module draws on selections from the diverse field of research based knowledge being produced within the academic domain of ME, from official knowledge discourses drawing on the school curriculum and other education policies, professional knowledge from within the field of MT or from practical experience and popular discourses circulating in the ill defined fields of mathematics education and mathematics teaching is not visible from the generic module descriptors in the syllabus handbook. In this sub-section we take a closer look at what discourses we can identify as being selected into the Curriculum module and how these are made available to student teachers in this pedagogic context.

In what follows most of the comments refer to the B.Ed Curriculum module, however, where it seems relevant I have also included statements made in the context of the mathematics methods component of the HDE.

Earlier Nicole was quoted speaking about the difference between maths and the Curriculum courses. She explained that in the curriculum course they focused on learner's work and misconceptions. She gave no indication of the extent to which the field of mathematics education was used as a basis for this work, or whether they simply relied on interpreting the work and using their own knowledge of mathematics as a basis. In discussing this with the lecturer of this module, Mr/s X revealed,

The thing I have enjoyed about that course [Curriculum 103] is you don't have to bother about whether you are covering calculus or whether you are covering algebra at the same time, because it is completely

divorced from that. That has been really good. There has been lots of freedom to kind of do your own thing, which has also made things difficult, because you've got too much to choose from. I started kind of going in **like this is not only method, they must learn the mathematical stuff too**. [...] right at the beginning we looked at products and factors, I deliberately choose this early because I felt that where the students were coming from it was simple stuff, there was nothing complex about the maths, there was nothing complex about any concepts, there weren't contexts and things that would get in the way. And we would look at Ok, traditionally this is how it gets taught, this is how text books set it out, we know the consequences of some, you know, kids mix the two up and bla, bla, so how do we teach them? So lets try and think of another way, and lets try and look at the two being taught together. What the typical misconceptions are, how we could address that, and those kinds of things. And we spent a lot of time on that. So **I looked at that in terms of what I called didactic analysis**, because I just didn't have another word for it. [...] because the section is not an obstacle. You can background that and foreground all the other stuff quite easily and the students don't get bogged down. [...] we looked at some of the issues around definitions and law and how those things are different. **Ala Ball and Bass kind of influence**. We also went through to the factor and remainder theorem as well to take the product factor theorem higher, beyond just grade 9/ 10. I didn't do a great job of it. I'm not sure that that levered up enough, given the other stuff that got left out. [...] I sent them off to school experience with some of the issues that had arisen in our discussions. So go and talk to teacher about how they deal with this, its likely you are going to see this taught, so look specifically for these issues, interview kids, here's a task interview them, see what they do, write it up. So that **the methods stuff was connected directly to school experience**. [...] we looked at a bit of geometry stuff that we were getting into. It was an assessment issue. So we took tests that had been set at schools. I'd collected some stuff, like whole tests of [learner work], and so we looked at some of that. How to mark it, how the marks were allocated, how to mark it, when you get this response you don't know what to do with, and then kind of analysed more deeply what was the kid really thinking. So let's kind of put the assessment thing away and **get into the learner thinking kind of stuff**. And we kind of worked between those all the time. (IAT-X2)

When asked earlier during the first interview if she expected the students to do many readings, she suggested that

[...] they are not, their reading skills are not good, and I just capitulate on that and don't give them reading from that point of view. So it was all worksheets. They didn't have to work with a formal text book. So they got the RNCS. (IAT-X1)

From this it appears that ME in this module is not necessary a selection of contents from the field of ME research that are a focus of study in-and-for-itself, but rather ME is seen to be comprised of practical ideas and suggestions that is very much integrated into the field of experience, which is also how MT appears to be seen, i.e., a practical accomplishment. For example, analysis of learner misconceptions is clearly valued. However, this seems to be based to a large extent on experiences of learning mathematics and on knowledge of school mathematics topics, rather than on specific discursive resources developed in the field of mathematics education research. That is, while Mrs/ X may be structuring activities etc. on the basis of her own specialisation into ME, it does not appear that students are necessarily being given direct access to these discursive resources. Rather it seems these are presented as recontextualisations which may be implicit in the structuring of the practices, or delivered in the form of short notes¹⁵⁶, and therefore they may not be discursively accessible to all students. Many of the discussions in the Curriculum classroom are related to teaching practice

¹⁵⁶ See discussion of imaginary and symbolic identification (c.f. Lacan) in Chapter 9, and Karyn's comments on notes about van Hiele in 'Karyn's story' in Chapter 10.

and tasks are set for students to do while out on Teaching Experience that relate directly to work done in class. This interpretation is supported by the relatively few discursive resources from the field of ME provided by the lecturer for this module (see Table 4 in Appendix E.1). While the students were provided with a few readings to work with, the lecturer's knowledge from her own experiences of mathematics teaching and discourses from the field of ME was clearly a basis for selections into the curriculum and for the pedagogic discourse produced within this context.

This approach to ME/MT (integrated) is one that also appears to have been the norm within the HDE curriculum, although the difference is that in the B.Ed it is given more serious space and time in that there are two specialist modules devoted to it. In the HDE it was easier to ignore the 'methods stuff' because of the pressure to ensure that the students (who are not seen as strong mathematically) get enough mathematics. That the 'method' components appear to be focussed on developing practice is also supported by Mr/s Y in her discussion about her involvement with the third and fourth year HDE's, as is evident in the following interview extract:

- D: This thing of reading and researching maths education to inform that, do you expect much of that from them?
- Mr/s Y: We haven't. The most we have expected is, for myself, we have dealt with van Hiele and they had to read and do a comprehension test on an article and so on, and I know that (other lecturers) have worked with the five strands of Kilpatrick. But ja, it was curious for me as well when I came here. I asked what are the theoretical frameworks they are learning in educational studies, and they were largely unaware. We don't know what to build on, which I think is bad. (IAT-Y)

Mr/s Y expressed her strong feelings that it is important for students to have access to particular theories of teaching and learning to underpin their practice:

We had an argument at the beginning of the year, amiable argument amongst ourselves, on what is the message we want to give our students to go out with. And I want to know that quite seriously for myself. And I argued that it is a luxury in our situation, in South Africa today, to say that we will give you a shopping basket of ways to do things, and it's up to you. I think it's a luxury. We are not there that we can make, our teachers can make those judgements. So I am rather strongly in favour of giving them my theoretical framework. And say try this out. And then you question it. It wasn't that well accepted. For reasons that I also understand. I know the human tendency is the moment I put that on the table it becomes the ultimate, you know, and we don't want that. (IAT-Y)

From the discussion so far, it is confirmed that the Curriculum modules are relatively strongly insulated from the Maths for Teaching and Applied Maths Modules. The Curriculum modules are seen as the space where *practical* knowledge of mathematics education and mathematics teaching are developed in a highly integrated manner and are directly related to teaching aspects of the school mathematics curriculum, selected on a basis of what the lecturer sees as relevant at the time. There is very little to distinguish between ME and MT and the work done by students is orientated towards practice and integrated into their Teaching Experience blocks

though assignments based on issues that are brought up in class. The interview data supports the suggestion that there is very little ‘reading’ of ME texts and explicit study of these as discursive resources to inform practice. While some readings are given to students, the examples of work in the archive based on such readings reveal mostly comprehension exercises. It is noted that the RNCS was provided as a resource, but in discussion with the lecturers and the students it was hardly mentioned at all. None of the course work collected in the archive for this module mentioned the RNCS. The areas visible in the course work examples provide some idea of the contents and include a focus on teaching and learning aspects of school mathematics and some aspects that would be recognised as being mathematics education: products and factors, the factor and remainder theorem; integers, exponents, equations and inequalities; and, assessment in mathematics, language in mathematics; didactic analysis of mathematics teaching; and definitions in mathematics.

It is clear that the work done in the Curriculum 103 module is concerned with developing competence in aspects of school mathematics as well as being focused on thinking about teaching and learning this mathematics. So in this sense the content of school maths (M) is integrated into an already integrated form of ME/MT in the Curriculum course.

Curriculum 103 is an integrated module based in an eclectic mix of discourses circulating in the field of ME and from the ORF. Ensor’s (2003) suggestion that in mathematics teacher education, mathematics education discourses are localised horizontal discourses is supported to some extent by the evidence produced here. It is however interesting that Mr/s Y (see previous transcript extract) wants to put her theoretical position up front – to teach it directly to student teachers so they can access the ideas structuring the practices that the institution believes are important. However, as she explains, the department made the decision not to do this. The net effect is that the dominant discourses structuring the privileged practices at CU remain implicit. The apparent reason for not providing this theoretical grounding for the approach being taken is that the college mathematics department does not want to dictate a new scripture to their student teachers – the teachers must be in a position to think through and make independent choices. But this means that the ‘scripture’ that structures the privileged practices remains implicit and may only be accessible to the few that can already read the context.

The pedagogic context of the Curriculum module will be explored in further detail in the next section of this chapter. For now we will move on to consider the Teaching Experience modules.

3) Teaching Experience Course

While there is a significant amount of specialist teaching practice done through the Teaching Experience modules very little information was made available about these modules and how they work to specialise the consciousness of the student teacher. It is evident from what students say that this is an important aspect of their curriculum, for example Nicole (GVT1-CU-B.Ed) explained that as far as she was concerned this was the best aspect of the curriculum and where they learn the most. At the same time however, problems with school placements sometimes interfere with what it is possible to learn, and this seemed to be related in some way to the selection of schools as well as to cultural problems¹⁵⁷. While there is some evidence for this, I am not going to discuss this issue here as it is clearly complex and there is no space, and too little evidence, to investigate it properly. But it does point to an aspect of the teacher education curriculum that requires more research. The issue of teaching practice was flagged in the survey results reported in Chapter 5 as an area that is most opaque and under specified. Here I will focus on issues related to the experience that are visible from the evidence collected.

It has already been shown that the practice teaching experience is specialist in the sense that in the blocks set aside for the first specialisation, the first subject is the focus of teaching and specialist lecturers go out to assess all student teachers. This is possible in the context of CU and may be connected to the fact that they have relatively few mathematics specialisation students. The assessment for the Teaching Experience modules is directly related to the evaluation of their practice. However while out at the schools the students also do a number of tasks that are connected to the other specialist courses. It appears that the mathematics lecturers give them a range of tasks during all their practice experience blocks that are related to curriculum (as already mentioned) and the mathematics courses, as indicated by Mr/s X in the transcript extract below:

I have to be honest, when I got here, I mean this is a personal thing, but it's what I saw. Teaching practice was like, they go out and they do stuff for three weeks and then they come back and we carry on. And more and more we started to think about, we've got to do this at this time of the year because that is what is going on in schools. Or we want our students to practice this stuff there or be more sensitive towards it, so we need to prepare them for particular issues on school experience. So in most of our courses now, there is some task that they have got to do on school experience that is related to work that has been covered. So it might be for example, with the calculus course, they go out and look for

¹⁵⁷ See Sonny's story in Chapter 10 where he describes his practice teaching experience.

examples, even at Grade 8 grade 9, of where some of the calculus thinking, is actually embedded in places. (IAT-X1)

It is not possible to reveal much of this except where it was part of the assessment of the Curriculum module, and that will be discussed in more detail later, but what is evident from this is that there is some relaxing of the boundaries between the mathematics and the teaching experience courses, as well as between Curriculum and the Teaching Experience courses. Specific aspects from these *MfT* and ME/MT modules are deliberately selected for recontextualisation into the Teaching Experience course through teaching practice assignments that require the students to reflect on connections and to work with knowledge developed in the more formal university based courses while out on practice teaching. These assessment items are considered in more detail in a later section of this chapter.

It is also apparent that there is an awareness amongst the college mathematics staff that there is a need for students to discursively discuss and observe examples of practice in order to see preferred models of practice and to have an opportunity to gain access to the recognition rules for what might be considered examples of 'best practice'. However, whether and how discursive resources are made available for reflexive interrogation of these models, or if this is simply reflected upon to develop images of best practice is not clear. Mr/s X explains how they have begun to start experimenting with this in the second year B.Ed.

We took two days out of teaching practice with the second years, and they were on campus for two full days with us. We worked like from eight to four. The kids were here in the morning [Grade 8s]. We taught and videoed and whatever, and in the afternoons we debriefed and we discussed and reflected [...] I did the lecturing [teaching]. [...] I deliberately manipulated stuff to teach the kids we were teaching as well as to teach our own students. And set up stuff that was going to open up a can of worms and I mean you can't do that, you know, students teach and you take what you get. And its quite, I mean I was fairly intimidated. You have like 12 observers, plus two video cameras wondering around and you kind of know that every thought that is going on in your head is somehow getting recorded somewhere. And I don't think our students are, its not appropriate to put them under that pressure. [...] It is something we want to pursue further. (IAT-X1)

In terms of the progression from first year to the fourth year, the department is starting to explore what the expectations of student teachers should be. Mr/s X explains that this is not so easy:

Its an emerging framework that is completely unsatisfactory. Well not completely, it just that its not clear what the progression should be from 1st through to 4th year. [...] It occurred to me now for the first time that that is the most intensive one on one time that you are ever going to get, with your students. So they might be second year performing at third, first whatever year level, I mean you need to deal with them where they are at. So you can't always say oh well this is second year this is what I expect, because maybe they can't do it, or maybe you should be pushing them way further. It is much easier in my opinion to push them further than to come with remediation type of stuff, or to say OK, is this student really worth a pass and if it is then exactly what constitutes competence at this level? I'm not clear on that in my own head. (IAT-X1)

She also is well aware that their expectations, their ideal for what student teachers should be and how they should teach in the classroom is not rooted in the current realities of schools and this causes difficulties when trying to assess,

There is a huge tension around what we expect and what's really possible in schools. You know, when its here are your five worksheets for the week, this is what you are going to teach, and I mean I had a few students say to me, but I can't, this stuff doesn't get at the conceptual stuff. I know the kids, it looks like they know what they are doing, but I know they don't [...] And I mean those things are hard and I'm not sure how we manage those tensions either, because we have to deal with that. Its not just about what you expect at each level, its about, this is not a closed system, you know. There are other factors that impinge all the time and we have to take those into account because otherwise we set up our students for frustration, disappointment, failure. It's a virtual reality. We can prepare them for the ideal learner centred, every kid behaves, every kid wants to do maths world. It doesn't exist out there. (IAT-X1)

That these tensions are recognised is interesting, particularly given the specific pedagogic discourse that is emerging as privileged within the institution. This will be described more formally in the next section. While there are difficulties, the department is attempting to put together some kind of assessment rubric that will enable it to assess teaching at different levels. Mr/s Y had been tasked to develop a rubric for this. She describes this in the following way, and the description in a sense attempts to provide a picture of what a successful mathematics teacher (good subject of the institution) would look like.

I'll give you a rubric that I wrote now, after the prac teaching. A four level one, where four would be a distinction. To say what it is. I conceptualised it in terms of awarenesses. I want to see an awareness of learning, I want to see an awareness of the content, and I want to see a certain level of awareness of own practice. And what would that mean? And it's a first attempt, it's a discussion document for us. For the 4th years, it came after looking at 4th years. Now who is so good and why do we think they are good and so forth and what do we measure against? And it should be reworked to what do we expect the first year student to do, bla, bla, bla? But to me, a successful student going out of our hands is a student who understands that teaching and learning is a complex field. Its not one that you can apply a set of rules to and you get a set of results out. And they must be able to hold more than one awareness in their mind at a time. When they teach, they must also be aware of what's happening in the learner's mind. When they are listening to the learner, they have to be aware of the mathematical links with other parts of the subject, and of what they could have said, that could have prompted this. So I want active awareness in the student of the complexity of the whole thing. And then I think, if you have a good map of how people learn, and there is enough information available today to map that, conditions for learning, and you have a map of your content, how the things are related, and you have a map of a teaching practice based on a learning theory, then it is experience that will give you the edge in the end. (IAT-Y)

Mr/s Y is very clear that this is not a generic rubric, it attends very specifically to mathematics teaching, she gives the example,

[...] I failed two fourth years on prac this year, because of a lack of awareness. You know they have all the things to look like a good teacher, and they will say the right things, 'come on guys I want you to think' and so on, but their subject knowledge is so scattered that there is no link there. That is just not good enough. Then you can't pass because you are going to do damage. And another one where his subject knowledge is good but he just lets the children go on. You know his teaching role is so diffuse that he can also not lead them on, or pull them to higher levels. And I failed him. (IAT-Y)

What emerges here is an image of teaching that is specialised (MT) and that integrates and applies knowledge and practices developed in the more formal university based modules in the context of a school. However there are major tensions in that the expectations of what it means

to be a good mathematics teacher, while probably being in line with the official discourses circulating at a general level in the South African context, are not in line with what is occurring in schools, nor with the expectations of student teachers by schools.

So far we have been able to piece together a picture of the various aspects of the curriculum and have begun to give a first level description of how these forms of knowledge and practice appear to be organised and how this constitutes a notion of *MfT*; an image of what is privileged in terms of M, ME and MT within the institution, and of some discourses that appear to underpin this. Before bringing together the different aspects discussed in the previous sections to present a more discursive interpretation in terms of the theoretical framework drawn from Bernstein, I briefly discuss aspects of the organisation of space and time in relation to the curriculum. This highlights further features of CU's teacher education practice that are relevant to the way in which mathematics teachers are being specialised within this pedagogic context.

3.1.2 Time and space in the curriculum

An interesting feature of the CU context is the way in which B.Ed students' time is organised across the curriculum, and the spaces this opens/ closes within the MTE context. Firstly it is clear that classification of learning spaces between B.Ed FET /SP education students and the general student population at CU is highly classified. Education students are completely insulated from students on the main campus geographically. Education students are taught exclusively by lecturers on the education campus, and, in the mathematics related modules never attend classes together with other students on the general campus. Nor are lecturers from the main campus involved in teaching specialist courses.

In relation to the organisation of time, as seen through the lecture time-table, it appears that the B.Ed curriculum is significantly different from what had been experienced in the past by HDE students. When the former College of Education was incorporated into the CU, the College timetable was changed to come in line with the general CU time table, which spreads lecturers across the whole day. While one would expect that change in time would have translated into a time table that would be fairly recognisable in terms of traditional university learning, that is, an average of three to four lectures per week per module together with either a tutorial or a practical (depending on the nature of the discipline/subject), this is not how the time table has been translated. In particular the TE time-table has been *filled* with contact time. This serves as a mechanism for controlling student learning and strongly frames the pedagogic space.

The reasoning behind using so many of the lecture slots for contact teaching seems to be connected to a particular interpretation of a time-table and to a general ethos which sees the students as requiring a large amount of direct teaching (They are in need of help – if they don't get this in the TE class, where will they get the opportunity to access it?) This was a traditional pattern in the HDE, where the College was run more like a high school than a traditional university, with a clear commitment to teaching teachers how to teach by teaching them in the way they should be taught¹⁵⁸. With the move to a curriculum that has greater demands in terms of the various components in the design¹⁵⁹, there was a need to have more lectures. The general college ethos did not seem to allow for a change to a curriculum that would involve less contact time and more independent work. This is also connected to the low entrance requirements of education students mentioned earlier and to recognition that student teachers had not necessarily been highly successful learners while at school. One of the consequences of this time table is that the pedagogic space for learning within the B.Ed curriculum is strongly framed by contact time in classes. There is little time outside of the classes/ lecture theatres for alternate forms of learning and pedagogic interaction.

This aspect of CU university life was first brought up in the first group interview with the B.Ed students Nicole and Emmanuel¹⁶⁰. For both of these students the time table had two aspects. The one related to lack of time for independent work, and the second related to the way they were taught in many of the lectures. These students average 7 x 55 min periods per day (the time table has 8 periods in a day). This means they have to be in lectures for about 35 periods a week. They are expected to be in class for all of these as registers are taken and DPs are linked to attendance. They also have a morning tea break and a lunch break. Emanuel expressed his feeling that this created stress, “honestly (how I feel) is not good, because we are always under pressure” (First group interview), while Nicole felt that the problem was in the pace of lectures, suggesting “if they just sped things up a bit during the day we could have more time to do things”. They both worked to help support themselves through their studies so they found they did not have much time to do independent work and to complete their assignments and so on. They generally use their lunch hour to relax and chat to other students.

¹⁵⁸ Specifically mentioned in the interview with the deputy head of the college while discussing excellence in the previous system and explaining what might be lost with the incorporation of Colleges of Education into the tertiary sector.

¹⁵⁹ For example, whereas previously HDE students would do Maths 1A, 1B, 2A and 2B over their four years of study, and each of these would be year long modules that would include ‘maths methods’, they now do specialist modules in mathematics, applied mathematics and Curriculum. In addition there are more demands in terms of the various fundamental and core modules as well.

¹⁶⁰ Nicole and Emmanuel are cited here and not Sonny and Karyn, because they are the two B.Ed students who are experiencing this extended curriculum.

For Nicole the most frustrating thing is that while they have to be in all these lectures, so much time is wasted. She had a previous experience of university life before attending CU and suggests “it’s so different at a big university compared to here. This is like school”. When pressed on this, she explains that when she was at the previous university she

was much happier at [UX], because I’m quite independent and I like to just get on and do things. I liked going there – you’d sit there for two hours in lectures and do a whole chapter and it’s your baby to go home and sort out stuff. Here it takes three weeks to do a whole chapter and you are spoon-fed. Maybe it’s because I have been at a normal varsity, I don’t feel like I have to be spoon-fed and have to sign that I’ve been in a lecture. It’s my (...) decision whether I want to attend lectures or not. And that’s what I don’t like about here. I feel as if I’m at school. (...) it’s so slow (...). (Nicole; GVT1-CU-B.Ed)

Emmanuel does not feel this to the same extent as he previously went to a technical college which worked on a similar basis to CU. However both these student feel that a lot of time is wasted in classrooms, and in particular in some of the courses where they are treated like the children they will one day teach and where their time appears to be filled with boring and unnecessary tasks, such as making charts of things they will never use and spending weeks doing it, or having to work through content designed for Grade 8s, for example. They both suggest that while they love their mathematics specialist modules there are large parts of the curriculum that they feel is wasting their time, and as Emmanuel puts it, “What I realise is, its good to be a teacher, but studying to be a teacher is boring” (Emmanuel; GVT1-CU-B.Ed). This sentiment was also expressed by both the HDE students in the sample. It is noted that this was not expressed in relation to the mathematics specialist modules, but included the compulsory mathematics modules and other modules out of the influence of the mathematics department.

While the student teachers feel the curriculum has too much contact time and that much of it could be sped up and/or discarded, Mrs/ X sees time as a major problem in that there is not enough of it to get through everything that the students need to know. In the M modules this is especially so, since they are teaching the students differently. She feels they have insufficient time to cover the work they need to do, especially since modules are completed over six months, so there is not the same time for consolidation and development as there was before with the HDE. She expresses this explicitly in the following extract:

(...) you’ve only got six months whereas before there had a whole year, with fewer contact periods per week but at least it was more spread. (...) I found it really difficult to balance the conceptual stuff with coverage. And what came out in the exam, in terms of the students work was, and they were saying to me, we could do the conceptual thinking stuff but we made lots of mistakes on differentiating and integrating. And, I mean they had had many many tuts to practice, but I wasn’t getting the stuff marked enough, marked in time, I wasn’t getting it back to them quick enough. And I was pushing the whole time, lets understand this stuff. Lets link this stuff to other things we know. And so the fluency stuff definitely came unstuck. And the coverage came unstuck (...) yet there were times when I just felt this

discussion is very valuable and the misconceptions are really, they are pouring out there and we are starting to deal with them. And like, why shut the door. You know. But then the consequence was, we didn't get far enough. And also whether in a semester long course you can really get those concepts sorted out because it's too much too soon. I remember myself taking the first six months of first year to really figure out what a limit was. Or I thought I had figured it out. And how all this stuff works. And so we are expecting them to get it all in six months, which maybe is not wise. So maybe that course should run in parallel with algebra for the whole year. I can't begin to think of those alternatives now. (IAT-X1)

The issues that are brought up in this discussion of time and space are significant and point to dilemma's in the design of the curriculum, to the institutionalised pedagogic practices of teacher education within the CU context, as well as to issues related to changing practices. Even more significantly it points to a particular construction of the student teachers – access is provided through contact teaching which models conceptions of good practice. The student teachers clearly find this frustrating in some of the modules – however in the mathematics specialisation, this does not seem to be a concern.

3.1.3 Classification and framing and the construction of pedagogic discourses for M, ME and MT at CU

Maybe just one [more] thing, that was an observation from me, almost as an outsider when I started here at the beginning of the year. One asked yourself if you model in teaching, if you model in your own teaching the principles and the things that you base it on, will it carry over? There is research that shows it doesn't. But I have noticed that somewhere, some people must have been doing things right here. Because the 4th and 3rd years, they were my first acquaintances in the students, and I found them very willing to argue, very willing to talk, and I know they don't come out of school like that. And I just think that is through modelling and them gaining that comfort, you know, that they won't be ridiculed if they aren't correct and so on. That definitely transferred. (IAT-Y)

From the discussion in sections 3.1.1 and 3.1.2 a number of aspects with respect to the '*what and how*' of the MTE curriculum at CU become visible. This is recognised in relation to the overall selection and organisation of specialised contents and practices in the B.Ed curriculum and to the way in which these appear to be made available within the pedagogic context. Referring back to the model (described in Chapter 5) of specialised discourses within the teacher education programme we can now provide a first level interpretation of the CU curriculum.

Firstly we recognise selections of all three knowledge discourses (M, ME and MT) within this curriculum, although MT is integrated into M and ME in the contact modules.

Selections of M appear to be organised in the curriculum for two purposes: 1) relearning old (school mathematics) in new ways; 2) learning new mathematics (university level mathematics/ more advanced mathematics/ new aspects of school mathematics brought into

the new curriculum) in non-traditional ways¹⁶¹. These selections are made available across all the different specialist modules.

Selections of M contents and practices into the curriculum are based on an interpretation of what mathematics teachers *need to know* to teach FET mathematics (described as *MfT*). These selections are consciously influenced by:

- an assumption that student teachers' previous mathematics learning experiences were impoverished and that they need to be re-taught and re-learn a good deal of old mathematics;
- relevance to the new school curriculum (NCSM – i.e., official knowledge recontextualised in the ORF), particularly new areas of focus, including new contents and an emphasis on processes;
- a commitment to a conception of mathematics teacher education influenced by specific discursive resources from the field of ME¹⁶²; and,
- an explicit rejection of too much of a focus on 'higher mathematics', that is selections from formal/abstract/pure mathematics, the discipline itself (seen in terms of what would be privileged in the normal undergraduate mathematics major offered by academics in a typical South African university mathematics department)
- an implicit assumption that all students coming into the mathematics programme for secondary school teaching, can learn to be mathematical (know mathematics, and think in mathematically productive ways beyond procedural competence) if access is facilitated by these new pedagogic modes

Access to these privileged selections appears to be structured through a regulative discourse which is based in discursive and official discourses which underpin the selections. In this sense while ME discourses are not explicitly part of the M focused modules in terms of the contents to be acquired they frame access, and so are *implicitly* integrated into the M modules. That is, that provides the pedagogic space for students to voice their thinking, to respect each others' ideas, to explore ideas and present arguments, to work with mathematics in 'new ways'. Computer technology is used as a tool to facilitate the development of different ways of

¹⁶¹ It is recognised that this is not evenly realised in practice throughout the context for, e.g., Mr/s Z's classes which are clearly more 'traditional' than Mr/s X's or Y's. However, even Mr/s Z is aware that she needs to change, and is attempting to implement the new practice.

¹⁶² Particularly the idea of "unpacking" as opposed to "compressed" mathematics and of the mathematical work of teaching (Ball & Bass, 2000; Ball et al., 2004); discussion-based classrooms and notions of connected knowing in mathematics (Boaler, 2000; Boaler & Greeno, 2000), the van Hiele levels, and a number of others that could broadly be described in terms of variations of social constructivist learning theory (e.g. use of learner misconceptions and errors; concept definitions and concept images).

thinking. Thus the instructional discourse is characterised by relatively weak framing with respect to sequencing and pace but stronger framing with respect to selection. It privileges mathematical reasoning, particularly conceptual understanding, but due to weakened framing of sequencing and pace leads to a reduced focus on fluency.

Implicit within the pedagogic discourse for M is a model for teaching and learning mathematics which is to be accessed implicitly through learning experiences in the MTE classroom, i.e., a model for MT.

Selections of ME and MT into the formal curriculum are organised mainly within the Curriculum module. While there does appear to be some access in the Curriculum module to discursive resources in ME (see list in Appendix E.1 Table 4), this appears to be limited and it is unclear how access is structured. From the evidence presented so far it appears that these aspects of ME are presented as resources for teaching and learning mathematics in practice and that they are quite localised to the students'/ lecturers' mathematical learning and teaching experiences. It appears that ME is not a distinct field of learning, and is integrated with forms of MT and selections from school M. ME and MT both appear to be mostly structured through experiential learning and seen as practical accomplishments within the curriculum, rather than as discursive resources with which to interrogate forms of practice. They are a means to developing an orientation to teaching and learning mathematics that is privileged and provide resources for enabling this type of teaching in practice. However, it seems clear that modelling of practices (whether through the lecturers teaching M modules or Curriculum modules, or in the Teaching Experience modules through observing and discussing 'model' lessons) is a key aspect of access to ME/MT within this curriculum.

MT is developed through three contexts: (1) in M classes through modelling of good mathematics teaching practice; (2) in the ME classes through modelling and discussion and (3) in the Teaching Experience modules through observation of teachers, of the lecture delivering 'model' lessons, reflecting on own experiences of teaching, and being evaluated by a specialist lecturer in practice.

To summarise we see that the relations between the various specialist discourses (classification) are relatively weak as shown in Table 18.

Table 18: Classification strength between different specialist discourses (insulated +/- integrated -)

Specialist discourses (what)	M	ME	MT
M		C ⁻	C ⁻
ME	C ⁻	C ⁻	C ⁻
MT	C ⁻	C ⁻	

The analysis shows that M, ME and MT are implicitly integrated in general¹⁶³. Although they are taught in separate modules at different times (classification of space is relatively strong), the same lecturers teach and assess all the modules and often team teach (classification of agents is relatively weak), and there is a commonality in the dominant regulative discourse that binds them. The integration of the three specialist discourses is recognised in the following ways: ME is implicit in the maths specific modules through the principles for selection of M contents, and though how it is taught. In turn, teaching M produces a model for teaching and learning mathematics that constitutes the privileged notion of MT. In the specialist Curriculum modules, selections of M are used as the vehicle for introducing ME notions and for implicitly modelling privileged MT practices. The boundaries between the discourses are therefore relatively weak; they are not strongly insulated.

There is a sense in which we can recognise two specialist discourses within the formal institutionalised curriculum offered through the contact campus based modules: *MfT* (maths for teaching, which is mathematically focused but which implicitly integrates ME and MT and is selected on the basis of what the teacher should know to teach); and a blend of ME/MT which is also located in mathematics – well known selections from the school curriculum – which are used as a vehicle for illustrating selections from the field of ME and privileged MT practices.

Relations within these various discourses (framing) is summarised in Table 19.

Table 19: Framing strength within specialist discourses

		M	ME/MT	MT (in practice)
Discursive order	selection	F ^{el} +	F ^{el} +	(?) individualised
	sequencing	F ⁺	F ⁺	(?)
	pacing	F ⁻	F ⁻	F ⁻
	criteria	(?)	(?)	insufficient info
Social order	hierarchy	F ⁻	F ⁻	F ⁻

¹⁶³ Although there is the exception of the M classes that are taught by Mr/s Z. Nevertheless, the overall thrust of the curriculum is to weak boundaries between the three discourses.

The framing relations are not completely clear at this stage of the analysis. However when considering the information revealed thus far we can say with some confidence that in terms of selection, there is relatively strong external framing with respect to selected MTE discourses and the ORF as represented by the NCSM. There is also fairly strong internal framing, with the lecturer being predominantly in control of selections of the instructional contents and pedagogic discourses (ID/RD) across the various modules and in the MTE classroom context. However, it is possible that there is weakening over selection in some classes since students are clearly encouraged to participate in classes through discussion and to insert their own ideas into the discussion. With respect to sequencing of contents the overall control is in the hands of the lecturer and is therefore relatively strong, however, within specific classroom contexts, there may also be some weakening of framing. There is evidence however that pacing is relatively weak, indicated by the students' descriptions of the discussions and of the lecturers' (particularly Mr/s Z and Y) acknowledgement that time and coverage is a dilemma given the pedagogic mode operating in the classes. At this stage it is not clear how strong framing is with respect to criteria (evaluation). However, it is clear that in general there is a relatively weak framing of the social order, with students being encouraged to voice their ideas and opinions and relaxed informal relations between lecturers and students.

3.2 Pedagogic mode in the teacher education classroom

In section 3.1 a fairly thick description and an initial interpretation of the FET/Senior Phase B.Ed mathematics specialist curriculum instituted at CU was provided. This gave some insight into the organising structure of the curriculum, the selection of contents and classification and framing relations within and between the specialist contents. The focus now moves to pedagogic interaction (IP) within this teacher education context through a second level analysis and interpretation of a specific MTE class/lecture. The detailed methodology for producing the data and interpreting any IP in a pedagogic context was discussed in Chapter 6. The purpose of the analysis is to assist with revealing how access to the subjects labelled in the first description as *MfT* and ME/MT are constituted through pedagogic communication in a specialist MTE lecture at CU, and *what* legitimate text is constituted within this context (i.e. what becomes recognised as instances of *MfT* and ME/MT). In this section I deepen the analysis and provide additional data to assist in recognising the pedagogic mode for this MTE practice.

I observed and recorded examples of teacher education classroom practice from one of the modules being taught by each of the three specialist lecturers at the time I was collecting

evidence at CU. I observed Mr/s X teaching a Curriculum 103 class; Mr/s Y team teaching a Statistics class (together with a post-Doctoral fellow who was at CU at that time); and Mr/s Z teaching a Linear Algebra class. While each of these reveal aspects of the practices being instituted at CU at that time, I made a decision to focus the in-depth analysis provided in this section on Mr/s X's practice, as it is recognised as an instance of what could be described as her dominant pedagogic practice. While this is a glimpse into one lecturer's practices, and is therefore limited, I argue that it does provide significant insight into the pedagogic mode that was being instituted in the teaching of ME/MT within the CU College mathematics department at that time. This is justified on two grounds.

Firstly, in section 3.1 it became apparent that the College mathematics department's privileged selections into the programme and privileged position on how to make these accessible to student teachers is most likely to be exemplified in the practice of Mr/s X. She leads the department and her position is clearly dominant. Other lecturers while having their own styles and interactions with students, work together with Mr/s X and ascribe (whether willingly or simply because they must change) to her broad ideological, professional and epistemic positioning in relation to what is to be privileged in the MTE curriculum. Secondly after working with the student data for this case it was also confirmed that all students selected as 'good' subjects identified themselves as mathematics teachers in terms of images produced through their interactions with Mr/s X. She appeared to be their role model for their conceptions of themselves as successful mathematics teachers¹⁶⁴.

While this analysis can only provide a glimpse of one aspect of practice in relation to a particular module, it does enable me to identify practices with which the students (as good subjects) strongly identified, and which can be used to strengthen, extend and deepen the interpretation of the pedagogic context provided in Section 3.1.

In this section I analyse a video record of a Curriculum 103 lecture. This lecture takes place over a double period (1½ h in length) with the second year B.Ed students¹⁶⁵. Although it is a single lesson, other evidence from interview material supports the conclusion that this is a good example of the pedagogic practice that is privileged by Mr/s X.

¹⁶⁴ See Chapter 10 for details.

¹⁶⁵ Nicole and Emmanuel are both in this class.

From the group interview with CU students I already had an image of Mr/s X's classroom/ lecture theatre as a place where "there is like lots of interaction" (Nicole, GVT1-CU-B.Ed) and where "you are gonna talk, you are gonna think" (Emmanuel, GVT1-CU-B.Ed). All interviews with students confirmed that classes within this practice (Curriculum 103) were mostly discussion based. The discussions in the classes generate home-work and practice teaching assignments (Emmanuel suggests in the first group interview that they go to these classes to "get assignments"). Mr/s X takes in work regularly and attempts to mark it fairly quickly so there is a reasonably fast response time¹⁶⁶. The focus of these tasks is always related to what they are doing in the class at the time and the evaluation of the tasks feeds back to create learning opportunities. As will be seen, this doxa is confirmed by the video analysis of this instance of Mr/s X's MTE practice.

3.2.1 Pedagogic evaluation at work in the IP of a Curriculum 103 lecture

The detailed analysis and coding of the transcript in terms of the methodology presented in Chapter 6 is presented in Appendix E.2. In this section the analysis is presented and interpreted. The terminology introduced in Chapter 6 (Section 5.3) is used. Explanations are not repeated.

1) General analysis of the pedagogic context and IP

The first thing to note is that the class is very small, 12 students altogether attend the lecture. The classroom is a flat space with movable desks arranged in a horseshoe shape so that all the students sit around the room and there is space for the lecturer to walk around the centre. There is a very relaxed atmosphere and the students interact easily with one another and with the lecturer. All relate to one another using first names. There are a number of late arrivals. These students simply come in sit down and enter into the classroom discourse. In general terms, classification of space and framing of social relations within the classroom are both weak.

A second feature to notice, in the movement of events across the duration of the lecture, is the changing pattern in the primary object of acquisition through the different sub-events, from

$$Mt \rightarrow Tm \rightarrow Mt \rightarrow Tm \rightarrow Tm \rightarrow Tm \rightarrow Mt,$$

as shown in Table 20. The IP moves from M as the major object of acquisition in the first third of the lecture, to T as the major object in the second third, and back to M in the final third. The

¹⁶⁶ Mr/s X did reveal that she was drowning in the marking and didn't feel she was returning marked work quickly enough, but did feel strongly that she needed to evaluate the work she gave students to do. It appears to be a mechanism through which she can ensure they are doing necessary work. It is noted that the numbers of students involved is small – if numbers increased this practice would be very difficult to sustain.

selection of M content is related to school mathematics, which is not surprising given the purpose of this module. The major resource for the first two thirds of the lecture, which moves through four events from E1 to E4, are ‘student productions’, i.e., examples of student work which are put up for scrutiny by the whole class.

Table 20: Movements in the object of acquisition across the IP of a Curriculum 103 class

Primary/secondary object	Sub-events	Duration of sub-events	Main resource used	Movement in pedagogic judgements	Comment
Mt	E 1.1 → E 1.4	30 min	student solution to word problem	R	all legitimating appeals made to M
Tm	E 2.1	1 min	L exposition – reflecting on E 1	E	appeal made to authority of L
Mt	E1.5	2 min	L exposition; L pulls together discussion (E1.1 to E.1.5)	N	meaning contingently fixed; criteria summarised by lecturer
Tm	E 2.2	2 min	L exposition – reflecting on E 1	E	major appeal made to authority of L
Tm	E 3.1	4 min	student's method for checking word problem	R begins	L sets up independent homework
Tm	E 4.1 → E4.3	22 min	students formulation of word problem	R	major legitimating appeals to experience or authority of L
Mt	E 5.1	30 min	L presents set of word problems to be solved	R begins	appeals made to M, L sets up independent homework work

It is noted that there is one point in the lecture where meaning is contingently fixed (N). This is in relation to M and the evaluation of a specific student solution, which acts as *an example* through which the legitimate text is to be recognised. While school M is an explicit object of acquisition in the first third of the lecture, and contingent necessity is established with respect to the example, the t object (which is the stated purpose of the module) is implicitly embedded in the IP through modelling (as will be shown below). At the same time, when the focus moves to the T object in the second third of the lecture, the event is closed before N is reached, and thus the recognition rules remain opaque and the possibility of student teachers realising the legitimate text is reduced.

The next comment is made in relation to the movement through different forms of pedagogic interactions in this pedagogic context. The results of the analysis are summarised in Table 21. It is noted that across the duration of events there are a spread of different forms of interactions, which open up different discursive spaces for pedagogizing knowledge. It is clear from the final line in the table that the dominant form of interaction involves student presentations and lecturer questioning. There is only one event (E2) in which these are not observed – and that is an insignificant event of very short duration. The IP here is based on

some presentation of a students work (e.g. in E1, Precious¹⁶⁷ puts up her solution and is asked to explain (present) her thinking in relation to this in E1.2, E1.3 and again in E3.1). The lecturer then assists the student to clarify their explanation by asking questions. The explanation elicited is summarised and then put it up for discussion by the whole class (we see this occurs in the two major events - E1 and E 4 – where the space is opened in the classroom) or used to set up further independent work that will be discussed at a later stage (as in E 3 and E4). The whole class discussion is characterised by various students making evaluative comments, punctuated by lecturer questions to push them to clarify their thinking and to move the discussion to include someone who does not easily volunteer their opinion. It is also punctuated by points at which what has been said is summarised (lecturer exposition), and this generally signals the start of a new sub-event, or a new event altogether.

Table 21: Forms of pedagogic interaction across events in the context of a Curriculum 103 Lecture at CU

	whole class discussion	small group discussion/ work	individual work	lecturer exposition	lecturer question and answer	student presentations	lecturer questioning	student questioning
Mathematics	4	2	2	1	0	3	5	0
Proportion sub-events (N=6)	66.7%	33.3%	33.3%	16.7%	0%	50%	83%	0%
Teaching	3	0	0	3	0	4	4	0
Proportion sub-events (N=7)	42.8%	0%	0%	42.8%	0%	57%	57%	0%
Mathematics & teaching	7	2	2	4	0	7	5	0
Proportion sub-events (N=13)	53.8%	15.4%	15.4%	30.8%	0%	53.8%	38.5	0%
No. events form used	2	2	2	3	0	4	4	0
Proportion of events (N=5)	40%	40%	40%	60%	0%	80%	80%	0%

This general pattern of interaction clearly supports earlier conclusions in Section 3 of this chapter, that is, internal framing with respect to social interaction is weak and the pedagogy appears to be discussion-based. In this specific case internal framing with respect to sequencing is also weakened, for example, after E1.4 the lecturer signalled the move to E2, however a student interjected and took the focus back to E1, which enabled the movement to E1.5 and the fixing of an instance of contingent necessity. While the lecturer clearly controls the selection of tasks and student responses that will be used, that is, the selection of contents, the framing of pace is generally weakened, although there are points where the lecturer firmly asserts control to move things on (e.g., after E3.1 is introduced).

¹⁶⁷ Refer to the discussion of the example of E1 in Chapter 6, Section 5.3.3.

A further point to be made, in relation to the forms of practice and the pedagogic space that these open, is that there are significant differences depending on the major object of acquisition. When M is the primary object in focus, we find that there is a broader spread of forms, including individual work (in E1.1, E5.1) and small group discussion/ work (also in E1.1 and E 5.1), and the proportion of whole class discussion and lecturer questioning is high. When T is the major object in focus, there are no instances of individual work or small group work observed, the proportion of whole class discussion and lecturer questioning are much lower, and the use of lecturer exposition is increased. Before interpreting these findings, I will now consider the spread of legitimating appeals across the various events in the IP.

A final point is that across the full 1½ h of the lecture, while the lecturer asked many questions to clarify thinking and move the discussion, student teachers did not ask a single non-trivial question. In addition no incidence of lecturer led question and answer sessions were observed.

2) *Legitimizing appeals in pedagogic evaluation*

A summary of the overall distribution of the legitimating appeals across all events/sub-events within the IP of the lecture is presented in Table 22.

Table 22: Summary of legitimating appeals across the IP of one Curriculum lecture

	Mathematics	Mathematics Education	Metaphorical/ everyday knowledge	Experience of either Lecturer or student teacher	Curriculum	Authority of the lecturer
Mathematics	6	0	0	0	0	0
Proportion of appeals (N=6)	100%	0%	0%	0%	0%	0%
Teaching	1	0	0	3	1	3
Proportion of appeals (N=7)	14.3%	0%	0%	42.8%	14.3%	42.8%
Mathematics & Teaching	7	0	0	3	1	3
Proportion of appeals (N=13)	53.5%	0%	0%	23.1%	7.7%	21.3%
Events in which appeals made	2	0	0	1	1	2
Proportion of events (N=5)	40%	0%	0%	20%	20%	40%

In the previous sub-section it was noted that there were differences in the forms of practice that structure the pedagogic spaces when M and T objects are respectively in focus. It is through considering the way evaluation operates that we will be able to interpret how these spaces work in pedagogizing knowledge (M/T) in this MTE classroom, and what constituted as *MfT* and *ME/MT* in this IP.

Considering the appeals across events in which M is the primary object, we see that in *all* cases *all* appeals are made to the field of mathematics itself – no appeals are made to ME texts/ everyday knowledge or metaphors/ the authority of the lecturer or a text. In the previous sub-section it was also noticed that while a judgement of contingent necessity was reached in E1¹⁶⁸, this was in relation to a specific example. However, it is noticed that the appeals to mathematics are grounded in appealing to the internal *logic* of mathematics itself. For example in E1.1 when the lecturer insists that the students produce *mathematically* convincing arguments to show which solution is correct, or in E1.2, where the lecturer insists the students must first evaluate Precious’ solution by considering whether it is algebraically correct (i.e. the technical aspects are correct in the move from line one to line two), and then moves to the translation from words to symbols, insisting that the students focus on the internal logic of the problem statement and assess whether or not the symbolic form correctly represents the mathematical relationship expressed. There is no appeal here to everyday meanings.

There was clearly a dual focus in E1. Working through Precious’ solution enabled the lecturer to *illustrate* an orientation to solving what is a relatively simple problem (in particular for those students who had clearly not successfully solved it, including Precious). At the same time it provided an opportunity to evaluate this particular solution, and so *illustrate* an orientation to “unpacking” a student production. The point being made here is that in both texts (orientation to solving *and* the orientation to evaluating the solution), are implicit; they are illustrated by the example. What is explicit is the example itself. This discussion also raises the point that while the primary focus of the event appeared to the students to be on mathematics, what was being illustrated through the IP was a specific instance of *M/T* and of MT itself.

In particular it became clear that while the students can appeal to mathematics as grounding, they did not appear to have access to any specific discursive resources from ME or MT with which to consider what had been illustrated. This raises questions around the possibilities of access to the central T message implicit in E1, part of which is explicitly asserted in E2, but never moves past the existence (E) into reflection (R) proper. In a sense the object of E1 was a teaching object that was disguised as a mathematical object. While symbolic resources were available for doing the mathematics in the example, the overall T message remains implicit

¹⁶⁸ Refer to Chapter 6, Section 5.3.3. Transcripts from this event formed the basis for the example presented there. The full analysis of the transcript can be found in Appendix E.3.

and there is a possibility it will only be read by those who are already ‘in the criteria’ since no discursive resources are brought in here to interrogate this and to produce meaning beyond the image/ model.

When moving to consider the events in which the focus was on T as the primary object, it is clear that the majority of legitimating appeals are made to experience (e.g. of students specifically in relation their own learning of mathematics and experience of the lecturer’s teaching as modelled during E 1), and to the authority of the lecturer. There is also a case where an appeal is made to mathematics (E3.1) and the school curriculum (E4.1). It is noticeable that *no* appeals are made to the discursive field of ME. We also note that in this case the pedagogic evaluation, as indicated in the previous section, while drawing on a wider range of appeals never fixes any contingent meaning. This reinforces the point raised in the previous paragraph and appears to confirm that ME/MT in this IP within the pedagogic context remains implicit and is not grounded in a symbolic/ discursive field.

3.2.2 Some insights into the pedagogic context and mode of pedagogic practice in MTE at CU

The analysis of this particular lecture enables us to get to a deeper understanding of how evaluation, with respect to ME/MT is working within the CU pedagogic context. In the previous section while we were able to get some purchase on the principles regulating the selection of discourses into the curriculum and regulating the recontextualisation of these within the pedagogic context, we were not able to recognise how evaluation was operating to open up the possibility of providing access to the recognition and realisation rules for (re)production of these privileged texts. In the this section we have examined, in a fair amount of detail, the operation of pedagogic evaluation within a specific example of pedagogic interaction taken form the Curriculum 103 module. While this analysis only enables us to make conclusions with respect to this single example, it does provide insight into how access to the legitimate text is structured.

This example confirms the earlier conclusion that Curriculum 103 works with a selection of school mathematics content as a means for developing a new (privileged) approach to teaching school mathematics, a discussion based-approach. In a sense this practice attempts to provide access to multiple texts: to provide a space for *relearning selections from school mathematics* (in a different way), to *model an approach to teaching* these selections, and to *provide a pedagogic space for developing ME/MT knowledge to enable practical realisations of this teaching approach*. A pedagogic space, primarily grounded in experience, is created for

reflecting on school mathematics learning and developing an approach to teaching and learning mathematics.

A key feature of this practice is seen in the *variation* of types of classroom interaction – this enables the opening up of pedagogic space in the MTE classroom context. Space is opened for an invisible pedagogy to operate that creates the possibility for different voices to be heard and evaluated. This is specifically enabled through the questioning that the lecturer uses to guide whole class discussions, small group work, and to interrogate the thinking involved in students' solutions. What is most illuminating within this context is the clear difference between pedagogic judgements in evaluating acquisition of mathematical texts as opposed to teaching texts.

In this particular slice into IP, we saw that when M was the primary object of acquisition, the grounds for legitimating or negating any particular possible realisation of the object/ text/ notion, was rooted within the field of mathematics itself. The authorising field for judging mathematical products is the discursive field of mathematics, based within the grammar of mathematics itself. Students were to voice their ideas, but they were to justify their positions with reference to convincing mathematical arguments. That is, they were to evaluate the productions through a mathematical gaze grounded in the discursive/symbolic domain of mathematics. In the pedagogic context of the lecture, a *selection of* students' (incorrect) work was a major resource for enabling reflection on what was to be acquired and for movement towards necessity through negation. The movement through the various evaluative events suggests a wider pattern, one in which the lecturer sets up work for students to do, and then in the next lecture uses their productions to enable access to the evaluative criteria for judging legitimate productions. While this is seen to be modelled through a particular example, it is possible that this is an iterative process that works over time through different examples to increase the possibility of access to fuller realisations of the mathematical object(s) in focus. It is also possible that this illustrates the type of mathematics leaning/ teaching that occurs in other M focused modules as well. Even though this analysis is of an ME/MT module, it privileges a particular form of M and of learning M.

On the other hand when T is the primary object of acquisition, while the practice *looks* similar, in that it follows the same patterns of interaction (putting up students' productions to examine possibilities of legitimate (re)production), the major grounds for evaluating any particular possibility is based in *experience*; the experiences of the student teachers themselves and of

the lecturer. In this specific slice of MTE practice, we saw that while particular realisations were put up for evaluation, the grounds for pedagogic judgement were diffuse and few discursive resources were available from the field of ME or education more generally to ground judgement. It was also apparent that there were linguistic resources required to which all students may not have had access. This tends to support the earlier suggestion that ME/MT within this pedagogic context are practical/ experiential accomplishments and that ME does not appear to be constituted as a field of study within this curriculum as a resource for reflexive interrogation of practice. By the end of this lecture, the recognition and realisation rules for the T objects that were the focus of acquisition remained implicit.

It is further noted that implicit within this M (ME/MT) learning/teaching practice is a *model* for ‘best’ practice in MT, which it is assumed, is a primary object of acquisition for the entire module. Aspects of this model do appear to surface as primary objects on occasions (for example in E 2 above), however the possibility of its acquisition is structured in the form of reflection on the practice that has been modelled, and in this particular case, the evaluative rules for the practice remain completely implicit. Discursive resources from the field of ME, while appearing to structure the practice, are not made explicit or used to reflexively interrogate the model.

In the sections of this particular lecture where M is the primary object, framing is relatively weak in terms of sequence and pacing – but overall selection and evaluative criteria are controlled quite firmly by lecturer. For example, while what gets to be put up on the board is generated by the class discussion and the productions that students come up with, the lecturer selects this from what has been generated (she does not for example, ask for a volunteer). The lecturer steers the conversation (in the events where the focus is on M) through the way in which evaluation takes place in the classroom – she steers things in such a way that there is no question about what is a legitimate reproduction and an illegitimate reproduction. What is incorrect is clearly negated and replaced by a correct production. Thus the criteria are fairly strongly framed, the grounding is clear – it is to be authorised from within mathematics itself. However, the pacing and the sequencing is relatively weak with students input being a critical factor in how the focus moves from event to event. Social relations are flattened and students and the lecturer interact within the context as knowledgeable participants. An invisible pedagogy operates in which it appears that the students’ have considerable control, however, the context is closely managed by the lecturer who keeps the direction and creates pedagogic space for access to recognition and realisation rules. The instructional discourse is clearly

embedded in a regulative discourse that values students thinking and works with the ideas produced by the class. The lecturer is modelling a way of teaching through listening to students thinking and working with their productions to legitimate certain ways of thinking and doing and negate others. This is both at the instructional and at the regulative levels.

In the parts of the lecture focussed on T a similar pedagogy is implemented – however the framing of evaluative rule now appears to be weak – the grounding is not firm; things may or may not be accepted and the grounds upon which this is to be decided are not clear. The knowledge base for acquisition is opaque, but at the same time is taken for granted. Experience belongs to all and all experience is valid.

The practice appears to fit fairly well with the description of a competence-based pedagogic modality described by Bernstein. In particular with respect to the M objects of acquisition it appears to be informed by a constructivist pedagogy that focuses on students building knowledge of school mathematics through negotiation of their sensible ideas and thus creating the possibility for the acquisition of a specialised mathematical voice. In other words, a form of pedagogic constructivism is operating to create the possibility of acquisition of a legitimate text for which evaluative rules are clearly located within the contents and grammar of the discipline. On the other hand with respect to T texts (ME/MT) it appears that acquisition is structured through a form of constructivism in which the evaluative rules are implicit and knowledge is localised and based on experience. Thus the possibility is that ME/MT knowledge and practices will be differentially distributed across different groups. It is also probable that substantial discursive resources, even through they may be structuring the pedagogic interaction and there is an attempt to recontextualise them into the pedagogic context in various ways, may remain implicit and so not available for developing reflexive competence in the field of mathematics teaching practice.

3.3 Assessment and evaluation

The analysis of the pedagogic context in the previous section produces a description of *MfT* that arguably represents a dominant pedagogic mode for the maths specialist modules at CU. The specific example of interactional practice is from a Curriculum module rather than a mathematics module, nevertheless it is suggested, on the basis of interview material, this might represent a wider modality than one limited to the specific pedagogic context of Curriculum 103, which on the surface might be expected to represent learning in mathematics education or mathematics teaching. To get a deeper picture of what is constructed as the

legitimate text for the various discourses circulating more broadly throughout different specialist modules it is necessary to examine examples of formal assessments – it is here that the evaluative rule in operation will be at its most condensed.

It is noted that that assessment tasks examined here are not a full set of assessments from all modules and the sample of items/activities analysed is limited by what was provided by lecturers during the site visit (see Table 23).

Table 23: List of formal assessments in the archive

Module name	Assessment type	No	Purpose	No eval items
Maths for Teaching 101	Tutorials	3	Formative	26
	Assignments	1	Formative	1
	Final examination	1	Summative	9
Maths for Teaching 103	Assignments	4	Formative	8
	Final examination	1	Summative	10
Maths for Teaching 104	Tutorials	9	Formative	50
	Class tests	2	Summative	9
Applied Maths 101	Computer lab	1	Formative	1
	Assignments	2	Formative	9
	Class Tests	3	Summative	10
Applied Maths 102	Spread sheet tasks	2	Formative	4
	Portfolio items	1	Formative	4
	Assignments	1	Formative	1
	Tutorials	2	Formative	25
	Class tests	1	Summative	8
Curriculum 103	Class Assignments	2	Formative	2
	Class work task	1	Formative	2
	Report	1	Formative	1
	Mini lesson	1	Formative	1
	T P assignments	2	Formative	10
	Major test (midyear)	1	Summative	4

Nevertheless, the examples provided do give an insight into what is privileged and how the legitimate text for the production of the ‘good subject’ is constituted within this teacher education programme. Formal assessment items collected included a number of different assessment types (such as, tutorials, assignments, tests, portfolio tasks and examinations) that are marked by lecturers and ‘count’ in some way towards the final result for the modules. Examples of a range of such items were collected for 6 modules: Maths for Teaching 101, 103 and 104, Applied Maths 101 and 102, and Curriculum 103.

As can be seen in Table 23 there are both formative (tutorials, tasks and assignments) and summative (tests and examinations) assessment items included in the archive. It is noted the various types of assessments from each module had different elements and parts. They were therefore not considered as ‘wholes’. Rather each one was considered in terms its internal structure and was chunked into ‘evaluative items’. That is, into individual items used to assess a coherent aspect. In this way the assessments for the whole module were divided into individual evaluative items (assessment tasks).

While the sample is limited, all examples contained in the archive are considered in the analysis that follows so as to give as full a picture of the way in which the legitimate texts for the various modules are constituted. That is, all the texts that students are expected to (re)produce across different types of formal assessment items provided by lecturers are analysed.

It is important to remember that my interest is in trying to describe how different organisations of knowledge in a curriculum might specialise the consciousness of the pedagogic subject differently. I have already indicated that at CU there appears to be a particular view of *MfT* as a key element of the curriculum and that this is connected to a discussion-based pedagogy that privileges conceptual understanding and mathematical processes and practices. This conception was evident in both the discussions with lecturers as well as with students selected as ‘good’ subjects of the institution and also visible in the MTE class observed. I now move to consider whether or not this carries into the formal assessments collected in the archive.

The analysis of the archived tasks leads to new dimensions being added to the previous description and to a refining/ expansion of what is meant by *MfT* within this context. In particular we find that while in pedagogic interaction it appears that mathematical practices are highly valued, specifically the need to argue convincingly on mathematical grounds for any particular production, this is not as strongly evidenced within the formal assessment items, which in the mathematics modules appear to favour the (re)production of more *procedural* elaborations as much as they do *principled* elaborations of mathematical knowledge and texts (following Dowling, 1998). The nature of this elaboration is interesting and enables a finer description of how *MfT* is constituted at CU. In the next section I present the overall analysis and interpretation of the assessment tasks collected from CU.

3.3.1 Analysis of formal assessment tasks across CU modules

All tasks in the archive were analysed using the methodology discussed in Chapter 6. Many of the examples of assessment tasks were presented in Chapter 6 (Section 5.4) and these are not repeated here. In addition the terminology explained in Chapter 6 is not repeated here. The full analysis of each module and the items within it is summarised in Appendix E.3 Table 6. Appendix E.3 also contains Table 7 a condensed summary of all items analysed.

The first thing to note in the table is the wide spread of assessment items that were found in the CU sample. Twelve different types of assessment items were recognised. In what follows I consider two specific aspects: (1) the spread of items across different modules, which will give us some insight into the construction of valued legitimate texts within different modules and across the pedagogic context as a whole; and (2) differences in the nature of the items within a particular type, which gives insight into how learning *MfT* is structured across the various modules.

1) *The spread of items across different modules*

The module that had the widest spread of items is the Curriculum 103 module, as summarised in Table 24 below. Nine different item types were recognised. We notice that while there are some tasks that focus entirely on T as the primary object, the majority of tasks involve combinations of M and T. None of the tasks focus entirely on M. This supports the previous conclusion that this module is relatively weakly classified with respect to the specialist aspects of the curriculum and integrates aspects of M, ME and MT.

Table 24: Summary of analysis of all assessment items selected from the Curriculum 103 module at CU

Module Name (Lecturer X, Y, Z)	No of events	M ⁺	M ⁻	T _k ⁺	T _e ⁺	T ⁻	M ⁺ T _k ⁺	M ⁺ T _e ⁺	M ⁺ T ⁻	M ⁻ T _k ⁺	M ⁻ T _e ⁺	M ⁻ T ⁻	T _k ⁺ M ⁺	T _e ⁺ M ⁺	T ⁻ M ⁺	T _k ⁺ M ⁻	T _e ⁺ M ⁻	T ⁻ M ⁻
Curriculum 103 (X)	20			2	1		1		1			1	2	8		1	3	
% (N=20)	100			10.0	5.0		5.0		5.0			5.0	10.0	40.0		5.0	15.0	

40% of the tasks analysed from the module are of type T_e⁺M⁺. The remaining tasks are spread across the other 8 types (each between 5% and 15% of the total items). This provides support for the conclusion made in the previous section that the grounds for legitimating mathematics teaching texts (T) are more experiential than discursive. That is, discursive texts from the field of ME are not the major resource for constructing pedagogic arguments; it is experience that is valued the most. It also supports the conclusion that while the focus of the module is on teaching the school curriculum, these selections of school mathematics are ‘unpacked’. That

is, when mathematics is considered in the reproduction of a task that is dominantly pedagogic, the mathematics itself is also a serious concern and (re)production of syllogistic arguments with respect to this aspect of the task is expected. The mathematics itself may not be the main object of acquisition in these tasks, but it is not taken-for-granted, a mere 'that'. To examine how ME discursive texts are implicated in this pedagogic context, it is necessary to consider other items analysed for the module.

The remaining task types analysed in the sample from the Curriculum 103 module included: $T_e^+m^-$ (15%), T_k^+ (10%), $T_k^+m^+$ (10%), T_e^+ (5%), $T_k^+m^-$ (5%), $M^+t_k^+$ (5%), M^+t^- (5%) and M^-t^- (5%). Two things jump out immediately from this list. First, none of the tasks focus on only M. This is not surprising, given the purpose of this module. Secondly, how few tasks (5 %) require application of simple procedures (M^-/m^-) or recall of specific texts (T^-/t^-), that is, where no argument needs to be constructed at all. This points to a significant aspect of this MTE practice, and supports a comment made by Emmanuel, "you gonna think" (GVT1-CU-B.Ed). The practice expects student teachers to think deeply and to produce non trivial arguments. However, what is not visible from this is how the assessment items are structured, and so how access to these is enabled. In other words, what does it mean in this context to 'produce' arguments? This will be discussed in the section that follows.

If we consider *all* tasks that require pedagogic arguments based in the discursive domain of ME, MT or education more broadly, we find that this makes up 30% of the total. 25% of these have T_k as the primary object. This indicates that a significant proportion of the tasks for this module *do* require the student teachers to engage with discursive texts. That is, there is the possibility of some access to ME and/ MT as fields of study, and there is more of a balance between experiential and academic knowledge than was visible in the analysis of IP in the previous section. What this analysis is unable to show however, is the extent to which these discursive resources are accessed through recontextualised notes/ talk from the lecturer or through access to texts themselves. That is, how access to this discursive base is distributed.

To summarise, the analysis of the Curriculum 103 assessment items confirms that this module is integrated with respect to M, ME and MT. While T is clearly a major focus, school mathematics is engaged with through working in principled rather than procedural ways. There is a clear leaning towards learning from experience as a basis for constituting legitimate ME/MT texts. However, this is balanced by the possibility of access to discursive texts from

the field of ME and MT. How these are made available is not visible from this part of the analysis.

I now move to consider the mathematics focused modules, where the spread of tasks is much narrower. A condensed summary of the analysis across all these modules is provided in Table 25.

Table 25: Summary of analysis of all assessment items selected from Maths for Teaching and Applied Maths modules at CU

Module Name (Lecturer X, Y, Z)	No of events	M+	M-	T _k ⁺	T _e ⁺	T-	M _k ⁺	M _e ⁺	M _t ⁺	M _k ⁻	M _e ⁻	M _t ⁻	T _k ⁺ M ⁺	T _e ⁺ M ⁺	T _k ⁺ M ⁻	T _e ⁺ M ⁻	T _k ⁻ M ⁻
M for T 101 (Functions and Algebra) (X)	36	13	21						2								
% (N=36)	100	36.1	58.3						5.5								
M for T 103 (Calculus) (X)	18	9	8						1								
% (N= 18)	100	50.0	44.4						5.6								
M for T 104 (Linear Algebra) (Z)	59	3	53						2			1					
% (N=59)	100	5.1	89.8						3.3			1.7					
Applied Maths 101 (Statistics) (Y)	20	6	14														
% (N=20)	100	30.0	70.0														
Applied Maths 102 (Financial Maths) (X)	42	6	30						2					3			1
% (N=42)	100	14.3	71.4						4.7					7.1			2.3
All M	175	37	126						7			1		3			1
% All M (N=175)		21.1	72						4.0			0.6		1.7			0.6

The summary supports an earlier suggestion that while there is awareness that students will become teachers, these modules focus primarily on mathematics. The first thing to note is the vast majority (about 94%) of all items across mathematics focused modules have only one object of acquisition, which unsurprisingly is M. Across the modules there is an insignificant focus on T, with only one item having this as a primary object. This was in the Financial

Mathematics module and the particular task was concerned with *informing* student teachers about aspects of financial mathematics across the NCS for mathematics and mathematical literacy. So while the task did not expect any pedagogic or mathematical arguments to be constructed, its purpose was to ensure students become familiar with an aspect of the curriculum that is entirely new. All other items that included t as a secondary object did not focus on t in-and-for-itself, but rather to insert a virtual pedagogic subject as a device for getting the student to produce their argument (i.e., t^*).

Secondly, we notice that the majority of tasks are of type M^- (72% across all M focused modules). That is, tasks which require procedural reproduction of some kind or another. Less than a quarter (21,1%) of the tasks demand the production of principled arguments through chains of syllogistic reasoning. This does indicate that there is a major focus on procedural fluency across M modules. However, when we consider the individual modules we notice that this is differentiated. It is instructive that the module with the highest proportion of procedural¹⁶⁹ type tasks is Linear Algebra (89.8%). This module also has a low proportion of ‘unpacking’ type tasks (only 5.1% M^+ , and 3.3% M^+t^* , a total of 8.4%). This supports the earlier conclusion that Mr/s Z’s practices, in this case represented by Linear Algebra tasks, are different from the other two lecturers.

Two modules in particular, Functions and Algebra, and Calculus, are significantly different from the others. In both these cases, there is more of a balance between M^+ and M^- type tasks. (In the Functions and Algebra: 41,6% M^+ (36,1% M^+ and 5.5% M^+t^*) and 58.3% M^- ; in Calculus 55.6% M^+ (50% M^+ and 5.6% M^+t^*) and 44.4% M^- . Both these modules are taught by Mr/s X and reflect a practice that focuses on learning mathematics through ‘unpacking’.

It is important to remember that these are the two modules that are taught to the B.Ed students in their first and second year of study. This confirms an earlier suggestion that the direction of the College mathematics department is moving towards a focus which privileges conceptual understanding in mathematics more, and less on procedural reproduction of mathematical forms. This may be the case early on in the novice mathematics teachers’ studies where, as Mr/s X clearly indicated, the focus is on learning mathematics differently. The final two

¹⁶⁹ Remember that this does not necessarily mean these are easy tasks or that students who manage to complete them do not have access to the deeper levels of conceptual understanding that structure them. All this indicates is that they could be reproduced through applying a step by step process learnt without necessarily understanding the mathematical bases for the steps. They do not need to demonstrate this understanding in (re)producing a legitimate response.

Applied Mathematics modules, offered to the HDE students in 2004, are more oriented towards procedural tasks¹⁷⁰.

While the above analysis gives us some idea about the balance between M and T and between procedural reproductive tasks ('compressed' tasks) and those requiring the production of a mathematical or pedagogical argument ('unpacking' tasks), it cannot reveal anything about the nature of the 'compression' or 'unpacking', and therefore how access to these forms of M and T are structured in the pedagogic context, i.e. how learning is structured across the various modules and how what was earlier described as *MfT* is constituted over the mathematically focused and teaching focused modules. This is considered in the next sub-section.

2) *The nature of different assessment items found at CU: compaction and scaffolding*

In the process of applying the methodological framework as described in Chapter 6, I found that it was possible to further differentiate between different forms of assessment, that is, add categories of differentiation to those incorporated into the model. This would give insight into the structuring of access to different forms of knowledge within the pedagogic context (i.e., to how knowledge is pedagogized within the recontextualising field as it operates within a particular institution)¹⁷¹. While I have not gone back to extend the original model, since I found that it was not necessary to do that for this project, this realisation did produce a deeper level of analysis of the CU pedagogic context that is reported here.

During the analysis of M^+ and M^- type tasks, across the various mathematically focused modules it became apparent that across different assessment items there were variations in the structuring of the tasks that produced differential possibilities of access to recognition and realisation rules for producing the legitimate texts. This enabled insights into the nature of access within the pedagogic context, and provided some evidence for what is constituted as 'unpacking' in relation to learning *MfT* within this pedagogic context. I will describe this through recruiting some examples from the archive.

The first example to consider is reproduced in Figure 25. This is classified as an M^+ task since it demands a full explanation which requires an 'unpacking' of the meaning of the abstract

¹⁷⁰ We could speculate on the reasons for this, as there is not direct evidence. This could be partially due to the fact that these are both entirely new aspect of the curriculum, and so these students have had not prior experience of either of these.

¹⁷¹ This could lead to the further development of the model (external language of description) produced for analysing assessments in the MTE context, and presents an example of the possibility of methodological and theoretical developments within the discursive gap.

symbolic form, $\underline{u} \cdot \underline{u} = \|\underline{u}\|^2$. It is noted that a student who does not recognise the requirement of the task (i.e. does not possess the recognition rule for what it means to ‘discuss fully’ in this instance) may be unable to realise the expected response. No assistance is given to the student in the structuring of the item. The question assesses the students’ ability to recognise *and* realise the legitimate text. The task is presented in a *compact* form. There is no scaffolding in the question to guide the student through what is expected. This is typical of the few M^+ tasks found amongst the Linear Algebra assessment tasks.

6. Is it possible for $\underline{u} \cdot \underline{u} = \|\underline{u}\|^2$? Discuss fully.

Figure 25: An M^+ type task from the Linear Algebra module (assessed Tutorial 3)

It is noted that there are very few such highly compact ‘unpacking’ tasks in other mathematics modules. In most cases, the questions are *broken up into parts* and students are *guided* through the expectations. In other words the tasks are structured in such a way as to assist the student to recognise the context, and so enable easier access to what is required in terms of realising the expected text. The task in Figure 17 that was used to illustrate M^+ tasks in the methodology section (Chapter 6, p 217), while requiring the production of an argument, appears in a less compact form, than that in Figure 25 above. As discussed in the methodology, it provides a context which orientates the student to the requirements.

A further example of an even *less compact* M^+ type task is the guided tutorial task from the Functions and Algebra module shown in Figure 26.

- 7) Work on the same set of axes that you used in (1)
 What happens if we swop x and y: e.g. $x = 2^y$
- a) Draw the following graphs on the axes.
 - i. $x = 2^y$
 - ii. $x = 3^y$
 - iii. $x = 4^y$
 - b) Compare the graphs of
 - $y = 2^x$ and $x = 2^y$
 - $y = 3^x$ and $x = 3^y$
 - $y = 4^x$ and $x = 4^y$
 - i. What is the same?
 - ii. What is different?
 - iii. What causes the “sameness”?
 - iv. What causes the “difference”?
 - c) Write down the equations of the graphs in a) in the form $y = \dots$

Figure 26: An M^+ type of task from Maths for Teaching 101 (assessed Tutorial)

The question is recognised as an M^+ task. While part a) and c) could be seen as procedural, the demands in b) requires the student to unpack the graphical forms, moving beyond recognition of pattern to give an argument for what causes the changes evident in the graph of the function and its inverse. The argument can be judged on whether or not it is mathematically principled. This is a task that has a detailed scaffold to guide the students through the processes needed to access concepts connected to functions and their inverses, in particular through answering the question what *causes* the “sameness” and “differences” when comparing their graphical representations. That this is an assessed tutorial task (using Geometer’s Sketchpad) is significant. As a formative assessment this provides a greater possibility of access to recognition and realisation rules for the legitimate text than if it were a more compact task structured along the lines of the one in Figure 25. If this were to be used as summative assessment however, the over structuring of the task would not enable assessment of the recognition rule, and while it would still ‘look like’ a task that requires the production of argument, it could become a procedural task checking whether the argument had been learnt or not.

The example in Figure 27, also classified as an M^+ task, comes from a final examination, and therefore is a summative assessment. In this question the student is expected to ‘unpack’ the ‘Squeeze Theorem’. Students are required to *explain* aspects of the theorem, not to reproduce it. Note how the question is structured to take students through the process. Most M^+ type tasks in the summative examination for the Calculus module provided similarly detailed scaffolds to assist the students to (re)produce their responses.

9) This question focuses on $\lim_{\theta \rightarrow 2} \frac{\sin \theta}{\theta} = 1$.

- a) We make use of the Squeeze Theorem to prove $\lim_{\theta \rightarrow 2} \frac{\sin \theta}{\theta} = 1$. The Squeeze Theorem states that:

“If c lies on an open interval $(a;b)$ and $h(x) \leq f(x) \leq g(x)$ for all x on $(a;b)$, except possibly at c , and if $\lim_{x \rightarrow c} h(x) = L = \lim_{x \rightarrow c} g(x)$ then $\lim_{x \rightarrow c} f(x)$ exists and is equal to L ”

Explain the main aspects of the Squeeze Theorem. Use a diagram to illustrate your explanation.

- b) Part of the proof of $\lim_{\theta \rightarrow 2} \frac{\sin \theta}{\theta} = 1$ is given in Fig.2 in the Appendix.
- Look at line 2. Explain in detail how the three expressions are obtained from the diagram. Draw on the diagram if necessary but write your answer in your answer book too. (6)
 - How is line 3 obtained from line 2? (1)
 - In line 4 the inequality signs “swop around”. Why does this happen? (1)
- c) Continue the proof to show that the inequality in line 4 holds for all non-zero values of θ in the open interval $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$. Explain all statements that you make. (3)
- d) Now explain how the Squeeze Theorem is used to prove $\lim_{\theta \rightarrow 2} \frac{\sin \theta}{\theta} = 1$. (3)

[20]

Figure 27: An M^+ type of task from the Calculus module (June Examination)

All the examples of M^+ type tasks given above require the production of a principled explanation or argument. However it is clear that they are not all exactly the same in nature – there are differences in the demands made on the acquirer in terms of the levels of independent thinking and cognitive demand required in order to recognise and realise the requirements of the task.

In the latter example, a great deal of explanation is required. In a compact form this question might begin with a) as it is, and then move to:

- b) Use the Squeeze Theorem to prove $\lim_{\theta \rightarrow 2} \frac{\sin \theta}{\theta} = 1$. Use a diagram. Provide a detailed explanation for each step in the proof.

Notice that in this more ‘compact’ form, in order to (re)produce the legitimate text, the demand would require that the proof itself be reconstructed and that full explanations (that are structured in the task as it stands) are also required. To realise this, the student would have to recognise that they need to not only reproduce the proof (which could be “learnt by heart”) but also to *independently* ‘unpack’ the proof, a very high cognitive demand. Access to the full mathematical text and its meaning would be required. In a sense the structuring of this task

alleviates the mathematical demand – it provides a text and asks for it to be ‘read’. The mathematics has been ‘unpacked’ in the structuring of the question, and the requirements have been so elaborated that the level of argument required is substantially reduced. If students have worked through this beforehand, the response could be learnt ‘by heart’ and reproduced here.

Compaction and scaffolding of assessment tasks was not only recognised in M^+ type items found in the CU archive. M^- type tasks also varied across different modules, appearing in a range of forms from highly compact to highly scaffolded. Figure 28 is an example of a highly compact form of an M^- task. It is noted that while questions of this type are found in all the M focused modules, they are most dominant in the Linear Algebra module (90% of items in the sample for the module), and far less common in the other modules for which assessments are available, for example in the Calculus module (where they appear in only 3 out of 18 items - that is, in 17% of the questions).

3)	Determine the following integrals. Express all answers with positive exponents	
a)	$\int \frac{3 + 2x^2}{x^2} dx$	(3)
b)	$\int \sin A^4 \cos A dA$	(3)
c)	$\int \frac{3t^2}{(2t^3 + 5)^2} dt$	(4)

Figure 28: An M^- type task from Maths for Teaching 103 (June Exam 2004)

Many tasks in the other maths specific modules appear less ‘compact’, in that they are broken up into parts providing a scaffold for the legitimate production. However they are still recognised as M^- type tasks because they require application of procedures or processes without the demand for a reasoned argument or explanation that would necessarily involve an unpacking of the underlying meaning. Figure 29 provides an example of such a task.

- 3) Consider the function $f(x) = -x^2 - 7x$. The graph has been drawn in fig. B.
- a) Reflect the graph of f in the x -axis. Label the new graph $g(x)$.
 - i) Draw the graph of g on fig. B.
 - ii) Write down the equation of g .
 - b) Translate the **graph of f** , 2 units to the left. Label the new function $h(x)$.
 - i) Draw the graph of h on fig. B. Show the intercepts with the x -axis.
 - ii) Determine the equation of h . Write your answer in the form $y = ax^2 + bx = c$
 - c) f^{-1} is the inverse of f .
 - i) Draw the graph of f^{-1} on fig. B.
 - ii) Determine the equation of f . Write your answer in the form $y = \dots$

Figure 29: An M^- type task from Maths for Teaching 101 (June Exam 2004)

Here we see that there is no demand for argument or explanation that would reveal underlying meaning or conceptual understanding, yet the task itself is structured into parts that lead the student through a series of processes. The structure of the assessment item provides a scaffold for the reproductive task – it ‘unpacks’ the requirements. In a more compact form the demand would include that the students “unpack” the requirements themselves and would assess their ability to do so. Overall in the archive of tasks for CU, these structured procedural tasks are the most typical.

The above discussion suggests it may be productive to expand the analytic space for distinguishing between different M^+ and M^- tasks in future analyses of assessment tasks. For example, one could distinguish between types of M^- task that are fully “compressed”, that is are ‘compact’ with no or little scaffolding, and the type of tasks that are expanded and structured through a scaffold that lead/ or guide students through the requirements. Similarly one could distinguish between M^+ type tasks that are compact or scaffolded. As a general methodology for considering other assessment tasks the analytic space could be expanded to include, for example $M_{c/s}^+$ and $M_{c/s}^-$ type tasks (i.e. compact/ scaffolded tasks that require chains of syllogistic argument to produce the legitimate text, and compact/ scaffolded tasks that require procedural reproduction to produce the legitimate text). It also suggests that the metaphorical terminology of “compression” and “unpacking” used by Ball and Bass (2000) may not be as useful as it seemed at first.

In considering the other types of tasks in the sample, it became clear that scaffolding questions to enable access was a common feature of all modules other than the Linear Algebra module. For example, **Figure 19** in Chapter 6 presented a compact M^+t^- task, whereas, **Figure 30** below is scaffolded. In both cases the presence of the ‘learner’ has no bearing on the requirements of the task, however we notice the brevity of the former task (from the Linear Algebra module)

when compared to latter (taken from the Calculus module) where expectations are made explicit through the scaffold given for the response.

8) A Grade 12 learner says:
"I know about limits. You just have to substitute the value into the expression.
For example $\lim_{x \rightarrow -1} 3x^2 - 7x = 3(-1)^2 - 7(-1) = 10$ "

a) The Grade 12 learner's statement suggests that she may not fully understand the **concept** of a limit as it applies to functions.
Choose a suitable example to explain to her the concept of a limit.

- Focus on the limit of a function at a particular x-value
- Choose an example of a function where you cannot find the limit by **direct** substitution
- Illustrate your example with numerical values in the form of a table and also draw a graph

Figure 30: An M⁺t type task from Maths for Teaching 103 (June Examination, emphasis in original)

What can we conclude from this structuring of assessment tasks? It is clear that regardless of whether the construction of a reasoned argument is required or the reproduction of a procedure or piece of information, the dominant structuring of assessment tasks in the CU pedagogic context involves introducing scaffolds to guide students to legitimate responses. In other words it appears that access to the criteria for producing a legitimate response is highly structured within the task. This can be seen as a ‘good’ practice in the sense of making explicit the evaluation criteria for any particular task, that is, it attempts to make explicit the recognition and realisation rules for legitimate (re)production. However, it also has the possibility, particularly if summative assessments are over structured, of limiting cognitive requirements of students and thus changing the cognitive demand of tasks. In some cases the demands can be reduced to such an extent that the task no longer evaluates access to the recognition and realisation rules of the full text – but rather to the ability to read small chunks of the text, bite-sized pieces of knowledge that may not require sustained intellectual work. For example, if the overall task requires an argument, but the structuring of it into parts reproduces all the links for the reasoning required, then it is possible that the task changes from something that would require principled reasoning in a more compact form, to something that ‘looks like’ it requires such reasoning. That is, it is so over structured that it becomes procedural.

In the CU context the evidence seems to point to a practice in which “unpacking” of a mathematical text in order to get to deeper understanding is valued. However the unpacking

may sometimes be so over elaborated that it is not clear that the possibility of access to full texts is expected. It is also clear that in this pedagogic context, “unpacking” not only refers to opening up the underlying meaning of mathematical texts, it also is related to ‘breaking up’ complex mathematical tasks and procedures into smaller pieces which can be more easily accessed. While it is not clear what the consequences of this are, it is possible that such over structuring could lead to lower cognitive demand and thus may limit access to the development of, what Kilpatrick et al. (2001) referred to as adaptive reasoning and strategic competence.

The use of scaffolding to structure assessments within this context is recognised as a central pedagogic resource for enabling access to mathematics learning, particularly in the formative stages of learning. How the scaffold is structured will be crucial in relation to the quality of learning enabled. The danger is that mathematical expectations of student teachers is lowered through over structuring the scaffold, and so producing a situation in which it appears that students have access to texts, however independent and insightful thinking and the possibility of access to complex mathematical realisations may be curtailed. If students are never expected to do the creative work to produce the links and arguments independently, and summative assessments do not evaluate their ability to realise the (re)production of such arguments, then what they will have access to are the steps of procedures in the scaffold rather than the processes, practices and a substantive knowledge base.

3.3.2 Some conclusions from the analysis of formal assessments from CU

The analysis of formal assessment provides further insight into the ‘*what* and *how*’ of pedagogic discourse(s) for MTE constituted within the pedagogic context of CU. In particular it suggests a MTE practice in which access to a wide range of M and ME/MT texts are formally assessed. Formative assessments are used extensively to enable the possibility of access to these various forms of knowledge.

The analysis suggests that in relation to mathematics discourses, access is evaluated through a range of assessment types, including those that demand the demonstration of application or reproduction of more procedural forms of knowledge as well as those that demand the production of more principled arguments. These are not evenly spread over all modules. This confirms an earlier finding that in the module taught by Mr/s Z the selection of contents and the orientation to mathematics learning is significantly different to what occurs in other modules. In the Linear Algebra module, there is a significant focus on the acquisition and

reproduction of specific mathematical texts. These assessments generally assess the students' ability to correctly/ fluently work with the mathematical forms, and to recognise and realise the requirements of given tasks. These assessments would be recognised as fairly common tasks assessing the acquisition of mathematical forms in a 'pure' mathematics class. Mathematics in this practice is focused on access to given texts within the field of mathematics. All tasks are presented in compact form and require the student to independently demonstrate their acquisition of the criteria for the legitimate texts.

In all other mathematics focussed modules for which assessments are available, there is more of a balance between different types of tasks, which supports the view that in this practice, valued mathematical texts include those in which students are required not only to demonstrate the ability to apply mathematical forms and use procedures to reproduce legitimate texts, but also to provide arguments which reveal deeper levels of conceptual understanding, and the ability to read behind the algorithms/ procedures/ texts. This is indicative of an orientation to learning and teaching mathematics *differently*, that is, an orientation that requires student teachers to provide convincing mathematical arguments that are grounded within the principles of the field.

However, a further feature of these dominant assessment forms is their structuring, which tends towards breaking up tasks so that the requirements are made more visible. That is, there is a tendency to scaffold the tasks in a way which leads the student through the processes required to produce the legitimate text. While this has the potential to be very productive, particularly in formative assessments where student are lead through processes which enable them to 'unpack' underlying meaning, it also has the possibility, in summative assessment tasks to mask levels of access to recognition and realisation rules and the potential to reduce what should be productive realisations of principled texts into procedural guided reconstructions.

The analysis of assessment tasks also provides some evidence to back the previous interpretation that ME and MT are integrated, often more like horizontal discourses produced on the basis of experiences of learning and teaching mathematics. However, it is clear that students are also required to produce pedagogic arguments and not simply reproduce descriptions of practice. There is also some evidence that they are provided with access to more discursive resources within the field of ME and/or MT, however, how this access is structured has not been revealed.

4 The characteristics of the institutions ‘good’ subject

The analyses of curriculum, pedagogy and assessment that have been in focus in this chapter provide the basis for an interpretation of the principles which structure the selection, recontextualisation and evaluation of pedagogic discourses, for specialising the consciousness and conscience of mathematics teachers, within the pedagogic context of MTE at CU. These analyses can be reflected back on the pre-interpreted domain (the basis for the discussion in Section 2 of this chapter) and be reinterpreted to assist with a description of the characteristics of ‘good’ subject(s) of the institution. This is done here on two levels: 1) the features of M, ME and MT as subjects (specialised knowledge discourses and practices) to be acquired within the pedagogic context, and 2) the specialised pedagogic identities (ideal images of the pedagogic subjects or mathematics teachers) that these discourses project.

4.1 M, ME and MT (for mathematics teachers) at CU

In this subsection I synthesise descriptions of the forms of M, ME and MT that are legitimated within CU’s pedagogic context, and some features of the pedagogic discourses through which these are communicated. This arises out of the analyses contained in the previous sections.

Mathematics is constructed as a specialised domain for teaching at CU. It is seen as distinct from the kind of disciplinary knowledge that mathematicians would teach to general students in university mathematics departments. It is a specific selection from the field of pure mathematics (traditionally taught at the university) and school mathematics (traditionally taught in schools). These selections include introductions to applied mathematics, mathematical statistics and financial mathematics, which were not traditionally taught in SA schools but that are included in the new NCSM. The selection is based on an interpretation of what novice teachers will need when they go out to teach the new school curriculum, and to some extent, cover all aspects of the NCSM. The rationale for selection is that novice teachers have the opportunity to relearn old (school) mathematics in new ways: so that they not only to know how to ‘do’ this mathematics but also why it works that way. There is also the opportunity to learn new mathematics (both school level and, to a more limited extent, university level) in these new ways.

These mathematical contents are constituted through a pedagogic discourse that appear to values relational over instrumental understanding, and emphasise conceptual understanding over procedural fluency; it values discussion-based learning, connected knowledge and conceptual understanding and is structured through a view of MTE that is relatively strongly

framed by a discourse that privileges “unpacking” as opposed to “compressing” mathematical practices (as described by Ball, 2000; Ball & Bass, 2000; Ball et al., 2004, and discussed in Chapter 2 of the thesis).

The selections of M in the curriculum and the dominant pedagogic mode described *in the talk* of both the lecturers and the students, project an image of mathematics¹⁷² as dominated by Orientation (3): mathematics, for inducting learners into what it means to be a mathematician, to think mathematically and view the world through a mathematical lens. This is supported by the analysis of a limited slice of pedagogic interaction. However, with the analysis of formal assessments, it becomes clear that while Orientation (3) is dominant in the talk, and some of the pedagogic interaction, in terms of what is *really* valued, i.e., what ‘counts’ in formative and summative assessments and is required for progression, is dominated by Orientation (4): mathematics involving conventions, skills and algorithms to master in order to gain access to further studies. In the talk and in the course outlines there is also a minor emphasis on Orientation (2): mathematics as relevant and applicable to aspects of everyday life and local contexts. This is particularly visible in one of the modules (Applied Maths 102: Financial Maths)¹⁷³ and is assessed within that module. Other orientations, (1): mathematics for critical democratic citizenship – allowing learners to critique mathematical applications in various social, political and economic contexts; and (5) mathematics as a human activity produced historically in cultural and social contexts, were not visible in the evidence collected¹⁷⁴.

In the talk, learning Mathematics is constructed as *more* than learning content – it is about seeing mathematics in a different way, it is about developing mathematical practices, conceptual understanding and mathematical reasoning abilities and practices. Learning this type of M, recognised as a form of *MfT*, is seen as important aim of the specialist mathematics modules at CU. While ME and MT are both *implicitly* integrated into M (through the principles of selection and the pedagogic mode), formal assessments tasks show that *MfT* is assessed most often in-and-for itself. The analysis also shows that the form of assessment is dominated by tasks that require procedural reproduction, although there are also significant numbers of tasks (particularly in the modules taught by Mr/s X) that require the production of arguments. However a further finding indicates, that while this appears to support “unpacking”

¹⁷² In the terms of the analysis of official knowledge projected from the ORF (through the NCSM) that was produced and discussed in Chapter 4.

¹⁷³ I note here that this might also have been visible in other modules for which assessments and outlines were not provided.

¹⁷⁴ Once again, I stress that the evidence collected was a slice of what was provided by lecturers at that time. This does not mean that these aspects were not covered in those modules for which no evidence was collected.

mathematics and conceptual understanding as the legitimate text of *MfT*, the over structuring of these tasks often reduces tasks to procedural reproduction. This may be a reflection of the need to make the tasks manageable by the students, who are generally seen as fairly ‘weak’ at mathematics.

The analysis also shows that **Mathematics Teaching** is important within the CU context and is constructed as a specialised practice. It is assessed by mathematics specialists in the school context, and is taught implicitly through modelling of practices in the MTE classes. **Mathematics Education** is seen to be integrated into M and MT and is not studied to any substantive extent in-and-for itself. While the field of ME research is used as a basis for selections and for structuring dominant lecturers’ practices, students are not expected to work much with these texts. Thus they do not have substantive access to the knowledge base itself. Rather their access is through the recontextualised offerings of the lecturers, which are sometimes explicit, but is most often implicit within the pedagogic context of the M and ME/MT (Curriculum/ Methods) lectures. At CU, ME and MT are closely interconnected, practical accomplishments, mostly drawing on the field of experiences. Nevertheless in formal assessments, students are required to produce pedagogical arguments, although these are expected to be rooted in their own localised experiences of practice and experiences in their MTE classes. There is little space for them to gain access to ‘codified’ wisdom of practice (as discussed in Chapter 2 in relations to Shulman’s work). Within the MTE context, MT and ME are integrated to produce a basis for MT in practice – a discussion based pedagogic mode, that puts learners thinking at the centre and examines this thinking (on the basis of the teachers’ mathematical knowledge) as a resource for structuring teaching and learning tasks.

4.2 Identities of good pedagogic subject(s) projected from CU

On the basis of the analysis presented, and the description of what would count as the legitimate texts within the MTE context of CU we can make inferences about the ‘good’ pedagogic subject of CU. Sh/e would be expected to understand selections of mathematics in deeply connected ways – to be able to take a mathematical definition and unpack its meaning; able to translate it from highly compressed mathematical/ symbolic forms into ordinary language, into graphical forms and so on in order to get to the core of its mathematical meaning. There would also be an expectation s/he could apply her/his mathematical knowledge meaningfully in various mathematical and non-mathematical contexts. However, this good pedagogic subject, would value mathematical understanding above fluency and the ability to reproduce given mathematical forms in a highly efficient manner. Their

mathematical identity would be strongly connected to the meanings they make – and connected knowing would be highly valued. They would reject a form of mathematics that required them to practice mathematical forms without thinking. They would develop a strong individual relationship with mathematics as a way of communicating and connecting ideas, and be frustrated if they were not able to get to the ‘why’ of a particular mathematical form. Their mathematical consciousness would be rooted in a knowledge discourse dominated by Orientation (3).

Given the close contact they have with their lecturers and the social relations developed with the MTE classroom, it is likely that they would be expected to identify, in particular, with mathematics teaching practices that would value discussion and see mathematical meaning as constructed within social contexts. The form of ‘constructivism’ favoured would be pedagogic rather than utilitarian. They would be the kind of teacher who took their learners thinking seriously and would be expected to listen carefully to learner ideas and explanations in order to guide individual and collective learning in their classroom context. They would take care over the examples, exercises and problems used to structure learning in their classes, choosing these carefully in order to guide the pedagogic context. They would work with definitions and learner productions, considering learner errors and misconceptions as a source of productive classroom interaction and learning opportunities. They would be interested in their learners’ ideas. They would see themselves primarily as mathematics teachers (rather than as mathematicians).

5 Conclusion

In this chapter I have provided an in-depth analysis of the three message systems (curriculum, pedagogy and assessment) operating within the institutional context of CU. I have systematically worked through three layers of analysis and interpretation, describing the contents of the curriculum, the classification and framing of knowledge discourses and practices, and the pedagogic mode operating within the MTE context. I have considered the way in which formal assessments are constructed and used within this context to produce what can be considered as the description of the legitimate text for M, ME and MT at CU, and in relation to this, a description of would be projected as a ‘good’ mathematics teacher (pedagogic subject) of the institution.

I have shown that at CU the relatively low entry level of students into the programme influences the conception of the ability of the student teachers, and colours the opportunities

that are made available within the pedagogic context. The student teachers are considered as coming into the institution in need of intensive contact and teaching so that they can relearn mathematics in better more meaningful ways – to be pedagogized into new subjects who will be able to work with old knowledge in new ways and with the new forms of knowledge expected by the official curriculum. They need to learn new pedagogic practices, and this is done through providing a new learning context that requires their attendance and gives them little time for independent learning and interaction outside of the classroom context. While there are some internal differences in the specialist M, ME/MT curriculum, determined by individual differences within the lecturing staff, the dominant discourse projected by the MTE context is an institutionalisation of a notion of *MfT* which privileges discussion-based pedagogy, process oriented mathematical practices and conceptual understanding. However, this is tempered by the expectation that the pedagogic subjects require considerable help in order to achieve these outcomes, and so prompts scaffolding and structuring of teacher learning that contains within it the possibility of turning the process orientation and “unpacking” of meaning into extended step-by step reproductive processes. That is, the possibility of reducing a connected, creative and deeply meaningful practice into a series of reproductive procedures.

In the chapter that follows I will move to consider the case of Rural University (RU), and using a similar process to the one adopted in this chapter, analyse the three message systems in relation to the RU institutional context. Later in Chapter 10 I will return to the case of CU and consider the experiences of the novice teachers of the CU curriculum in order to understand the images they project of themselves as mathematics learners, mathematicians, mathematics education specialists and mathematics teachers.

Chapter 8

The Case of Rural University

I want to have a teacher who is going to be confident, in the work which he or she is doing. And confidence really does not simply imply knowing lots of mathematics, but actually being willing to learn. We are in a learning process, all of us. [...] I'm saying these students therefore when they go out into teaching they themselves, still need to know quite a lot. But now I am happy if I'm getting a teacher who says, okay even if I am limited, I can just go as far as this, but at least I have this thing, I have this, you know, confidence that I am going to learn new things. (Dr A, IAT-A2)

1 Introduction

In the previous chapter I presented the case of City University. Following the methodology presented in Chapter 6 I produced an account of the institutional context and through an analysis of the three message systems of curriculum, pedagogy and assessment operating within that context, a description of the 'good' subject of the institution. In this chapter I consider the case of Rural University (RU), and utilising the same methodology and pattern produce an account of RU's institutional context and projected 'good' subject.

I begin the chapter with an interpretation of the doxa produced through presenting an account of the institutional context and the overall design of the B.Ed degree at RU. This is used as a basis for identifying the organisational structure of contents (knowledge and practices) in the MTE curriculum offered at the institution. In Section 3.1, I present an analysis of selections into the specialist mathematics modules and an interpretation of the legitimate texts for M, ME and MT produced through these selections. This is followed in Section 3.2 by an analysis of an example of pedagogic interaction in a selected MTE classroom, and in 3.3 by an analysis of examples of formal assessments from the B.Ed programme. The analyses of curriculum, pedagogic interaction and assessment are then rubbed up against one another and interpreted to produce an account of the (projected) characteristics of the institution's 'good' subjects (disciplines and persons).

2 The institutional context and overall design of the Bachelor of Education programme at Rural University.

Rural University is located in a rural area in one of the provinces of South Africa. During the Apartheid era it was one of the 'homeland' universities that had been specifically developed to serve a certain homogeneous 'ethnic group'. Today, more than ten years into the post-

Apartheid era, RU still serves more or less¹⁷⁵ that same ‘ethnic group’. This university can be described as historically disadvantaged. The student body is fairly homogeneous with the vast majority of students being Black Africans whose mother tongue is an indigenous African language (mostly the same mother tongue). However the language of learning and teaching (LoLT) at the University is English. Students originate from diverse areas around the province (i.e both urban and rural areas), and from at least one other province. Most students stay in the residences during the University term time.

Rural University incorporated two colleges of education in 2001. After the incorporation, the college campuses closed and all students were relocated to the main University campus. The colleges were retained by the provincial Department of Education (DoE) for other purposes. Some staff from these colleges stayed on at the university for a short secondment period to see their pipeline students through their diplomas, and thereafter returned to posts in the provincial DoE. None of the ex-college staff were employed in a permanent capacity by RU.

RU began the process of developing their new qualifications in line with the NSE early on and admitted their first intake in the 2001 academic year, which was the earliest possible date for the introduction of the new qualifications in terms of the policy. The ex-college staff had no input into the thinking and design of the programmes or the specialist courses for the B.Ed. The existing University Faculty of Education and the lecturers employed there took full responsibility for the design and development of all aspects of the new curriculum. The University Faculty of Education had traditionally offered a broad range of initial teacher education qualifications, including a BPaed (Primary) and a number of diplomas such as the Senior Secondary Teacher’s Diploma (SSTD).

The formal entrance requirements into the B.Ed degree at RU appear to be very loosely defined. In the documentation submitted to the DoE a whole range of possibilities are indicated under the section ‘Target learners and learning assumed to be in place’¹⁷⁶. The lack

¹⁷⁵ More than 95% of its students are still drawn from this group.

¹⁷⁶ These include: recognition of prior learning (RPL credits will determine entry points); NQF level 4, Further Education and Training certificate with at least a university entrance; Std 8/10 plus a PTC; Std 8/10 plus a PTD and SEC; Std 10 plus JSTC; Std 10 plus JSTC and SED; PTC plus a post Professional Certificate; PTC partially completed DE (Upgrading); 3 year University Diploma or any other teacher qualification below a first degree; Senior Certificate. It is noted that the acronyms used here are as indicated in the formal documentation. They represent some of the wide range of former qualifications produced through the past differentiated system of Teacher Education, and indicate a willingness to use the B.Ed as an upgrading qualification. [The acronyms mentioned are translated here. PTC: Primary Teacher’s Certificate; PTD: Primary Teacher’s Diploma; SEC: Secondary Education Certificate; SED: Secondary Education Diploma; JSTC: Junior Secondary Teacher’s Certificate; DE: Diploma in Education.]

of specificity indicates a willingness to consider the B.Ed as an initial qualification for new teachers (those having obtained a Senior Certificate for example), as well as an upgrading qualification for a whole range of teachers who would be considered as under-qualified. The lack of specificity in terms of the university entry level for the senior certificate also indicates the willingness to consider entrants into teaching who would not normally be accepted into a university degree. The Faculty of Education Prospectus for 2004 (RU, 2004b) provides details of the rules and syllabuses for the various qualifications offered, indicates fairly flexible admission requirements, but does not provide any indication of how recognition of prior learning (RPL) credits would be recognised. That relatively low levels of entrance are required in terms of the prior matriculation qualification is confirmed by the lecturers who indicated during the interviews that there are no specific mathematics entrance requirements into this B.Ed, other than the student has to have a senior certificate (matriculation) and have attempted (not necessarily passed) mathematics at matric level.

There is no selection. We simply take whoever says he wants to be a teacher. Whoever wants to be a maths teacher we simply take [...] whoever has attempted mathematics at matric level. So not necessarily that a person has passed maths. (Dr B, IAT-B)

The B.Ed at RU, as will be shown in the next section, allows for a number of specialisations. However, students who elect to become mathematics teachers *must* also become science (Biology *and* Physical Science) teachers. There are no other options available. It is assumed that students selected into the mathematics specialisation, also studied some science at matric level, although this was not clarified by the documentation or in the interviews.

The low level of entry required, together with the availability of provincial bursaries¹⁷⁷ had the significant consequence of relatively large numbers of students being attracted into teaching at RU, at a time when other institutions were struggling to recruit student teachers. In particular relatively large numbers were being registered in the undergraduate B.Ed (Senior Phase and Further Education Phase: Science Education/ Mathematics Education). In 2004 in the mathematics/science specialist B.Ed, there were approximately forty 4th year students (the 2001 intake was completing their 4th year in 2004). Looking at the whole B.Ed maths/science student teacher population, there were approximately 150 students in 1st year, 120 in 2nd year

¹⁷⁷ That provincial bursaries were available at RU for teaching qualifications was a surprise. All students confirmed that they made the decision to come to RU after they heard radio advertisements indicating that they could obtain full bursaries if they became teachers at RU. Provincial bursaries were not made available at other institutions in the province, which were only able to offer places on the basis of loans from the National Student Fund of South Africa (NSFAS). Making bursaries available at RU may have been driven by the need for teachers in rural areas.

and 100 in 3rd year, all becoming specialist FET/ Senior Phase Maths and Science teachers¹⁷⁸ in 2004. This means that there were approximately 400 undergraduate Maths/Science specialist teachers registered at the university in 2004. That these numbers put pressure on resources is an understatement. There were only two lecturers involved in teaching all mathematics and mathematics education modules to all SP/FET maths specialist student teachers. These two lecturers were also responsible for the mathematics modules offered on other programmes including the NPDE, ACE, PGCE, B.Ed(hons) and M.Ed. Both lecturers, Dr A and Dr B are well qualified with doctorates in mathematics education.

2.1 How Rural University meets the formal state requirements in their design of the B.Ed degree

The formal documentation required in terms of the Criteria (DoE, 2000a) was submitted to the Department of Education by RU in June 2000 and the B.Ed programmes described in the documentation were approved as programmes for employment in education in November 2000 (DoE, 2002b). The qualification and its programmes had been taken through the processes of interim registration with SAQA and accreditation with the CHE under the Interim Joint Committee (of SAQA, CHE and DoE) by November 2002. The formal curriculum documents for RU were collected from the DoE in July 2003. Table 26 provides a summary of the information submitted in the formal documentation and shows that RU conceptualised their B.Ed programme as aligned to the roles in the NSE.

Table 26: Summary of B.Ed (Senior Phase and Further Phase) curriculum design information submitted to the DoE for purposes of recognition and evaluation of qualifications for employment in Education

University	Rural University	Comment
Name of the submitted qualification	B.Ed (Senior Phase and Further Phase)	The qualification is not Generic, the phase specialisation is indicated
Specialist Phase Focus	SP + FET	The documentation indicates the 'Further Phase' rather than FET which is the language of the NQF. In the evaluation process the DoE indicated this should be changed to FET.
Total credits	480C (with at least 228 @ level 6)	Qualifications with mathematics/science as specialisations consist of 480C with 228 @ level 6; other specialisations consist of 480 Credits with 240 @ level 6 ¹⁷⁹ .
Choice of specialisations possible	There are seven possible choices: Science Education and Mathematics Education; Music and Life Orientation; Science Education and Technology; Life Orientation and Language Education; Human and Social Sciences and Science Education; Economics and Management	Each choice represents a fixed curriculum. Mathematics is only available in one of the choices - mathematics and science education must be taken together.

¹⁷⁸ Note these numbers may not be entirely accurate, as the institution did not provide official figures. These numbers are taken from the numbers the lecturers indicated during the interviews. Students also confirmed that this was the order of the numbers of students in the maths/science programme.

¹⁷⁹ This appears to indicate a recognition that students entering the mathematics/science programme may require more foundation modules (level 5) than students entering other specialisations.

	Sciences and Human and Social Sciences; Human and Social Sciences and Language Education.	
Integration of specialist role into more generic roles	Not explicitly integrated in documents. Implicitly appears to be completely separated	All exit level outcomes are described using the exact language of the NSE. Each role is separately indicated as an outcome with foundational, practical and reflexive competences indicated in very general terms, as in the NSE document.
No of credits for the specialist role in the whole programme	216C split between the various specialisations. For combinations that include maths/ science this is made up of 120C @ level 5 and 96C @ level 6. For other combinations this is made up of 108C @ level 5 and 108C @ level 6	This meets the minimum of 204C indicated for the specialist role in the NSE.
Maximum No of Credits for the maths specialist role in the whole programme	108 C (60 @ level 5 and 48 @ level 6)	There is only possibility; no variations are possible
% of programme focussed on maths specialist role	22,5%	
Credits allocated to Mathematics (raw no; % of total maths specialist role)	60C or 55,6%	
Focus of Mathematics modules	5 modules. From the names given to the modules 2 appear to be clearly related to school mathematics (Algebra; Space and Shape); 2 to university level mathematics (Calculus A; Calculus B - it is not at all clear what the distinction between the two modules might be); and 1 where it is not clear at what level the focus is (Algebra and Statistics)	All modules could have a theoretical and/ or practical bias – will not be able to say without going into the institution.
Indication that Maths Education and Maths Teaching are focussed on independently.	Not clear from the documents.	This will require a closer look at what is actually offered in these modules
Credits allocated to Mathematics Education and/or Mathematics teaching (raw no; % of total maths specialist credits)	48C; 44,4%	
Focus of ME/MT modules	4 modules: (1) Errors and Misconceptions in Mathematics; (2) Instruction in Mathematics; (3) Planning for Mathematics Teaching; and (4) Assessment in Mathematics Education.	
Relationship between Maths, Maths Education and Maths Teaching.	While modules are clearly named in terms of what appears to be a M or ME/MT (Maths Methods) label, the relationship between different modules is not indicated.	
Credits allocated to Core Education Modules (raw C; % of whole degree)	264 (55%)	It is interesting that such a large number of credits (7 x 12 = 84C) have been allocated to the core modules focussed on 'researcher and lifelong learner'. There is no clear indication of what this might mean.
Focus of Core Education modules	Appear to be influenced entirely by the official discourse of the Norms and Standards. Modules are explicitly grouped to cover the 6 'generic roles'. A total of 22 modules are allocated to core studies (these are taken by students for all specialisations). 4 Modules are allocated to 'mediator of learning'; 3 to 'leader, administrator and manager', 7 to 'researcher and lifelong learner'; 3 to 'interpreter and designer of learning programmes and materials'; 3 to 'community, citizenship and pastoral role'; and 2 to 'assessor'.	
Relationship between the core modules and the specialist modules	Appears to be no direct connection	
Credits allocated to fundamental learning	None specifically identified. However these are indicated as being integrated into the core modules. It is not clear into which core modules this may have been integrated. There are two modules in the core allocated to 'mediator	There is no mention of general mathematical/ numerical competence or of computer literacy skills. It is noted in the DoE evaluation document that if the

	of learning' that are related to language and may be connected to fundamental learning: 1) Mediating Learning, 2) Language across the curriculum.	qualification is also for Senior Phase it must to meet the minimum standards in terms of the NSE and that at least 24 C should be allocated to Maths, Science or Technology education. The BEd Senior Phase and Further Phase: Science Education and Maths Education; Science Education and Technology do meet these norms. However this is not the case for other specialisations mentioned. The DoE document recommends that the qualification be offered as a B.Ed FET only qualification.
Credits allocated to Practice teaching	Practice Teaching is not mentioned in the documentation as credit bearing module/ modules. However in the section on integrated assessment it is indicated that 'competences will be assessed using a variety of methods and instruments' including 'practice teaching/ internship' (page 20, Form 2, RU doc submitted to the DoE)	There is no indication as to what role practice teaching would play in the overall design of the degree. That no specific credits are allocated to this aspect of the programme is interesting.
Assessment of practice teaching	No clear indication as to how practice teaching is assessed from the formal documents.	
Conditions in terms of completion of the degree related to the assessment of practice teaching.	Nothing is mentioned about how the assessment of practice teaching contributes to the student evaluation in terms of earning credits towards the degree. It is not mentioned whether success in the practice teaching element is essential for achieving the award of the degree or not.	

(Source: original documents submitted to the DoE in June 2000 and provided by the DoE in July 2003; evaluation documents provided by the DoE in July 2003)

The documentation submitted to the DoE provides specifications for the B.Ed (Senior Phase and FET) with seven learning programmes leading to specialisations in this degree. Separate documentation was submitted for B.Ed degrees for other phases. The documentation meets all the formal requirements of the official discourse, being written in the format required by the Criteria and in the language of the Norms and Standards.

The learning programmes leading to all variants of the B.Ed offered by RU consist of 22 core modules that cover the six 'generic' roles of the educator together with 18 modules focused on the specialist roles. The overall design provides for a specialist Science and Mathematics Education B.Ed that is comprised of exactly forty 12 credit modules each meeting a specific purpose described in terms of one of the 'seven roles' of NSE. The extent to which the curriculum implemented fits with the description given in this documentation will be considered in the next section. I examine the implemented curriculum by drawing on the formal rules and prospectus obtained from RU and supported by information provided in interviews by the two lecturers involved in the programme Dr A and Dr B

2.2 The formal requirements of the B.Ed curriculum for mathematics teachers at RU

Information from RU's official rule book and supported in interviews indicates that the documents submitted to the DoE do represent, with only one minor variation, the curriculum that was implemented. As can be seen from the name for the degree in the rule book, RU changed its original formulation from Further Phase to Further Education and Training (FET).

The curriculum for the four-year degree is structured as shown in

Table 27. A glance at the table confirms that this curriculum appears to meet the minimums of the NSE, with the exception that the NQF levels at which each module is pegged are not identified. The curriculum has very clearly been influenced by a specific interpretation of the NSE, as will be shown below.

Table 27: The curriculum for the Bachelor of Education (Senior Phase and Further Education and Training: Science and Mathematics Education) at RU. (Source: RU, 2004b)

Year	Semester 1			Semester 2		
	Module	NQF level	C	Module	NQF level	C
1	Educational Research A (Philosophy)		12	Educational Research B (Practice).		12
	Intro to Design of Learning Materials		12	Processes of Teaching and Learning		12
	Systematics		12	Energy		12
	Measurement in Science		12	Errors and Misconceptions in Mathematics		12
	Algebra		12	Shape and Space		12
2	Mediating Learning skills		12	Human Development Education		12
	School Administration A		12	Educational Research C (Basic elements)		12
	Assessment in Schools		12	Learning Programme Design A		12
	Chemistry A		12	Ecology A		12
	Instruction in Mathematics		12	Calculus A		12
3	Educational Research D (Planning projects)		12	Educational Research E (Presentation and Publication of Data)		12
	Education Law		12	Media in Education		12
	OBE Assessment		12	Education for Democratic Citizenship		12
	Physics A		12	Plants and Animals		12
	Calculus B		12	Preparing to Teach Mathematics		12
4	Educational Research F (Research Design)		12	Health and Environmental Education		12
	Language Across the Curriculum		12	Equality in Education		12
	The School as an Organisation		12	Design of Learning Programmes B		12
	Waves and Perception		12	Materials		12
	Algebra and Statistics		12	Assessment in Mathematics Education		12

Notes on the modules shown in the table:

1. Students take five 12 C modules per semester (60C per semester/ 120 C per year) for four years, making a total of 480C in the degree programme. All modules are each allocated 3 or 4 forty-five minute lecture periods a week; three lectures and a tutorial/practical. This translated into contact time of 15 to 20 periods per week during each semester. This would be considered

2. There are six 'research' modules in the curriculum (Educational Research A to F) which aim to develop the role of scholar, researcher and life long learner. This role is clearly privileged in the curriculum having 72C allocated to it (one less than mentioned in the documentation submitted to the DoE). That is, more than a quarter of the credits allocated to core modules are for research related modules¹⁸⁰. In the group interview students indicated that they do core modules that focus on research every, year but that they found these modules fairly repetitive, as Phiri put it, "actually in research I cannot say much on that one. Because sometimes you find the repetition of what has been done previously. Then when you enquire about that they just say – research is just one thing until you reach masters!" (GVT1-RU-B.Ed)
3. *Intro to Design of Learning Materials*, *Learning Programme Design A* and *Design of Learning Programmes B* are modules that aim to develop the role of interpreter and designer of learning programmes. Thus a total of 36 C are allocated to this role. It is not clear how these modules are related to one another, or to the specialist role. In the interview students suggested that there is no connection, but also indicate that the modules are repetitive and the lectures who deliver them do not make any connections between them.
4. *Processes of Teaching and Learning*, *Mediating Learning skills*, *Media in Education*, *Language Across the Curriculum*, and *Equality in Education* are identified as modules which aim to develop the role of 'mediator of learning'. Thus a total of 5 modules, or 60C, are allocated to this role.
5. *Human Development Education*, *Education for Democratic Citizenship*, and *Health and Environmental Education* are identified as modules which develop the role of community, citizenship and pastoral care. A total of 36C are allocated to this role.
6. *School Administration A*, *Education Law* and *The School as an Organisation* are modules for developing the role of Leader, Administrator and Manager. A total of 36C are focussed on this role.
7. *Assessment in Schools* and *OBE Assessment* are modules related to developing the role of Assessor. A total of 24C are focussed on this role.
8. The remainder of the modules (18 in all) are identified as developing the role of subject specialist. In this particular learning programme the student becomes qualified to teach mathematics and science (which includes biology and physical science). The specialist credits are shared between science and mathematics, which are each allocated 9 modules (a total of 108C). The mathematics specialist modules are divided between mathematics (Algebra; Space and Shape; Calculus A; Calculus B; Algebra and Statistics) and mathematics education/ mathematics teaching (Errors and Misconceptions in Mathematics; Instruction in Mathematics; Preparing to Teach Mathematics; Assessment in Mathematics Education).
9. The modules indicated in 2 – 7 are referred to as 'core' modules, whereas the specialist modules are referred to as electives. No fundamental modules are identified in this curriculum.
10. There are no specific teaching experience modules in the curriculum. No formal credit allocation is awarded for practice teaching. The faculty handbook does not provide any information about practice teaching. However, from discussions with students and with lecturers it is evident that there are two practice teaching periods per year.
11. In the rules no NQF levels are specified against any of the modules. The only specifications given are that each module is allocated 12 C or 120 notional study hours (nsh) "devoted to lecturing, self study, assessment and practicals" (RU, 2004b, Rule E31)

The seven roles of a teacher are used up front as the basis for the overall design and are all specifically focused on in their own right, in particular there is a major focus on the role of "researcher". However, the curriculum structure does not in any way indicate how the specialist role is the overarching role into which all other roles are integrated. There is no indication of how the more generic roles are related to the specialist role or to each other. The generic roles take up the majority of the credits in the curriculum (altogether more than half the

¹⁸⁰ This is a large chunk of the undergraduate curriculum and it is not at all clear what the rationale for including such a high proportion of 'research' modules was. The B.Ed programme director was not able to explain the rationale for this in the initial teacher's qualification, except to suggest that this is what was required by the NSE.

curriculum is allocated to these roles). It is interesting to note, that while specific documentation submitted to the DoE for the degree seemed to suggest a specialist focus on the SP and FET, in practice it appears that the ‘generic’ aspects of this curriculum are the same for all B.Ed degrees offered in the institution, including the BEd programmes specialising in the foundation and intermediate phases. That is the only differences between the degree for the foundation and intermediate phase and the senior phase and FET is to be found in the elective modules. This undermines the appearance that these degree programmes are specialised to the phase.

There is a fixed curriculum. It is not possible to do Mathematics Education as a single specialisation. It is not possible to take Mathematics Education in combination with any subject other than Science. Science Education involves becoming a Biology teacher *and* a Physical Science teacher. The amount of time to develop the specialist role is therefore very limited.

The basis for the organisation of this curriculum is clearly the NSE. The seven roles dominate as the major organising principle for all the modules. However how these modules are related to one another is not visible from the documentation presented so far. The knowledge discourses that underpin the various roles are not clearly visible either. This organisation is represented in Figure 31. Each role appears to ‘stand alone’ with little to connect it to any other role.

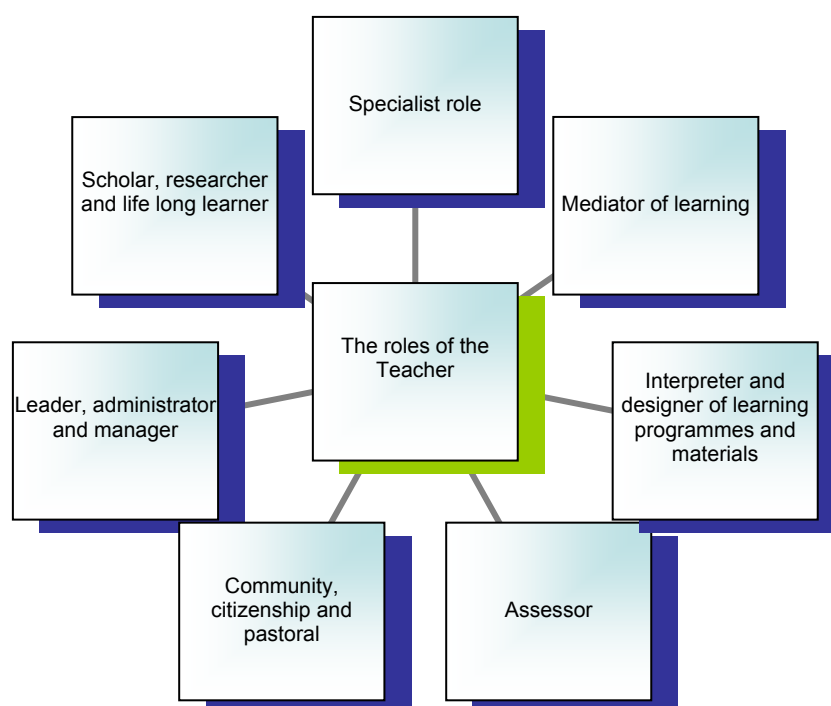


Figure 31: The B.Ed curriculum at RU is organised around the roles of a teacher as described in the NSE

I now move on to consider the modules specific to the mathematics specialisation and consider the relationships within and between these in order to begin the process of revealing the selection of specialist discourses into the curriculum and hence a description of the possible specialisation of consciousness within this context.

3 Images of ‘good’ subjects projected from Mathematics Teacher Education at Rural University

To reveal the pedagogic discourses operating within the RU context and to unpack the pedagogic identities projected from this base I need to move beyond the paper descriptions provided in the previous sections to interrogate the ‘what and how’ of the implemented curriculum. Evidence from the interviews with lecturers and students, course material, observations of classes and examples of assessments is used to help describe the construction of the legitimate text for mathematics, mathematics education and mathematics teaching within RU. From this a description of official knowledge(s) of the institution with respect to these discourses, and the possible pedagogic identities of mathematician, mathematics education specialist and mathematics teacher that these project is constructed. The general methodological approach discussed in Chapter 6 is followed to produce this analysis.

At the time that the empirical site visits for this research were carried out, the B.Ed was in its fourth year of implementation. All the mathematics specialist modules in the curriculum had been fully developed and the final two were being taught for the first time. In what follows I will look at these specialist modules in more detail in an attempt to understand what has been selected into these modules, and therefore been privileged in the curriculum, and how these privileged selections appear to be made available to student teachers.

3.1 Specialist knowledge(s) and practices in the RU curriculum

There are a total of nine specialist mathematics modules in the B.Ed curriculum. From the module names, six of these appear to focus on mathematics and four on mathematics education and/or mathematics teaching. These are organised across the four years of study so that in each semester at least one of these are in focus. Looking at 27 we see that the specialist modules appear to be more or less stand alone. The only modules that appear to be directly connected in terms of progression are the two calculus modules, the second year module *Calculus A*, and the third year module *Calculus B*. The titles of these do not give much information as to what is selected into the modules. I now consider information provided (in

interviews and in copies of materials) by lecturers and students to build an initial description of legitimate texts for mathematics (M), mathematics education (ME) and Mathematics Teaching (MT) produced through the selection of various contents and practices into the B.Ed curriculum at RU.

3.1.1 The organisation and selection of mathematically related contents and practices in the curriculum

From what has been presented above it appears that M may mainly be produced through the modules: *Algebra*; *Space and Shape*; *Calculus A*; *Calculus B*; and, *Algebra and Statistics*. Aspects of ME and MT look to be mostly produced within the modules: *Errors and Misconceptions in Mathematics*; *Instruction in Mathematics*; *Preparing to Teach Mathematics*; and, *Assessment in Mathematics Education*. A closer look at the descriptions of these modules and their implementation is now required. Unfortunately the Faculty Rule book, which does contain syllabus descriptions for some modules offered in the faculty, does not contain any descriptions for any of the mathematics specialist modules for the B.Ed (SP and FET). Therefore all information about these modules is obtained from the course outlines and course materials, where they were provided, as well as from interviews with the lectures and students. Table 8 in Appendix F.1 provides an overview of the materials collected from the lecturers, and clearly indicates that a limited selection of material was made available by the lecturers. Course outlines were not presented for all the modules. Where it enables a more robust description, the material provided by the lecturers is supplemented with the examples of work provided by students.

1) Mathematics Courses

When discussing the overall design of the mathematics specialist modules in the curriculum the lecturers were asked on what basis they made their decisions about what modules to offer and what to include in these modules. In both cases their replies suggested that they just did what they thought sensible for their context and students. However, neither of them was able to clearly articulate the basis for their decisions over selection. For example, when Dr A was asked to give an overview of the specialist courses in the B.Ed and a description of how they related to one another she explained:

I would describe it as something that really seems not to warrant any kind of [...] description to say, you know, this relates to this, because [...] here **you just pick on things we thought were important for our learners**. Then for me it's not easy to come with a kind of a uniform description of, you know, this is what it is all about. (laughs) [...] It was just based on what we thought would be best for the first years and then the following year etc., etc. But **there was nothing specific that**, you know, **guided us**. (IAT-A2)

Similarly when Dr B was asked how they decided which courses to do across the four years, she replied:

Dr B: Um. I wouldn't say we had much of input. We had an input because that was our specialisation, but there was a committee that was actually dealing with the modules, which modules would be taken [...] So its was a question of saying, what modules do you feel you have to offer to these B.Ed students, and then we had to give them the names of the modules. And the other thing was, that at that time, it was called senior and FET, and because there was no curriculum for FET. So it was a combination of the two, which made it very difficult, because it would mean we have to consider the senior level and at the same time consider the FET. [...] the national curriculum statement, it was not there for FET, it was there for senior level. But because now we felt these are the students who have to go and teach at the secondary school level, so they need to have, especially **the content, for secondary school level**, FET.

Di: So when you choose the content, what content do you focus on?

Dr B: Well, I would say **we focus on everything**. We have **very mixed students**, so we try by all means, as I said, we try, we split the content right up to the fourth year level, we don't say because they are weak here we have to take this out, no we just focus on everything. (IAT-B)

These lecturers say they have selected specialist contents for the MTE curriculum based on what they 'thought' was important for the kind of students (learners) that were likely to be doing the B.Ed. We see a suggestion that the basis for the specific selection may be connected to an interpretation of school mathematics curriculum, and at the time that the B.Ed was designed, this was still the old curriculum as the new FET statements had not been published. In order to get to a better understanding of principles that underlie the selections made, I consider the various modules outlines, notes and other evidence I have available.

The first year consists of two mathematics modules, *Algebra* and *Space and Shape*. Dr B lectures both these modules. The material provided for the Algebra module consists of a booklet consisting of a scheme of work for the module and selections from a photocopied text. The outline indicates that the module will be assessed through two tests and an examination. The scheme of work provides an outline of the work for the semester. The first three lectures focus on "How to study mathematics", "Current issues on mathematics", and, "The mathematics teacher" (RU, 2004a, p. 1). No specific material is provided for these lectures. The rest of the scheme covers selections from Grade 11/12 algebra spread over 36 lecture periods. The notes and exercises, which reveal the focus of these lectures, are photocopied chapters from a school level algebra text book¹⁸¹ that covers: quadratic equations; inequalities and functions; absolute value equations, inequalities and graphs; inverses of functions including linear, hyperbolic and absolute value functions; the remainder factor theorem; and, linear programming. The general pattern of the chapters is fairly traditional. An example of three pages from the text is reproduced in Appendix F.2 to illustrate the pattern used in the section on quadratic inequalities. Each section of the textbook follows the same general form,

¹⁸¹ The origin of the photocopies is not acknowledged. No author(s) or title is provided.

beginning with the presentation of facts, definitions, principles and worked examples relating to the whole topic, followed by a limited set of practice exercises and answers. There is nothing about this text that would enable us to identify it as necessarily aligned to the new curriculum.

This selection of material suggests that selection may be driven by a perception of the school mathematics backgrounds of students coming into the programme. For example, absolute value functions, inverse functions, and linear programming are all aspects of the ‘old’ school mathematics curriculum that would have been categorised as Higher-Grade (HG) work. If the majority of students coming into the programme had not completed HG mathematics this material would be new for them. This is supported by the information provided by students, for example one of the successful RU students, ‘The Minister’¹⁸², explains in his biographical questionnaire:

You will remember that I said it was compulsory to do maths in [SG] the school I matriculated. The first problem hear, the **first module needed my school Linear Programming** and I didn’t have a clu of it and the teacher said “**you’re not going to be standard grade teachers**” and that where really the group assistance intervene. But how it change or alternate in other semester we do content and other theory or (teaching strategies) when we learn content that when one improves cause **we are the one who are doing work** (micro teaching) and **teach as one will be teaching in high school using all material that is needed including teaching aids**. (TMBQ)

This extract emphasises that as a school student The Minister had not done Higher Grade school mathematics and that it was made clear to him that he would have to learn Higher Grade content which was not easy at first. This extract also points to a general methodology that appears to be used in many of the specialist MTE classes, that is, students are expected to *teach as one will be teaching in high school using all material that is needed including teaching aids*.

When asked more specifically about the algebra module Dr B suggested that it basically involved ‘revision’, as evidenced by the following extract from the interview:

Di: What do you hope to achieve through the algebra course?
Dr B With the algebra course, it’s **more of a revision to them**, and maybe going over, because you will find that **there are some misconceptions that you actually get**. Also with the algebra I let them do this, **make some presentations, that is where you can actually get some misconceptions, and be able to discuss those misconceptions**. I find a lot of misconceptions. So it’s more of, well, what I was actually looking at, focussing at, is more of revision. But I find that also, its not that I have to come in and do the problems with them, **I just want them to do the problem so in that way helping them**. As I said we also actually find some

¹⁸² All students were asked to provide a ‘name’ for this research. ‘The Minister’ is the name chosen by this student. It is noted that while the connotation could be interpreted as religious this would be incorrect. This student saw himself as a cabinet minister in parliament. This was not related to any political ambition, but rather due to the fact that his surname was the same as a well known minister, and everyone therefore referred to him as ‘The Minister’. He chose to use this nick-name in the project.

misconceptions. And the other thing with our students, at **the same time, I want them to develop confidence in speaking**. Because with the course ones, you actually battle. **Well with us, black people, English is our second language so in the first place standing in front of the learners is quite a problem** and then presenting and all those things, it becomes a problem. **So just to have the confidence**, because these people will be going out teaching to the learners and at that time they don't do this other core modules where it is teaching and learning, those things. They haven't done that yet.

Di: So if I have to ask you that question again, what do you hope the students will internalise from this experience of revision?

Dr B: Still basically its understanding. I would say. It's understanding the concepts. **Knowing the concepts very well. And be able to impart that to the learners**. I would say that. (IAT-B)

This description suggests that a major concern of this first year course is to enable the students to redo some school algebra in a way that will enable them to become aware of misconceptions they may have in their understanding of the content, and to provide a context in which they could develop confidence in standing up and talking in front of others; confidence in presenting ideas to others in English. How misconceptions are identified and dealt with, as is suggested by Dr B, was not possible to confirm. Students did not talk about this aspect, nor was it observed in the limited teacher education classrooms observed. However that student presentations and teaching is a focus of the pedagogy in practice in Dr B's classes was confirmed by students on a number of occasions.

A similar process to that described for the Algebra module was described by Dr B when discussing the first year geometry module, Space and Shape.

Di: In terms of the geometry courses, what would you hope to achieve?

Dr B: In the first place, I find that the majority of the students don't like geometry. That is the first thing. [...] That is why I start with the grade 10 work, which I feel is quite simple for them. So that now, **we look at the formulation of theorems, I don't want them just to cram the theorems, and to teach the learners in that way**. Because the tendency for the learners is to say Theorem number 5, and if you ask, what is that theorem number five, she won't tell you. [...] I usually say to the students, these theorems must be part of them, in such a way as they are able to use them. They are the tools for solving the problems. So if they don't know the theorems they won't be able to solve the problems. That is what I actually look at, because I know the way I was taught, the way the students were taught, is the teacher simply comes and say, we are going to do theorem number two, and he says this, this, this, just reading from the book. And will expect the learners to know, which is very difficult. So that is why I emphasise the formulation of the theorems. [...] Because I feel they are battling. They don't actually understand. Because **I want them to do this for themselves, not that I should do that for them**.

Di: The whole issue of proof in geometry, how do you deal with it. The idea of proof.

Dr B: I find that quite difficult for the learners. That is why I say **they have to know the theorems**. Being able to know the theorem, they will be able to analyse the theorem, so that they are able to prove it. They should know what they are required to find out of this theorem if they are required to prove it. That is my main aim. So that if **they know the theorem they will be able to understand it, they will be able to analyse it**. For example, taking out what you are given, they must be able to see what you are given from the theorem, what you are required to prove and what actually you have to prove and all that. (IAT-B)

The module is focussed on selected Theorems from Grade 9/10, that is, on what was in the old syllabus but generally not taught in the schools that students would have come from. The way

in which this material is covered in the course is through student ‘presentations’. Geometry is not taught to these student teachers in the MTE lecture theatre. Rather, groups are allocated theorems to ‘formulate and prove’ in groups outside of the MTE classroom. They then *present* their theorem(s) to one another using teaching aids if they can. The theorems must be presented in a way that is *different from how they might have been introduced to theorems at school* (i.e. where the teacher reads them out from a book and then expects learners to memorise them). That this is the focus of the geometry module was confirmed by students in their group interview, and in all the individual interviews. It was also observed as an example of a pedagogic interaction at RU.

The students, while acknowledging that this has given them confidence to stand up in front of a group and speak in English, recognise that they have not studied geometry in any depth and that what they have done in this course is inadequate to prepare them for teaching. This was brought up a number of times in the initial group interview, and in all the individual interviews, for example:

- Mazette [as teachers we are] expected to know everything [...] like we don’t know some things [...] some things are left out
 TM Like geometry. We left geometry out. Whereas this is something that is known that even teachers at schools right now are afraid of it, they jump those things, they don’t do them. Then we find that even here they jump those things.
 (GVT1-RU-B.Ed)

That the focus of this selection of Geometry was entirely based on the ‘old’ Euclidean Geometry syllabus and that none of the elements of the new curriculum (contained in the RNCS or NCSM) was considered is confirmed on a number of occasions by the students. They also confirmed that the real focus of the Geometry module was “some tips for teaching”, rather than on learning Geometry itself.

- Di and transformations, did you do some work on transformations?
 All S mumble looking at each other
 TM No. Because I went to school and the teacher said to me, ‘this is a very big problem can you teach us transformations’. And I said ‘what is transformations?’ [All students laugh]. Mathematics? Mathematics and transformations? And he took his book and said this is it. We never!
 Di Are there other things?
 P And **we did not get proper information on geometry itself**. Geometry [...] we taught it.
 Mz we were given work to present.
 P (interrupting Mz) actually, **actually, in geometry, we were given some tips as how to teach geometry, not the content**. We were given **some tips on how to use some media** [...] so we didn’t do much.
 (GVT1-RU-B.Ed)

While the above discussion focuses on the first two mathematics modules. It became apparent that this general approach to MTE was common in all Dr A’s classes, whether the focus was

on M or ME. *Preparing to Teach Mathematics* (third year) and *Algebra and Statistics* (fourth year) were also taught by Dr B. The module outlines confirm that both these modules focus on aspects of school mathematics, mostly selections from school algebra. I will return to discuss the *Preparing to Teach Mathematics* module in the next sub-section. The outline for *Algebra and Statistics* indicates that part of the module is focused on ‘Number Theory’. This is concerned with sequences and series and deals with content that would be recognisable as fairly standard ‘old curriculum’ Grade 11 and 12 work (including aspects normally taught on the HG). The notes used are a photocopy of a Chapter from the same text book as the algebra notes handed out in first year. In this sense the level of the mathematical work expected of the students in fourth year *is the same* as the level expected in first year. The *Statistics* sections include descriptive statistics and probability and appear to cover most of the content for the new Grade 12 NCSM. It is noted however that the examination for this course only assesses some aspects of descriptive statistics, which might indicate something about pacing. The issue of pacing and sequencing of mathematical contents will be returned to in a later section.

The information provided seems to support the observation that the principles for selecting contents of the mathematics modules discussed so far, i.e. Algebra; Space and Shape; and Algebra and Statistics, is driven by assumptions about what student teachers *need* to overcome some deficits in their prior school mathematical knowledge. This is based on recognising that most student teachers on the programme come from impoverished mathematics schooling backgrounds, and possibly did not study school maths on higher grade. The only aspect of the modules taught by Dr B that is new (not part of the old school syllabus) is Statistics. The contents of the ‘Algebra’, and ‘Algebra and Statistics’, modules are selections from a text book that covers aspects of the ‘old’ HG algebra syllabus. These texts have a clear orientation to mathematics as access to conventions, skills and algorithms to master, which is one of the five orientations to mathematics that are recognisable in the NCSM: Orientation (4) (as discussed in Chapter 4).

The way that these M modules are delivered is based on a view which suggests that RU students need to be given time to work on solving problems (exercises) themselves in order to get to know and understand relevant school mathematics, and they need to be able to express themselves in front of an audience in English, and so be given the opportunity to present their work and solutions. The lecture periods provide this opportunity. As Dr B confirms:

Di Your practice seems to be, and I’d like you to tell me if I’ve got the wrong image here,
Dr B yes

- Di It seems to be that you are providing them with problems that they have to do. And then they have to think about those and do them. And then they have got to come and teach them to everybody else.
- Dr B Yes! Yes exactly. [...] and we do that throughout. But when it comes now to course three, course four, that is where now I am actually strict, even with the lesson plan. **How the person is planning, how to present.** And what **I emphasise more is about the teaching aids and the media.** Well, they have to do whatever they can find with the teaching aids. [...] The problem is that, as I said, I find that **the students don't know mathematics.** So basically **they should know mathematics, understand it and be able to impart it to the second person.** That was my focus. (IAT-B)

From the above it becomes even more apparent that the mathematics modules taught by Dr B, while using the content of school mathematics, integrate 'doing' school mathematics with a form of 'mathematics teaching'. There is a focus on the students solving 'problems' which generally means working through fairly standard school mathematics exercises (refer to the example text in Appendix F.2). Mostly these are done independently and in groups outside of the teacher education class. While in class there is a focus on students presenting their solutions to one another. How these are evaluated in the pedagogic context is opaque¹⁸³, however there is certainly an intention to use the students' presentations of their problems as a platform to discuss 'misconceptions', and therefore to provide some kind of reflection on and evaluation of the texts presented. It also appears that they are assessed on their presentations – on how they present the problems to the rest of the class. Note the criterion emphasised is that they use *teaching aids and media*.

The other mathematics focussed modules, *Calculus A* and *Calculus B* are taught by Dr A. We could expect from their names that these would be focused mainly on post secondary mathematics and a different selection principle may be in operation. Unfortunately a module outline was not presented for either of these. However the material used in the modules was provided. This consists of photocopies of large sections of two calculus text books. The material for the *Calculus A* course is a photocopy of parts of a book "Calculus – one and several variables" (by S.L Salas Einar Hille and John T Anderson (no date given); 241 pages copied) which covers aspects of differential calculus, while the material for *Calculus B* is a copy sections of a book "Understanding pure mathematics" (no authors/ publishers given – Chapters 12 – 20; pages 293 to 523 copied). The volume of the material photocopied for these two calculus courses is striking. It is not possible to say exactly what parts of these photocopied texts were actually tackled, although some indication can be gained from looking at the final examinations for each of these modules. This material seems out of proportion

¹⁸³ This would involve examining examples of pedagogic practice. I do have limited examples available that will be the focus of the next section. However those, while confirming the practice, do not show any form of evaluation – as will be seen the evaluative rule is implicit and it appears that what is valued is the student's voicing their attempts, rather than a clear specialisation of their voice.

when contrasted to the material provided for the other maths course courses – both in level and in volume.

When discussing these modules Dr A was not able to explain the reasons for this choice of material, but she did give indicate that there was a progression from the one module to the next:

In the third year they will do, oh by the way **second year calculus** will be looking to things like linear, **its an introduction**, basic, maybe some differentiation you know, such and such, but in the **third year** we have got a module, Calculus B that **is more advanced**. (IAT-A2)

Later when pressed to explain what she selects in this module and what she hopes the students will get out of it she explains:

Calculus A course? Well my feeling is that, **that is one aspect of mathematics in the syllabus that gets taught in a very sort of, unfriendly manner. Its hard stuff and so I would say my aim there is to try and demystify it a bit**, ja. Like for instance [...] they... don't seem to realise the importance of having a graph [...] You try and understand it, what's this graph, what message is being conveyed by this graph? What is it saying? You know. And I try to emphasise that a lot. [...] instead of just coming to them and giving them a definition of something, you know, we use a lot of definitions, we come across a lot of definitions in calculus, etc, etc. But to say, what are the important things to look for in a definition? And we don't go to, for instance, into proofs which are quite complicated etc, etc, but even there to say you know, to prove something [...] what is it that I am focussing on? So those minor things, like, you know spending time to explain why do you have to use if and [only] if in this definition and not just if, you know. [...] I think therefore for me, **what I am trying to achieve in the Calculus A course is to say, it's to make it simple and friendly, and much more friendlier to students**. And also to try, **to make them understand**, [...] Yes. And the hope that when they go back to schools they will be able to teach this. Like for instance, one of the myths [laughs] one always, what I always find in students, they think that you know, in mathematics you have to always find and answer, and this answer has got to be exact. But what about the things we learnt in calculus? Most of them are based on estimations and approximation, but coming up with some very good approximations, such that you say okay, something is, you know. So such things, we may not realise the importance of [...] those things, Ja. [...] **I try not to frighten my students**, so to make them to say, 'hey! this is'. [...] In the third year when they have to do integration etc, etc, so I will not go straight into integration, but I will go back a bit and do more exercises because also there is this time pressure, you know. [...] And I encourage my students to say, OK you go to the library third floor you will find a lot of stuff, look at very introductory stuff only, as well. [...] But also the way I teach them, **they practice a lot in my presence**, ja. I don't just do things. I mean they know, they soon get used to it. You know, **at first they would come and expect that, you know, I'll be doing everything for them, but now they know that, If I looked at number one, number two is theirs** and we will continue like that.

(IAT-A2)

It seems clear from this transcript that the *Calculus A* and *Calculus B* modules operate in a different way to the other three mathematics focussed modules. Here the focus is on learning contents beyond what is expected in school mathematics and the selection of this material into the mathematics curriculum is clearly not based on what they need for school mathematics, although it is hoped that their experiences of learning this calculus will enable them to teach it in a way that will make it accessible to learners. That it is selected is not questioned at all, it seems obvious that it should be in the curriculum. Perhaps this is simply a function of recognising that university level mathematics always involves some calculus. The material

used and the type of questions asked could be recognised as typical first year university work. There appears to be a concern however to make whatever they do within this *understandable*, to make sense of definitions and formal notation, to use graphs to visualise meaning and make connections. However, the work done (exercises/ problems) appear to be focussed mostly on becoming fluent in the use of this mathematics rather than concentrating on the proofs and more conceptual aspects of the calculus.

This aspect of the curriculum was one that the students in the sample clearly identified with and were proud of doing¹⁸⁴. These modules were seen by the students as exceptional, since they involved doing ‘real university’ mathematics, the same kind of maths as those taking maths in the other degrees. Other mathematics modules were not as challenging and remained at the level of school mathematics. In the initial focus group interview this first became apparent, and was confirmed in the individual interviews on a number of occasions.

To summarise, the mathematics modules taught by Dr B, discussed earlier, and these calculus modules taught by Dr A, are quite different in terms of both principles for selection and transmission (how access is structured through the MTE lectures). The modules taught by Dr B are selections from school mathematics chosen on the basis of assumptions of what students are perceived to be lacking from their own school mathematical experiences. The calculus modules appear to be selected on the basis of what is taken for granted as necessary for a study of mathematics at higher levels, which is something that FET teachers should be given the opportunity to learn. The organisation and sequencing of these different modules across the four years of study does not appear to be based on any specific principles. For example, the selection of large amounts of school algebra into the curriculum is taught across the various years without any clear sequence in terms of progression of ideas and level. The calculus modules, which one expects would draw on algebraic foundations is taught in between these aspects.

Access to these M contents (principles of transmission) also appears to be based on two different sets of principles. In the Algebra, Space and Shape, and Algebra and Statistics modules, taught by Dr B, there is a commitment to ensuring that students work through school mathematics problems/ exercises as a basis for (re)learning mathematics and getting to know/understand it. They are not (re)taught any of this content directly, rather they have to work outside of class time on preparing solutions to given exercises (problems) and then in

¹⁸⁴ This is discussed in Chapter 11.

class time present and discuss their solutions (a form of teaching each other). This appears to be driven by a necessity to develop confidence in the students – confidence that they can solve problems, confidence that their ideas are worthwhile, and confidence to stand up in front of an audience and voice their ideas in English. There is within this the intention of getting students to work *in a different way to what they may have been used to at school* – this different way is about getting them to present aspects of school mathematics not simply by reading facts out of a book (e.g. stating the theorem and reproducing the proof from a book), but to use teaching aids (e.g. charts/ the board/ models) to present and explain (in English and in their own words). There is a view that it is important for students to voice their attempts at problem solving and that they will come to understand the mathematics by working through problems. How their voices are evaluated and specialised however is not at all visible from what has been presented thus far. It is becoming clear that these mathematics modules, while using the contents of school mathematics are not only concerned with (re)learning the mathematics itself. They are also focussed on creating a regulative context that will ‘empower’ students to find their own voice, particularly to express themselves in English and to present their ideas in a context in which they can build confidence. In a sense what we have here is an integration of M and MT – a pedagogy that focuses on doing mathematical problems, voicing ideas and presenting/ explaining (imparting) problems to others.

In the calculus modules, working through the problems is also seen as very important however in these modules the lecturer does teach and do examples with the students. Students also spend time in the class working on problems with the lectures help. The focus here is on providing access to the mathematical ideas and methods of calculus through a pedagogic discourse that enables the students to see calculus as more *friendly*, that is, meaningful and understandable.

In the above sections I have discussed the mathematics focussed modules in some detail. One point that was not made, and which is relevant to the student teachers themselves, is the aspects of the school curriculum (old and new) that have been neglected by this selection. I do not go into any specific details here, except to note that the coverage of school mathematics is limited, for example trigonometry is not considered at all while geometry and algebra sections selected are focused on limited contents and do not cover many aspects in the new curriculum. Many of the new orientations to mathematics recognised in the NCSM (see Chapter 4) are neglected. In the next subsection I will focus on those modules that appear to be concerned with mathematics education and/or mathematics teaching.

2) *Mathematics Education and Mathematics Teaching modules*

While the module *Preparing to Teach Mathematics* at first seems to be about mathematics teaching, we find the outline indicates more than half the lectures deal directly with exponential and logarithmic equations and functions (especially dealing with all those aspects from the ‘old’ curriculum that would be defined as HG). There is a definite split in the outline, with 8 lectures dealing with aspects that could be identified specifically as dealing with (mathematics) teaching and mathematics education. These lecture topics cover: ‘Brainstorming on planning for teaching’; ‘Discussion on lesson plan’; ‘Lesson plan and learning outcomes’; ‘Phase organiser and programme organiser’; ‘Assessment standards and questioning techniques’; ‘Learner centred instructions and cooperative learning’; and, ‘Group work, problem solving and discovery method’. One lecture period is allocated to each topic. There is no indication of any specific resources or reading for these lectures. Also, in none of the interviews did any student/ lecturer discuss these contents. Some of these topics certainly do seem to be driven by an understanding of the new curriculum requirements, although the language and wording referred to aspects of the first C2005 GET curriculum, which by 2004 had been discarded. What is interesting is that the remaining 12 lectures¹⁸⁵ are focussed on aspects of school mathematics, in particular exponential and logarithmic laws, equations and function. This part appears to follow the same pattern as the *Algebra, Space and Shape* and *Algebra and Statistics* modules, with the focus on doing school mathematics and on presenting solutions. It is interesting to note that in the final examination the majority of the questions for this module are focused on fluency with exponential and logarithmic forms, rather than any aspects of mathematics education. Dr B lectures this module.

The other modules, which also appear to focus on forms of mathematics education and mathematics teaching, are *Errors and Misconceptions in Mathematics*, *Instruction in Mathematics* and *Assessment in Mathematics Education*. All three of these modules are lectured by Dr A. These modules seem to be quite different in nature to the *Preparing to Teach Mathematics* module. This conclusion is mainly based on interview material. No course outlines or formal assessments were provided by the lecturer for these modules. The only outline available is for the *Instruction in Mathematics* module, and this was provided by

¹⁸⁵ This is a second semester module – it appears that the second semester is very short because a significant amount of it is taken up by practice teaching. It seems that there are approximately 21 lecture periods – that is about seven weeks of lectures in the second semester. This is contrasted with the first semester in which it appears there are approximately 42 lecture periods over 14 weeks.

students¹⁸⁶. Some course material was also provided for the *Instruction in Mathematics* module, in particular some articles on the history of mathematics. However, from the interviews and the limited material provided, we are able to describe some of the basis for the selection of contents into these courses.

The lecturer does not seem to be able to clearly articulate the basis for why these modules were selected or why they are sequenced in the way they are. However it seems that there was agreement between Dr A and B that these contents should be selected. For example when discussing the inclusion of the first year modules including the *Errors and Misconceptions in Mathematics* module, Dr A suggests,

- Dr: A (...) with the first years, I remember handling a module on error patterns in mathematics, misconceptions, this idea. But from time to time, I always ask myself, when the students come here right from high school and was it really okay, a good option, to say that they begin to think, you know, in terms of their practice, you know. Because for instance, what we are saying there to students is that you are imagining yourself, you are putting yourself in a classroom situation. And you have to deal with all these misconceptions, first of all what are they, what brings them, why do learners make all these sorts of errors, and then thirdly how do you deal with them? So that is out emphasis, can you imagine therefore at first year level fresh from high school, and then already we are actually saying you know you are in the classroom situation. Maybe that is not bad, but I keep on asking myself whether we shouldn't have thought about having this module right at the end, you know when really a learner has seen, has been to schools to observe lessons, has been to school to do the practice teaching, you know has undergone a number of different modules, now we begin to say, okay what are the things that you have found learners to be doing, you know, why? What causes them? So **that just proved my point that really it wasn't based on anything, unfortunately, but we just had to do, make those decisions to say, okay, from our experience we think this will be okay.**
- Di but what you did think was that focussing on error patterns was important [...]
- Dr A It is an important thing, obviously that there was no disagreement over that at all. (IAT-A2)

Here we see the lecturer once again indicating that there was no conscious basis for making the decision to do this module in the first year, neither was there any conscious reasoning given to why this ought to be done – it was *obviously* important. She indicates that while this was not conscious, there was no disagreement between Dr A and Dr B that this (error analysis) should form part of the mathematics teacher education curriculum. Error analysis and misconceptions are an important topic in mathematics education more broadly and it appears it is a common thread in mathematics teacher education in South Africa (Adler et al., 2005b). This aspect circulating in the field of mathematics education clearly underpins the inclusion of this module, even if not consciously. Later in the interview when she was asked to try and express what she hopes to achieve through this module, we see that what motivates this is a discourse which puts learners at the centre of pedagogy,

¹⁸⁶ Two of the students in the sample produced their portfolios for INSTRUCTION IN MATHEMATICS as part of their selection of significant work done across their B. Ed degree.

- Di [...] Say for example in the Error Patterns course? What are you hoping the students will internalise?
- Dr A: Okay. If I may come specifically to that one. What I am hoping is that I'll be having teachers who are sensitive in terms of, you know, what students do and in terms of being interested in looking at their work. You know, so you are not just interested in putting either a cross, those crosses etc, etc, but if you really interested to say, okay, if so and so is unable to handle this, what could be causing it? Because the aspect of communication, also, we emphasise in this course. The aspect of going back to learners and say, lets sit down. Why did you do that? Because in the midst of doing that they were able to uncover all sorts of misconceptions that learners may be ... so sensitivity for me is a very important one. Yes and doing something about it. Of course you cannot hope to cover everything in terms of, you know, but at least I'm just hoping that they will be sensitive, you know. (IAT-A2)

That the mathematics education courses offered by Dr A are all underpinned by discourses that attempt to put learners at the centre of pedagogy. This is also illustrated in the *Instruction in Mathematics* module. The course guide for this module (provided by one of the students) suggests, in the section on aims that:

Most teachers would agree that occasionally children experience difficulties in learning mathematics. Part of this is a result of the manner in which our learners are taught mathematics. Instruction in Mathematics course is designed to make an attempt in this problem. (Instruction in Mathematics Course guide, prepared by Dr A, p 1)

There is a suggestion that the difficulties that learners have with mathematics is a direct result of how teachers teach the subject, and that this course is focussed on how to teach in a different way, a way in which will help learners not experience these difficulties. Dr A stressed this when asked what they hope to achieve through the *Instruction in Mathematics* module. She suggested

Yes. First of all, they will realise that there are different approaches. Maybe it is the basket analogy I explained. I will just want to bring different ways of doing things, you know, teaching, you know, investigations, problem solving, you know. (IAT- A2)

The 'basket analogy' was explained earlier in the first interview. Dr A suggested that she sees teachers being equipped with a basket of things (containing, for example, chocolates, oranges etc.), and whenever they are confronted with something in the classroom they will reach into the basket and find the thing (whether a chocolate or an orange) that will be appropriate for that time and context. In this way they do not rely on a particular theory or way of seeing things, but rather they have a whole set of choices from which they must make their selection depending on the context they find themselves in. How they are to acquire the rules of recognition and realisation for the contents of this 'basket' and the appropriate contexts for their use is discussed in the following transcript extract.

- Di You talk about your basket with all the different chocolates and things in it, are those, where are the chocolates coming from? Who produced the chocolates?
- Dr A Yes. Who produced the chocolates? (laughs) That's a good question? But who produced the chocolate, er, I get many of those from readings, from articles, from conferences, from focusing on what has worked for certain people, but I just don't want to. I hate the idea of coming to say, OK, I am a constructivist teacher, you know. And constructivism is a, b, c, d. I

hate that idea. Because I am saying to my students, you see, you must ask yourself is this going to work for me? Is this working? What can I find? Something in the basket, that I can take. You see, for instance, at times I think we underestimate the problem we are sitting with in many South African classrooms, mathematical classrooms, the fact that we are dealing with mixed abilities. To me that causes a huge challenge. How do I go about, you know, teaching all these learners of different backgrounds you know, so, that is why I am saying the chocolate, perhaps, could work with these students, and the orange perhaps could work, so we need to consider all that.

D You say I'm going to take out this particular chocolate and look at it. The students. How do they get access to that basket? You have access to it, you have got it. How do they get access to that basket? Where is the basket for them?

Dr A Ok. That's a good question. Its not my basket. Yes maybe I am contributing quite more into this basket, but like for instance the approach that I am adopting, with my students at the moment, let me take this assessment module as an example. You see there is no kind of strong, strict guidelines about what each one of us should do in a classroom. How you should go about assessing learners. So I would say to students, let us go out and think about what is it that we ourselves in this class, we want to see, we want to have them, you know, informing perhaps our assessment scheme or what ever. You know. What is it that, we go through a very long discussion for instance, on say, ok lets look at the role of class work. Do we need that? ... and so we put more into that basket.
(IAT-A1)

It appears from this that Dr A is suggesting an eclectic approach. Each student will have to decide for themselves what approach they should use. She recognises mathematics teaching approaches as being more like a collection of horizontal discourses (localised to context, what has worked for someone). While she knows that many of the ideas that she has in her 'basket' are selections from things she has read from the field of mathematics education (articles and conference papers), she also recognises that this field is weakly organised and does not have a strong grammar (so there is no one way of going about something). While she is working with principles that are possibly based in this field herself, it is not at all clear how she sees students gaining access to any principles on which to base their approach. In some sense it appears that it may simply be a question of practice. While she indicates that students are given some reading to do, for the most part it appears that the way students get to know these different approaches is to get them think about what would be best and then to discuss their thoughts. This is confirmed later when the pedagogic mode in operation in the *Assessment in Mathematics Education* lecture is discussed (see Section 3.2 below).

For now I want to focus on the question of what underpins the selections into the *Instruction in Mathematics* module. In discussing the principles underlying the selections into this module, the following was suggested:

Di Do you have an underlying theory in that course?

Dr A They way I would approach it is to say lets look at this. Lets look at how we can do it. So it's a problem posing sort of approach that I adopt. I wouldn't come to them and say, OK class, today we are doing problem solving. But I would come up with something, for instance, if I am explaining the importance of sometimes using mathematics and relating it to our everyday experiences, I would say, lets think about these birds they are flying, and all of a sudden as they fly, one bird greets them and says hello a hundred birds, and so on, and then the other birds respond and say, you know, 'no we are not a hundred' [... some problem is framed] and

then what's the answer? Ok, lets go for the answer. So we work out that. I would try and go right round the class, but eventually I'll say maybe, shouldn't, don't you think that it may be a good thing if we set up this way sometimes if we want to teach linear equations, etc, etc, so that we don't just go straight into linear equations and say, today class we are going to, so that is my approach, it is more of a problem posing ... yes.
(IAT-A2)

Here we see Dr A suggests that she wants to illustrate a particular approach through this module. In particular she wants to illustrate an approach which uses problems as the basis for introducing new mathematical topics and for linking mathematics and 'everyday' experiences. However, how this is made explicit is opaque. Also there is no evidence that this is assessed in any of the modules for which formal assessments are available (see section 3.3 below which discusses the formal assessments). While she expresses her intentions in terms of a 'problem posing' approach, further discussion on this module does not necessarily support this view. However, it does seem that throughout the idea that working problems (practicing) is important for developing problem solving ability, and this forms a basis for reflecting on approaches to teaching problem solving.

In the following extract Dr A illustrates this in more detail

You [student teachers] have to decide what you have to do. [...] I'm not a big fan about having these study guides with strong prescription about you know, students will do this and this and this, you know, because the problem, the danger, I've seen in that with my whole experience of teaching is that students will tend to think 'what is important is in these things'. I stress the point that [...] what I am doing, what **I'm giving you** I think is **what I feel is important** – and rather make them some notes and **we discuss about certain things, we debate things, issues etc**, etc. But really to say I hate this thing to see students, you know, using these guides as, as sort of a bible to them, you know. So **I'm very open about what I'm teaching**, you know. I'll look at this and this and this and then I'll discuss a particular point. Like for instance, if I may come to what I was doing to give you an example, I was doing with my B.Ed 1 class [...] misconceptions, errors you know, in mathematics. But, to think that, we begin, we start by analysing you know, what could bring in this misconception and in many cases, we also point fingers at us as teachers. You know, that a lot of our teaching also leads to these kinds of misconceptions. And instead of coming to them and say okay, we look at misconception a,b,c,d ... I begin by looking at such issues like, I mean things like that you ne, we would rarely hear, find teachers mentioning in classrooms, like for instance, a lot of them have heard that dividing a number by zero is not allowed. But maybe you would be fortunate if you could get one who would be able to tell you why, and convince you why dividing, a division by zero is. So the way I would approach a module like that one I, I would go into what I think are the basics, you know, the depths, what should form the, the, depths of their understanding – look at issues of zero. To come back to the class I had about two days ago with them, the whole lecture period for instance was, we spent the whole period talking about the algebra misconception and the algebra misconception that we looked at on that particular day, was this whole issue of signs. Multiplication of signs. How often do you find learners knowing that if you multiply a negative number by a negative number I will end up a, our result is a positive number. And we tend to underestimate for instance, the confusion that it may bring to our learners. And. So we spent the whole period talking about, you know. What does it mean to start with things that are negative, and then the result is positive? So, that is my approach really. And **those kinds of things sometimes they come into my mind**, and, therefore, it is for this reason that **I don't want to be confined**, very much with you know, with what I am doing you know. Yes. And the whole class, you, if you had seen the debate, that went in there, and students coming with very interesting novelties you know, [...] but eventually we would want to see how can I convince my students, mathematically that that indeed this is wrong [...] we ended up not having reached whatever consensus, so **that's the kind of liberty that I want in my classroom situation**. Yes.
(IAT-A2)

Here we see the description of a practice in which the selections of knowledge/ contents into the curriculum is fairly eclectic in the sense that it will depend on a particular context at a particular time, and will work with the ‘stuff’ that is introduced into the enacted curriculum (within the pedagogic contexts of particular teacher education classes) by the student teachers in the class.

Moving to consider the *Assessment in Mathematics Education* module we find that the pedagogic approach taken is much the same as that used in the *Instruction in Mathematics* module, i.e., discussion and coming to a group consensus. However, the principles for selection are grounded in an understanding that assessment is a crucial lever of change in the system, as seen in the following extract.

(...) **assessment is one of the very important determinants of how successful our reform is in mathematics, transformation, you know, outcomes based education.** So I try to spend a lot of time just talking about the importance of assessment. And **I approach it the same way.** Why study assessment? And learners will come with this and this and this, etc, etc, but also in a module like assessment, I don’t want to leave things at just a superficial level. To say, okay in assessment, we can look at different methods, we can look at portfolios, we can look at projects, but what would it really mean to do a project in mathematics. [...] That is what I will try. I know its difficult. And I know I am not doing enough. But that is what I try. Because one thing, I want my students to say, I have been in the class and now that I am teaching, I can always go back and think about what we did in the class. And it will not only help myself but also the other teachers, the colleagues that I am working with, you know. It must be clear when we say, in our department at school, this is our policy and these are the things we are looking at. But what is it, what are the, so I try therefore not to leave issues as we just read them from books etc, and from workshops etc, etc, because I have looked at those and you know, still they can’t explain to you. [...] Not only to say, okay journals are okay, portfolios are okay, but what are the specifics. What are we trying to look at in the journals and the portfolios, as an example. And **we cannot expect somebody to give answers for us, because answers simply don’t exist.** They are not there, you won’t find them. [...] I don’t have the answers, **maybe as a class we need to work out** for instance, that, ok if we are going to use a journal form of assessment, maybe **for us this is what we think is important.** [...] So to come to your question, what I am trying to get at, one of the things that I am trying to say to the students is that at least here is some idea of doing certain things. Because as opposed to that he can always change the way he does it. But at least there was some exposure, there was some debate, there was some discussion around certain issues you know.

(IAT-A2)

So while there should be some idea of how to go about it, to get these ideas of how to go about assessment it seems that the resources to be used is what we think will be useful, as expressed by Dr A:

[...] I think I am very, **I try to be very democratic,** yes, in the way that will suggest that, you know, **students also have a voice.** I want to give them a voice you know. To suggest how we do it. In this module, the one on assessment, **eventually we will bridge a consensus to say, for us in this class of 2004, this is what we believe assessment in mathematics FET level should look like.** Of course, we will go to the other documents, like for instance the National Curriculum statement for mathematics, later on, but for instance I haven’t touched it [yet]. I haven’t talked much about it. But I have said, okay **what do you think is important?** And then we will say, can we incorporate some of those things? Because to be honest with you, **teachers are not aware of the kind of flexibility that is given to them, that as long as they aim to do something and you are accountable,** you know, yes.

(IAT-A2)

This supports the conclusion made in the discussion of the *Instruction in Mathematics* module. Here we see what really does appear to be an important aspect of the curriculum – to recognise the student’s voice and to take what they bring seriously, so seriously that the approaches that are developed are based, to a large extent, on what they bring to the class. They must think about an issue, consider the contexts they are familiar with, and come up with suggestions for practice. These will then be used as the basis for discussion and for coming to a consensus of what counts as ‘good’ mathematics assessing (teaching) practices within their contexts. This practice is illustrated in the pedagogic context analysed later in Section 3.2.

It appears from the above discussion that in Dr A’s ME classes, there is a weakening of internal framing over discursive relations particularly with respect to selection (what is brought into the context for discussion – students voices and ideas are taken up into the context as requiring serious consideration). It is also clear that classification is weak, what is to be learnt is not clearly distinguishable, the recognition rules for what counts as legitimate (re)productions are fairly opaque and diffuse. What ‘counts’ as legitimate is often not arrived at, and if it were it would need to be decided be on the basis of consensus within the group (although as the lecturer she would try to convince the group, particularly if there were mathematical grounds). That is there is no discursive knowledge base for making these decisions. It becomes apparent throughout the interview that in relation to ME and MT there is no right or wrong way, no clear basis/ principles or criteria exist for making decisions about what counts as legitimate. The way ME and MT are constituted within this curriculum is through consensus based on what the lecturer and students think and feel based mainly on mathematics learning experiences.

When asked directly, Dr A tried to articulate her ideas on the theory of teaching and learning underpinning her selections into these modules,

- Di: Just going on from there, to ask you, is, do you have any main theoretical ideas that you use for the basis for what, for what you selected. Is there any main theory that you, theory of teaching and learning that you use, or, you work with with your students?
- Dr A: Oh ja. Not any particular theories. But, well from time to time I would mention to students that um, well, what we are doing maybe somebody may have looked at these, and er, but really I’m not restricted by er, whatever particular theory
- D: Okay. So you’re not, you’re not looking at a theory, you’re basing it on your experiences and your ... what you have read and the whole wide ...
- Dr A and also **what is expected of teachers**, you know, of teachers. What it is that they should be teaching? So if perhaps **we can regard the NCS as providing some theoretical sort, some theory**, then perhaps yes.
- D You’ve used that?
- [...]
- Dr A ... we talk about the fact that you know **in order to deliver such a curriculum you will need a teacher who has these qualities**. And, where do we get that? We have to go to the **Norms and Standards for Educators, which really, really spells it out**. So for me, that is the start.

What is the kind of teacher that we are trying to produce at this university [...] And what is the kind of a teacher that has been envisaged, you know, in the whole curriculum transformational process. So for me that is the beginning. For instance we talk, we spend some time maybe about **teachers themselves, being scholars, researchers and life long learners**. We really try and explain what that means. You know. And we find examples where really we can be a scholar and a researcher and a life long learner. So for me **those roles for teacher educators is the beginning**. Yes. (IAT-A2)

Dr A sees the role of scholar, researcher and life long learner as being the most critical. She wants her student teachers to know that it is okay if they do not know everything, and to be confident to go and find out what they need to know. As she puts it:

what I encourage them to do is say, ... go and see if you cannot find these, if you cannot go and talk to teachers who may have experience and who may have looked at this problem. Go and read, you know, the books, you know, talk to people, talk to who so ever you come across. So I don't really rush them, I want them to go and look for this information on their own. [...] So I like students working on their own and students doing all sorts of presentations and, we discuss issues, that is my approach. [...] But the roles are only important in as much as you try and you know, translate them into what is it that you, in terms of your mathematics teaching, what is it that they actually mean. [...] I want to see a teacher who is hungry for knowledge, yes. And even me, I try to preach that gospel, to say as we are here I also have to consult a lot, have to talk a lot, have to talk to teachers, because I am hungry for this knowledge, I don't know everything. So for me a teacher, therefore, if I can have such a teacher, that would be incredible, that would be excellent for me.

An important thing for Dr A in learning to become a mathematics teacher is the attitude one has towards learners and she stresses the importance of this as a thread that goes through all her classes (M and ME),

(...) well, yes. For instance, I don't know, the way I have taught them is that they have got to be open about what students bring into class. They have to be sensitive to students answers and, so in other words, it's no more a case of I teach them this, and. Just to give you an example for instance. One thing I do a lot. I would use an example of multiplication for instance, to say look we tend to focus too much on teaching students certain algorithms, certain rules, certain laws, etc, etc, but I bring them a lot of examples on multiplication which students are not aware of. To say, ok, if your student were to come to you with this answer, what do you think would have happened to you. Would you have accepted it, etc, etc. but, you know, be open to different methodologies, to different ways of doing things, etc, etc. so, those are the kinds of teachers I would have liked to have in the end. But you know, what I am doing might not necessarily determine that I will end up with those kinds of teacher.

To summarise there are four different modules which were originally identified as possible vehicles for specialising mathematics education and mathematics teaching identities. One module (*Preparing to Teach Mathematics*) appears to focus mostly on (re)learning some school mathematics, in particular some selections from a fairly traditional (in South Africa) algebra curriculum, with a lesser focus on aspects of what could be seen as professional/general pedagogic knowledge that appears to be influenced by early 'OBE' type prescriptions (official discourses) generally circulating through training workshops when C2005 was introduced. The bulk of the module seems more appropriately located with/ identified with the *Algebra, Space and Shape* and *Algebra and Statistics* modules, which all have similar

approaches to both content and pedagogic practice, and use the same school level text book as the source for course work material.

The other modules (*Errors and Misconceptions in Mathematics*, *Instruction in Mathematics* and *Assessment in Mathematics Education*) are differently organised. While doing mathematics problems still seems to be a major focus in all three of these modules, they are not necessarily focussed on traditional school mathematics, for example, they include non routine problems and puzzles (for example see Figure 39 in section 3.3 of the current chapter). Students work on the problems in the classes as well as in their own time. Doing the problems enables the students to build confidence in their problem solving ability. In addition, when they voice their ideas it is not always in the context of teaching other students, it is also in a context where they participate in a class discussion (large class) so that they can come to a consensus on what counts as ‘good’ practice and what practices they should be collecting in their ‘basket’ for later when they go out to practice. There is a definite implication that when dealing with maths we need to bring the students to a mathematical consensus, but with mathematics education and teaching the field is open, and as long they come together to discuss the issues and come to a consensus on how to think about these and what to do in relation to this, the job is being done. Nobody has the right to say what is right or wrong here, as a teacher you must decide what is best in your context. However there is together with this a general attitude/ disposition that Dr A attempts to cultivate – one in which student teachers are open to listening to their learners and in which they strive to understand their learners’ thinking; where they recognise their own limitations and see themselves as scholars and researchers striving to improve their knowledge and practice; and, where they develop confidence in themselves to do so.

3) *Practice Teaching*

I will now consider the place of practice teaching in the RU curriculum and whether and how this is connected to the specialist discourses discussed above. Earlier it was established that practice teaching has no formal credit allocation¹⁸⁷ and from that point of view it is possible that this aspect of the curriculum is experiential, enabling the students to practice teaching in an authentic context, but probably with little tutoring/ formal assessment of practice by

¹⁸⁷ This is a serious omission within the MTE programme. Without specific module credits, and therefore fees, the practice element of the programme is completely under-funded. While teachers go out into schools, there is no possibility for properly supervised learning in and from practice. The costs of a properly organised, supervised and assessed practical learning experience are not factored into the programme.

university based lecturers. In this sense it is unlikely to have a mathematics specialist focus. This is confirmed by discussions with students and lecturers. For example, Dr A explains,

(...) in the Norms and Standards for Educators, the whole issue of practice teaching, for us I don't know, it wasn't really clear, it was like, its not there (...) there was just a mention, a sentence or whatever about teaching practice, and the approach unlike what we used to do, where we used to have methods of mathematics, methods of this and this and this and so now, what we have decided to do in the faculty here is that people are told, say, **try and incorporate the practice in what you are teaching**. (...) in many cases we don't seem to be doing justice to that. You know we focus too much on teaching and, teaching this and this and this and really this becomes very obvious when students have to go out on teaching practice and begin to ask how do we do this? You know, how do we write lesson plans? You know. And then sometimes the question is, I mean, BUT what are you doing in your respective modules? That is not a problem for mathematics only, but I think is generally a challenge in the faculty we are facing. (...) But on a personal level really, I'm one of those people who have, who **really tried to incorporate it**. You know, if I'm teaching a particular thing, lets say, I'm talking about problem solving, I'm talking about that, but I would also say okay lets look at what, you know, we can do, how this can be done in the real classroom practice. (IAT-A1)

Here we see that Dr A sees that some of what they do in the context of the lecture theatre is intended to feed into their practice and prepare them for teaching in the classroom. Recall Dr B's comment that one of the reasons for using the approach which gets students presenting to their classmates in first year, is because they are going to go out and teach and have had no experience of this.

In general however, practice teaching is experiential. Students go out to schools to teach twice a year from their first year. No credits are allocated to this aspect of the curriculum. Students find their own placements at schools of their choice (usually closest to where they live, for financial/ logistical reasons) so there is no control over who school mentors might be etc. From second year on, lecturers come and see the students once for each specialisation in the second semester practice block. Thus they are observed teaching mathematics by a university based lecturer three times over their whole university career. There is no developmental aspect/ tutoring aspect involved in these visits. They are simply evaluated in general terms by a lecturer who may/may not be knowledgeable in their area of specialisation. If a student is lucky they may end up with a teacher in the school who provides some mentoring.

3.1.2 Space and time in the curriculum

The first point is that education students study together and are taught all their Mathematics and Mathematics Education modules in the Education Faculty. From this perspective they are taught in strongly classified spaces away from other RU students taught in other faculties. However, it is also the case that since these students are located on a general university campus and the majority of students on the campus are residential, the space outside of the MTE classes is more weakly classified. This opens up opportunities for interaction outside of

the MTE classes with students who are not education students, not only for social activity but also for academic interaction. In particular it appears that the context enables productive pedagogic spaces in which mathematics education students interact with mathematics students in the science faculty¹⁸⁸.

A further aspect is that the learning spaces are relatively large lecture theatres that seat approximately 100 students. These have fixed rows of chairs and desks which face a podium in the front. There are two aspects associated with this. Firstly that the learning space within the MTE classes is relatively strongly classified with respect to seating arrangements and this limits possibilities of interaction. A second problem with space, particularly in the large core lectures is that there is insufficient seating for all students, which leads to problems of overcrowding and limits possibility for diverse forms of pedagogic interaction.

It is a further feature of this context that the University time-table is structured so that there is fairly limited contact time. Students have on average 15 – 20 lectures per week and this enables time outside of the MTE classroom for independent and group work. It is clear that lecturers have heavy teaching loads and structure work for students to do outside of the contact periods that makes demands on the student teachers to take responsibility for a great deal of their own learning. That there is relatively little contact time also means that there is a potential problem with coverage of contents.

Finally the logic of sequencing of contents over the four years of the degree is opaque. The contents of Algebra sections can be seen to progress from Grade 10 contents in the first year of study through to some Grade 12 contents in the fourth year. In between these however are the Calculus modules. These do progress from introductory aspects to more advanced aspects over the two modules. However, they are completely isolated from the other M modules which all consist of pre-calculus contents. The ME modules appear to have no logical progression and in this sense the various modules are horizontally organised and are unlikely to build vertical progression within the field of knowledge.

3.1.3 Classification and framing and the construction of pedagogic discourses for M, ME and MT at RU

From the discussion in sections 3.1.1 and 3.1.2 a number of aspects with respect to the ‘*what and how*’ of the MTE curriculum at RU become visible. This is recognised in relation to the

¹⁸⁸ For example, see Chapter 12 for the discussion on interaction with science students in relation to solving calculus problems.

overall selection and organisation of specialised contents and practices in the B.Ed curriculum and to the way in which these appear to be made available within the pedagogic context. Referring back to the model (see Chapter 5) of specialised discourses within the teacher education programme we can now provide a first level interpretation of the RU curriculum.

Firstly we recognise selections of all three knowledge discourses (M, ME and MT) within this curriculum.

M contents appear to be selected into the curriculum for two purposes:

- M(1) (re)learning school mathematics that students may not have had proper access to in the past (mainly algebra but also introductory aspects of geometry) or that are new in the NCSM (statistics);
- M(2) learning some first year university level mathematics (calculus) to get some experience of more advanced mathematics.

Access to M is differentially constituted depending on the purpose. M (1) is to be acquired through practicing problems/exercises independently from the lecturer (working through high school algebra texts in groups/ on own outside of the MTE class) and on publicly explaining these realisations to peers using various teaching aids (e.g. charts etc). These presentations apparently¹⁸⁹ provide opportunities for identifying errors and misconceptions and for addressing these through class discussion. M(2) is also to be acquired through working on problems and exercises, however this is under the guidance of the lecturer, who leads discussions to assist with understanding the content and concepts, who does examples to illustrate methods, and works with students in class as they work through exercises.

Selections into ME appear to be fairly eclectic, framed by the lecturer's orientation to mathematics education and based on her experiences as a teacher, on a general commitment to learner-centred pedagogy (e.g. as seen in the focus on error analysis and the need to consider learners thinking in teaching mathematics), a commitment to developing the NSE roles, particularly 'scholar, researcher and life-long learner', and to transforming mathematics teaching practice through changing assessment practices. ME is not considered as a field for students to study in its own right, nor is it considered as providing any specific legitimate texts

¹⁸⁹ There is little evidence to suggest this happens in practice. It did not occur in the example of pedagogic practice observed where the lecturer evaluated the presentation rather than the mathematical ideas. Also, one of the students, Mazet clearly indicated her disappointment with these lectures where they are not taught and where their mathematical (re)productions are not evaluated (see Chapter 11, Mazet's story).

that should be acquired/ adopted. It is populated by ideas and methods to address issues in mathematics teaching and learning that appear contextually relevant. These contents are generated from practice and general thinking about practice, from official curriculum documents, and from some influences from within the general field of ME brought in by the lecturer. The ideas/ tips/ methods are collected in a 'basket' that can be used later in practice.

Access to ME is principally through class discussions, for example, debating different ideas that are brought into the pedagogic context by the students and the lecturer, or through working with examples from school mathematics and reflecting on these. There are no correct or incorrect realisations. However, there is an attempt allow all voices to contribute and through debate come to some common consensus with respect to the different issues under discussion.

MT appears to be constituted as practical local knowledge. It involves using aids and charts to assist in giving explanations (during class presentations) and is informed by experiences of doing school mathematics and ideas generated through ME and collected in the 'basket'. Access to MT is provided through the evaluation of presentations in the M (1) MTE classes, through reflection on learning experiences in ME classes and through experiential learning when out on practice teaching.

Relations between these various discourses (classification) varies, as shown in Table 28. M(2) is strongly classified with respect to M(1), ME and MT, and has a strong internal grammar. M(2) is weakly classified with respect to MT, these discourses are to be acquired simultaneously through problem solving and presentation. While M(2) has a relatively strong grammar, MT has a very weak grammar and is constituted as a localised and practical horizontal discourse. ME and MT are also integrated. ME is constituted through an eclectic mix of localised, official and academic influences and has a weak grammar.

Table 28: Classification strength between different specialist discourses (insulated +/ integrated -)

Specialist discourses (What)	M(1)	M(2)	ME	MT
M(1)		C+	C+	C-
M(2)	C+		C+	C+
ME	C+	C+		C-
MT	C-	C+	C-	

The principles for the sequencing and organisation of these various contents into the four year curriculum are opaque. Progression in ideas and levels are clearly not a consideration (e.g. selections of M(1) are found in all four years of study, while M(2) is in the second and third year). However, there is a basic principle that each year students will do some modules focussed on M and some on ME/MT.

Relations within these various discourses (framing) are not fixed and are likely to vary as shown in Table 29. In general, evidence suggests that there is a general weakening of framing with respect to pacing across all discourses, evidenced for example, by the ‘coverage’ seen in the summative assessments collected. In every case these appear to assess only a small part of the overall module outline. For example in the Algebra and Statistics module, the outline suggests the first test will be held in April, whereas it is only held in May, and the examination does not include a single question on probability and only covers some very basic descriptive statistics.

Table 29: Framing strength within specialist discourses

		M(1)	M(2)	ME	MT
Discursive order	Selection	F+	F+	F-	F-
	Sequencing	F+	F+	F-	F-
	Pacing	F-	F-	F-	F-
	Criteria	F-	F+	F-	F- (in context of ME and pract teaching) F+ (in context of M(1))
Social order	Hierarchy	F+	F-	F-	F- dominates

Framing with respect to selection and sequencing appears to be relatively strong in relation to M (in both cases contents are defined in terms of notes and problems/exercises provided in photocopies of text books). However, these are weak in the case of ME and MT. No specific texts are selected, all voices must be heard and incorporated into what at the end of the process should be recognised as the legitimate text, and will depend on the specific context.

With respect to criteria for evaluation (recognition and realisation rules), it appears that in M(1) these may be weakly framed in the pedagogic context (since the M1 texts are reproduced by the students and ‘presented’ for discussion, it does not appear that they are ever evaluated by the lecturer apart from in groups and in the classroom contexts¹⁹⁰, and the evaluation therefore may be glossed over, as was seen in the example of pedagogic practice observed, or left up to the class’ comments). In the case of M(2) the criteria are strongly framed (the lecturer uses direct teaching methods and students work on problems under her guidance, examples of student work included in the archive show that some marking has been done). ME and MT are both weakly framed with respect to criteria – there is no right or wrong text, any evaluative criteria are produced through consensus in the ME classroom context. MT is weakly framed in the context of practice teaching where it is assessed only three times over the four years by a non-specialist lecturer. However, in the M(1) context, it appears that there is some evaluation of MT (as presentation) and here Dr B gets fairly ‘strict’ about planning and use of teaching aids.

Finally framing over social relations within the context of Dr B’s lectures appears to be relatively weak in all classes. While there is respectful interaction (for example everyone refers to each other using a title and surname), Dr A attempts to foster a ‘democratic’ classroom in which student voices are valued (in Dr A’s classes (M(2) and ME) they are elicited and their thinking is taken seriously), and self confidence is encouraged. It appears, in the case of Dr A, the influence of the NSE is fairly strong, not so much with respect to the selection of contents for the instructional discourses, but rather with respect to the regulative discourse and in particular with respect to an orientation towards self and others. To be confident enough in oneself and one’s abilities to be open enough to recognise one’s limitations and to “be hungry” to find out more, to consult other people and other sources, to find out more, to be a scholar and a researcher.

3.2 Pedagogic mode in the teacher education classroom

Section 3.1 provided a fairly thick description and an initial interpretation of the FET/Senior Phase B.Ed mathematics specialist curriculum instituted at RU. This gave some insight into the organising structure of the curriculum and classification and framing of its contents. The move now is to focus on the pedagogic interaction within this teacher education context through a second level analysis and description, using the methodological approach discussed

¹⁹⁰ Students did provide examples of work done in these courses, but none of this had been formally marked by the lecturer.

in Chapter 6. This analysis will be used to provide some insight into *how* access to specialist discourses is constituted through pedagogic communication in the MTE lecture theatre. In this section I deepen the analysis and provide additional data to assist in recognising the pedagogic mode for RU's MTE practice.

During the site visit to collect the empirical evidence I observed examples of teacher education classroom practice from one of the modules being taught by each of the two lecturers at that particular time. Each video covered one period (about 50 min of MTE lecture-room practice). I observed Dr A teaching a fourth year *Assessment in Mathematics Education* class and Dr B a first year *Space and Shape* class. It is recognised that this is a very limited set of examples of pedagogy from the MTE classroom. However what we observe in these examples does help confirm and deepen the interpretation provided in Section 3.1.

While each of these lecture observations reveal aspects of the practices being instituted at RU at that time, I made a decision to focus the in-depth analysis provided in this section on Dr A's practice. The grounds for making this decision were twofold. First this is as an instance of what could be described as a dominant pedagogic practice in operation in mathematics education¹⁹¹, and therefore as providing insight into the pedagogic mode within this institution. This is justified on the basis of the description given in 3.1 and on the analysis of empirical evidence provided by students discussed later in Chapter 11. Student interviews revealed that they identified strongly with Dr A and the images they had of themselves as teachers were built on ideals constructed through interaction with Dr A. In particular they recognised themselves in the way she interacted with them, building self belief and confidence in their own capabilities.

Secondly, in the previous section it became apparent that what could be considered as RU's mathematics section's privileged selections into the programme and privileged position on how to make these accessible to student teachers is represented in the practices of both Dr A and Dr B. So the choice of which lecture to analyse would be based on which particular lecture would provide the best slice of pedagogic practice. After observing the two lectures, it became clear that Dr A's lecture provided a better slice than did Dr B's. Below, I give a brief description of Dr B's lecture to support my decision.

¹⁹¹ Note that this may/may not be typical of Dr A's *mathematics* classes - she was not lecturing any M classes at that time. However it is a typical ME class.

The Space and Shape lecture that was observed provided a typical example of one of Dr B's lectures, and confirms a practice where at the beginning of the module, the students were broken up into groups and allocated particular aspects of the work (in this case Grade 9/ 10 theorems, e.g. if the opposite sides of a quadrilateral are equal, then it is a parallelogram) which they were required to 'present' or 'teach' to the rest of the class. They were required to do this in a *different* way from what it was supposed they had learnt in school. That is, they had to use teaching aids (for example, a chart or model) to assist with providing an explanation that would enable access to the ideas. The point was that the theorem be 'formulated' and presented in a meaningful way, so that their learners could have access to it, and not just be expected to memorise it as a script. This practice had been described to me by both the students and Dr B previously, and is what I observed during the lecture. The typical procedure was for a group to come to the front of the lecture theatre, introduce themselves and give an outline of how they would go about their presentation. (e.g., 'Ladies and gentlemen, today we will do theorem x. We are Miss R, Mr, S ...' etc., introducing each member of the group by name and telling the class what part of the presentation they would be doing. For example Mr T might be introducing the statement of the theorem. Miss R would show the chart, Mr S would measure angles, and so on). They would proceed with 'presenting the theorem'. When complete everyone would clap and Dr B would say thank you very much and affirm their presentation in some way or another. Then the next group would come up and so the lecture proceeded. At the end of the lecture time, Dr B went to the front and spoke briefly to the whole class where she evaluated the presentations. The comments made were general comments related to the use of the aids, etc. and whether or not they had managed to get the message across. No evaluative comments were made with respect to the Geometry which was apparently the focus of this module. In general the presentations attempted to show the 'practical' side of geometry – that is they attempted to make the theorem meaningful by introducing measurement as a mechanism for 'proving' the relationship in the theorem, rather than the formal 'proof'. While this practice is interesting as an example of a method for developing confidence in speaking to large groups (there were approximately 140 future FET mathematics student teachers in this group), it did not give me any insight into the lecturer's teaching practice and the way in which the IP in a lecturer-led MTE class would be constituted. Dr A's class provided a better slice of such a practice.

In what follows I provide an in-depth analysis, in accordance with the methodology described in Chapter 6, of the practice observed in the *Assessment in Mathematics Education* class taken by Dr A. As will be seen in the following sections, this slice into MTE practice also presents

challenges as evaluation is implicit within this context. It is acknowledged that these two observations give a limited glimpse of the practice, and that it cannot be assumed that this is representative of pedagogic interaction at the institution. However the analysis does provide an additional source of evidence for the overall interpretation of the pedagogic context of RU being built in this chapter.

3.2.1 Pedagogic evaluation at work in an Assessment in Mathematics Education lecture

The detailed analysis and coding of the transcript in terms of the methodology presented in Chapter 6 is presented in Appendix F.3. In this section the analysis is presented and interpreted.

1) General analysis of the pedagogic context and IP

There are about 40 students in this MTE class. The class is held in a lecture theatre which can seat approximately 100 students. The space is slightly tiered with fixed rows of desks and fold up seats. These all face a raised platform at the front from which the lecturer operates. There is an OHP and a chalkboard at the front. The atmosphere is relaxed and respectful. All students come into the lecture theatre on time. There are no late arrivals. All students address the lecturer formally as Dr A, and Dr A addresses them by using their titles and surname, e.g., Mr Mpe, Miss Molefe¹⁹², etc.

In considering the IP observed in this context, the first thing to notice is that throughout the lecture there is one primary object of acquisition (T): to understand *what* to assess, and, *how* to assess in mathematics. The aspects of this under consideration in this lecture are assessment of ‘conceptual understanding’ and ‘problem solving’ in mathematics. This is the *Assessment in Mathematics Education* module so it would be expected that the focus may be on ME and/or MT rather than on M per se, and this is what is found. There is some movement in the IP through four sub-events, labelled as E1.1 to E1.4, identified across the duration of the lecture.

Table 30 provides a summary of these movements.

¹⁹² These are not real names from the RU context.

Table 30: Movements in the object of acquisition across the IP of an Assessment in Mathematics Education class

Primary/secondary object	Sub-events	Duration of sub-events	Main resource used	Movement in pedagogic judgement	Comment
T: Know why/ what and how to assess in M	1.1	10 min	lecturer asserts	E	introductory comments made – setting the scene
T: what/ how to assess 'conceptual understanding' in M	1.2	14 min	student production	E, R begins	student example is affirmed; evaluation implicit
T: what/ how to assess 'problem solving' in M	1.3	11 min	student production	E, R begins	student example is affirmed; evaluation implicit
T: what to look for in assessing 'problem solving' in M	1.4	15 min	worksheet in groups	E, R begins	L affirms students as they work

A significant feature of the IP was the way evaluative judgements appeared to operate in this context. While it was simple to recognise the announcement of shifts in the primary objects of acquisition, the pedagogic context did not move significantly from the initial moment of existence E, into reflection (R) proper. It appears that pedagogic communication in this lecture could be considered as the beginning of the process of reflection.

Texts were brought into the practice which appear to form the beginning of some move to R, that is as examples of what could count as instances of, for example, *what* to assess when assessing 'conceptual understanding' and 'problem solving'. However very few possibilities were generated and little movement was recognised towards *identifying* what would count/not count as a legitimate instance of the T object(s) to be acquired.

The overriding impression is that evaluation works at an implicit level in this context. It does not explicitly work at negating inappropriate texts and affirming appropriate texts by appealing to legitimating grounds (however they are constituted), and so reveal criteria for moving towards necessity. Rather evaluation appears to *accept* and *value* all contributions as possible instances of what is to count, and in this way *affirm the individuals* who bring these into the pedagogic context. This will be illustrated through an example.

The next comment is made in relation to the movement through different forms of pedagogic interactions in this MTE context and the pedagogic space that this supports. A summary of the forms of interaction across the IP of the lecture is found in Table 31. Across all the events five forms of pedagogic interaction were observed: in E1.1, lecturer exposition; in E1.2 and E1.3 student presentations accompanied by lecturer questioning; and in E1.4 small group work and

discussion. In addition in E1.3 there was some movement towards a whole class discussion. The use of student presentations and lecturer questioning is clearly the dominant form of interaction in this practice. How this works to constitute the legitimate text for *what* it means to assess ‘conceptual understanding’ and ‘problem solving’, for example, appears to be through a practice that accepts all student productions (examples) as legitimate examples without providing any grounds for this acceptance. In other words it acts in affirmation of *whatever* is brought into the context: the students’ contributions are always recognised and affirmed first. If questions are raised this only happens *after* they are affirmed (as will be shown in the example below). Also, if they are questioned, the question is put as a suggestion, or given as a hint, rather than being explicitly expressed, and thus remains at an implicit level. It is also left for the class to decide on, since, as is asserted (in E1.1) there is no right or wrong here, and “nobody is going to say to us ‘this is how you do it’” (Dr A, LO-VT-AM).

Lecturer questioning in this context appears to be used as a basis for clarifying the examples brought in by the students and in attempts to move things forward within the pedagogic space. However the focus of the questions works to acknowledge the contribution, rather than interrogate it, and so the criteria for recognition of the legitimate text remain obscure and implicit. The pedagogic space that is opened in this context is limited to the experiences of the participants. This is illustrated in the example that follows.

Table 31: Forms of pedagogic interaction across events in the context of an Assessment in Mathematics Education Lecture at RU

		whole class discussion	small group discussion/work	individual work	lecturer exposition	lecturer question and answer	student presentations	lecturer questioning	student questioning
Mathematics		0	0	0	0	0	0	0	0
Proportion	sub-events (N=0)	0%	0%	0%	0%	0%	0%	0%	0%
Teaching		1	1	0	1	0	2	2	0
Proportion	sub-events (N=4)	25%	25%	0%	25%	0	50%	50%	0
Mathematics & teaching		1	1	0	1	0	2	2	0
Proportion	sub-events (N=4)	25%	25%	0%	25%	0	50%	50%	0
No. events form used		1	1	0	1	0	2	2	0
Proportion of events (N=4)		25%	25%	0%	25%	0	50%	50%	0

An example: Affirmation as a key feature of pedagogic interaction in the Assessment in Mathematics Education lecture

The main object of acquisition is announced at the beginning of the lecture and this clearly indicates that the process for making decisions over what will come to count, for this group, as legitimate in terms of what and how to assess in mathematics, will be built through consensus. There is no authorising field or correct way to think about this. As Dr A puts it during the introductory part of the lecture (E 1.1),

What are the kinds of things you may be looking at? There are **no fixed rules about how to do it**. That's why I'm saying this discussion is open. **This type of assessment is open for discussion**. Because nobody is go to say to us 'this is how you do it', isn't it? But here **we need to come to some kind of consensus**, to say maybe, if we are focussing we want to check the concepts, we want to look at understanding, conceptual understanding, these are the kind of things we should be looking at. (...) where we will say **as far as we are concerned these are the kind of things that our assessment scheme should incorporate**. There **are no fixed rules** about these things. (Dr A, LO-VT-AM)

In the previous lesson the class had started this discussion and students were each asked to think about what it would mean to assess 'conceptual understanding' and 'problem solving' in mathematics. They were asked to select questions for assessing each of these and to bring them to share with the class. They should be able to explain *what* these questions would assess in term of 'conceptual understanding' and 'problem solving', and *how* they would be used to assess whether a learner had achieved this or not. The main resource the students were expected to use was their own experiences as fourth year mathematics student teachers. It appears that the lecturer was setting up the situation where the examples that the students bring would be used to assist the whole class to come up with some criteria for assessing these particular aspects of mathematics learning. In E1.2 and E1.3 students are invited to come up to share their examples with respect to 'conceptual understanding' and 'problem solving'. The pattern in both these sub-events is as follows.

Firstly a student presents his question – a question that is apparently designed to assess either 'conceptual understanding' (in E1.2) or 'problem solving' (in E1.3). The student does this by writing on the board and explaining their idea. The lecturer then asks the student some questions to *clarify* the contribution, and makes a summary of what is being presented on the board. Once this is done the student sits down and the Lecturer invites comments from the rest of the class. In both cases another student adds something to what has already been presented. The lecturer then asks the class if what has been presented (as represented by her summary list) is "okay". It appears students are expected to *already have access to the basis for the text that is required* (that is, what it means to have conceptual understanding, and what it means to problem solve in mathematics). The examples they bring therefore represent ways of assessing

these assumed notions, and will be used to summarise the criteria for the legitimate text (lecturer's summary). On a number of occasions the lecturer states that she does not have the answers, the students should present the answers. This process is illustrated by considering the following extracts from the transcript.

In E 1.2, a volunteer, Mr Mpe, comes forward and presents his example of a problem which assesses 'conceptual understanding'.

Mr Mpe: My problem was on Pythagoras' theorem. (...) Firstly I looked at it as if we have already done the chapter of Pythagoras' theorem. **So first of all I look at the definition, "what is defined as Pythagoras' theorem?"** (...) so **I ask for the definition** on the conceptual understanding [... do...] they have understanding of the definition. So first they should define it. **Secondly, I looked at the formula that is used** when you are getting the sides of a triangle, of a right angled triangle, like this one is a x squared plus y squared is equal to and then I put a question mark [writes on the board: $2. x^2 + y^2 = ?$]. (...) So **this is like looking at the conceptual understanding of the Pythagoras theorem.** Then (...) **the next question is, "What is the name given to the longest side of, what, a right angle triangle?" So that I can see (if) they can relate the definition of what, of Pythagoras' theorem, with what they have seen.** (...) they [...should ...] know that this side is called what? The hypotenuse (...). (See Plate 6 below for a view of the board at the end of this presentation). (LO-VT-AM)

We note that in his presentation the student has suggested that assessing for 'conceptual understanding' is the same as (1) checking that the learner has knowledge of the definition and its formula – i.e. what is meant by conceptual understanding here is related to knowing the content/ facts related to the specific mathematical object, and (2) that to test for conceptual understanding you need to assess if they can 'relate' the definition to things they have 'seen' – i.e., can they relate the definition to a practical situation, for example, a 'model', drawing' on some or other 'visualisation'? (In this example, can they relate the formula for Pythagoras' theorem to the correct sides of a right angled triangle, and name the sides).

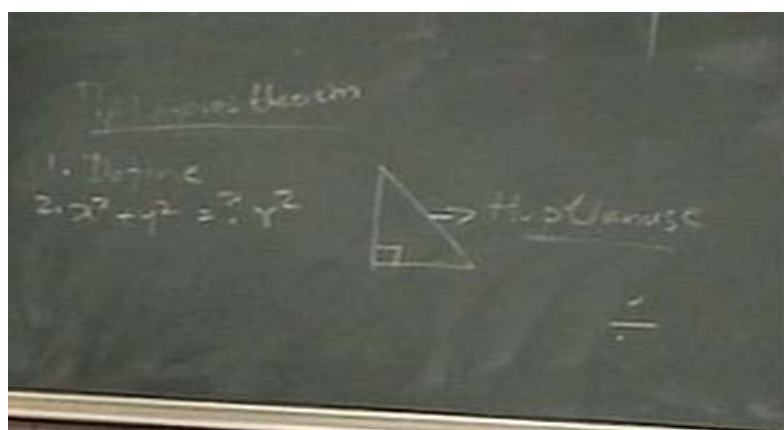


Plate 6: Mr Mpe writes up his example of a question to assess conceptual understanding

The lecturer comes back to the front of the lecture theatre and uses questions to begin a discussion of Mr. Mpe's problem. The following interchange, which is illustrative of what is later seen to be typical when a student's ideas are clarified, takes place:

- Dr A Okay. So in other words **you wanted them to start defining things first**, isn't it?
- Mr. M Yes.
- Dr A Okay. Okay. **Thank you very much.**
- (...)
- Dr A Maybe before you sit down, what is it that you wanted them to define here? Can we come to the specifics?
- Mr M The specifics are 'What is the Pythagoras theorem?'
- Dr A Pythagoras Theorem?
- [...]
- Mr M yes
- Dr A Certain terms of the theorem isn't it? State the theorem. [L writes: state the theorem on the board] **Right! Thank you very much.** Yes, and then in number two?
- Mr M: In number 2, to give them the formula, then they are going to put in what, ...
- Dr A: Okay. Lets say, the formula, ...
- Mr M ... [not audible]
- Dr A **Ok, they were expected to complete the formula in relation to the Pythagoras' theorem. Isn't it?** [writing on the board – see Plate 7 for the summary provided at the end of E.1.2]
- Mr M yes
- Dr A The formula, it had to do with the formula, isn't it? **Ok. Thank you.** Something else?
- Mr M The very last one was just **to see if they can identify the hypotenuse on the right angled triangle.** The hypotenuse. **Because I have had learners that are ...** [inaudible]
- Dr A Okay so it was still a way of saying okay, the new terms, that learners have to define, certain things in the data, what is the hypotenuse? What is this side? Isn't it?
- Mr M yes
- Dr A **Ok, very good. Thank you very much. Isn't it? It's a very good example.** (LO-VT-AM)

We see here that all the questions addressed to Mr Mpe are for clarifying what was said in the presentation. The student attempts to justify his position in relation to his experience of learners. Dr A, accepts what has been presented more or less as is, simply rephrasing it, thus suggesting better phrasing for the questions presented. However, the criteria that the student used to decide that this is a good example for testing 'conceptual understanding' are not probed. Mr Mpe is affirmed – it is “very good a very good example”. Why this is so is not made clear. The evaluation that takes place is affirming, but does not reveal criteria for what is to count as a 'good example'.

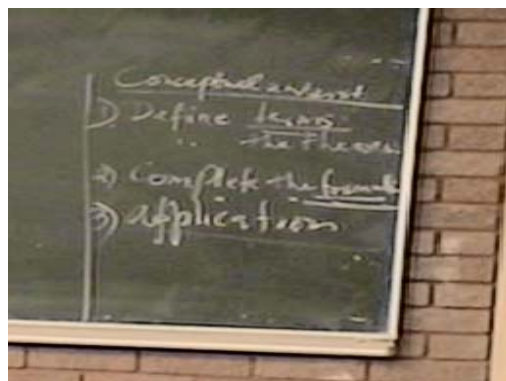


Plate 7: Dr A's summary of what to assess when assessing for conceptual understanding

As the lecture unfolds we see this is a pattern. Students are continuously affirmed. They have important contributions to make, they are knowledgeable, what they say or do is always 'interesting', 'good', 'very good', 'excellent'. Students are never told that what they have said or written is incorrect. However, it is noted that there are a few occasions where the lecturer

hints that what they have said may later be adapted or even rejected. There is an implicit message that this is ‘not the whole story’. For example, E1.2 continues after the above exchange. Dr A focuses on the list she started earlier and attempts to get the rest of the class involved in developing it. Another student suggests that one needs to ask a question that tests application of the theorem and Dr A responds with “Can you give us an example, for instance? Application of the formula. This is **very good**.” (LO-VT-AM)

The student comes to the board and addresses the class, eliciting a common Pythagorean triple (3, 4, 5) from them. This is ‘plugged’ into the formula to show an ‘application’ of the theorem from which conceptual understanding can apparently be assessed. The grounds on which this will assess ‘conceptual understanding’ remain completely hidden. Dr A responds with:

Okay. Good. Excellent! Yes. This was an example of the application of the formula. Isn’t it? Ja. Ok can we, [pause] Have we exhausted the kinds of things we can look for in conceptual understanding? [looks at class?] Yes? (LO-VT-AM)

Dr A does not give any indication of why this is a ‘good example’ of an application that will test ‘conceptual understanding’. There seems to be a ‘taken for granted’ meaning of ‘conceptual understanding’, that has not being exposed at this stage. Questioning is not used to clarify here. This contribution is *affirmed* as being an *excellent* example. The event continues a little longer before closing. Mr Mpe attempts to defend his questions, explaining that he had not given an application to test ‘conceptual understanding’ on the grounds that applications assess ‘problem solving’. There is an exchange in which Dr A at first seems to affirm Mr Mpe. This is followed by the hint of a question as Dr A says that this is an ‘interesting idea’, i.e., the suggestion that the same thing (an application) can be used for assessing both ‘conceptual understanding’ and ‘problem solving’ is ‘interesting’. She does not reject Mr Mpe’s suggestion. She simply indicates that there is more to this, saying to the class:

Dr A: Okay. Do you want to think about that? [short silence]. Okay. **I don’t know the answer**, isn’t it? [gestures with her arms in air]. **Is it Okay?** But **maybe we can come to some more other examples and then maybe we can agree or disagree on what he is saying.**

Dr A looks back at the list she started earlier

Dr A: **Is this list okay?** Have we exhausted this list? (...) Are there other things we can do if we want to check conceptual understanding of learners? Conceptual understanding of learners? What else can we do? [short silence] Okay. We can come back to it. In the meantime some ideas can come up for what is it, what other concepts you can actually be looking at here. (LO-VT-AM)

The event ends with Dr A attempting to solicit some comments from the whole class, and asking if someone else would like to share their example of a question that would assess ‘conceptual understanding’. Nobody responds, and the sub-event is brought to a close with a second volunteer invited to come up to show their example for assessing ‘problem solving’.

We note that in this last exchange, Dr A signals that the matter is not closed – it is being left open. What it means to assess for conceptual understanding is not as yet established. She signals that she is not willing to provide the answer (“I don’t know the answer, isn’t it?”). She wants to know from the class if what has been put up on the board is “okay”. There is an implication that the class will come back to this issue later – that is, the event will continue sometime in the future. There is also an implicit evaluation of the suggestion that an application can be considered as an instance of both ‘conceptual understanding’ and ‘problem solving’. However, what the decision is or what criteria should be applied to come to, are not clear.

Clearly this short observation cannot tell us much about the overall focus of the module or anything about how and if necessity and the notion are ever arrived at. But it does illustrate a particular pattern. Students are seen as knowledgeable and their contributions are affirmed. It appears that their *experiences* are to be taken as the grounds for legitimating their texts. They are positioned as knowledgeable, they will bring to the discussion things that will be helpful for the class to use for working out what to assess and how to do it - they will bring examples which will form one basis for developing the consensus mentioned in E1.1. It also appears that Dr A will not present herself as an authority in this context – decisions over what comes to count will be brought about through consensus.

To summarise, the lecturer begins with examples that are brought into the class by students and works with these, affirming all students’ contributions and giving no explicit indication that what they have brought may be inappropriate. There is no discussion on what is meant by conceptual understanding or what problem solving is in this context – these are taken as common knowledge within the class. The lecturer leaves the students’ examples without making conclusions or without reaching a consensus and moves on to give them an example of her own, an example of a problem that she implicitly suggests will be appropriate for assessing problem solving. The issue of assessing for ‘conceptual understanding’ appears to have been left aside (at least for the time being). The problem presented to the students is an investigation (How many different squares are there on an 8x8 square board?). Students work on it in an attempt to solve it. They do not appear to refer at all to the notion of assessment as they do this. The lesson ends with a request that they go away and finish solving the problem, and then *think about what they will assess* in relation to this problem. They should come back with what they think next time and this will be used to continue the development of ideas. The

implication is that a consensus will be reached – everybody has access to similar processes which will lead them to a legitimate realisation.

2) *Legitimizing appeals in pedagogic evaluation*

A summary of the overall distribution of the legitimating appeals across all sub-events within the IP of the lecture is presented in Table 32. Through considering the legitimating appeals we may be able to get better interpretations of the way evaluation operates in this context.

Table 32 Summary of legitimating appeals across the PI of one Assessment in Maths lecture

	Mathematics	Mathematics Education	Metaphorical/ everyday knowledge	Experience of either Lecturer or student teacher	Curriculum	Authority of the lecturer
Mathematics	0	0	0	0	0	0
Proportion of appeals (N=0)	0%	0%	0%	0%	0%	0%
Teaching	0	0	0	3	1	0
Proportion of appeals (N=4)	0%	0%	0%	75%	25%	0%
Mathematics & Teaching	0	0	0	3	1	0
Proportion of appeals (N=4)	0%	0%	0%	75%	25%	0%
Events in which appeals made	0	0	0	3	1	0
Proportion of events (N=4)	0	0	0	75%	25%	0%

First we notice that there were only two types of appeals made, one to the school curriculum (in E1.1) and three to the experience of the student teachers (in E1.2, 1.2, and 1.4). The appeal to the curriculum was simply to state why it is important to learn about ‘what and how’ to assess, but was not an appeal to establish any criteria of what would count as a good example in this case. The only other grounds for pedagogic judgement are experience. This confirms the analysis given above – the students experience is to be the basis on which they should construct the legitimate text. The lecturer deliberately stands back from this, suggesting that they must decide, and that she “doesn’t know”, or at least if she does she is not going to impose her ideas on the students. The implication is that the process will unfold through experience. The students will be given examples, and will do examples, and at some time or another, through considering these they will come to some conclusions (consensus) over what is a legitimate text. The criteria for the legitimate text are therefore to be constructed by the students themselves, and what ever they bring, will be affirmed as a possibility.

3.2.2 Some insights into the pedagogic context and mode of pedagogic practice in MTE at RU

The example of interactional practice analysed here supports the conclusions reached in the previous analysis with respect to the classification and framing of ME in the MTE curriculum at RU. We see that the contents are weakly classified – everything brought into the pedagogic context is recognised and affirmed. There is little to distinguish what is being learnt in terms of a discursive field of knowledge different from any other or from local experience. Framing is weak with respect to selection (the students, as volunteers, bring in most of the examples which become the content for consideration), pace (the students are given as much time as they need to express their ideas), criteria (there appear to be none), and social relations (relaxed but respectful).

This particular lecture had a low density of, and a narrow spread of, legitimating appeals. The major resource for ‘evaluating’ possibilities is experience. In addition all possibilities are affirmed. The forms of practice provide limited discursive space within the classroom setting to enable movement towards necessity (since everything is simply clarified and affirmed – there are no deficits). Affirmation is a key pedagogic resource. Students are affirmed, they are competent and knowledgeable. What ever they put up will contribute meaningfully to the final construction of the legitimate text. Evaluative principles are implicit.

The pedagogic mode recognised here follows a logic which fits well with Bernstein’s description of a logic of competence discussed earlier (in Chapter 4). This is a practice that appears to affirm the texts that students’ bring into the context; texts that have been produced through experience. Evaluation of these texts is so implicit as to be virtually invisible. While at some stage in the process the group may come to some consensus and explicitly articulate a set of criteria for the legitimate texts, this seems unlikely (since at the end of the day, nobody has any answers and each student will have come to some conclusions over what counts for them).

This section provided some insight into the pedagogic communication through which knowledge for T (ME and MT) is constituted within the context of a MTE lecture. It is clear that this gives little insight into the way M is constituted. However it does confirm that experience is the major resource for constructing ME and MT as domains of knowledge for teaching. Rules for recognition within this context are implicit and while some form of consensus over the legitimate text may be arrived at some time in the process of the module,

these will still be open since each individual student will have to make the final decision over what counts for him/herself. In other words the discursive resources that may be available from the field of production are not being made available as objects of study and therefore the possibility of students' specialised consciousness being grounded in anything other than experience is unlikely. The regulative discourse which underpins the instructional discourse in this context works to encourage the students to voice their ideas and reflections and to develop their confidence in themselves and their ideas. It affirms them as competent, recognises their contribution as valuable, encourages them to believe in their own ability, and is filtered through respectful social relations where all individuals are taken seriously and listened to. The regulative discourse in this context does not seem to be specialised to a specific knowledge form (e.g. habits of mind for engaging with a specialised discursive field), rather it is very general, creating an atmosphere of encouragement and self-belief.

In the next sub-section I move to broaden the focus on evaluation. The formal assessment items for the various specialist modules are analysed to provide a further layer of analysis.

3.3 Assessment and evaluation

As with CU, it is noted that this is not a full set of assessment items from all modules and the sample of activities is limited by what was provided by lecturers during the site visit. The number and range of formal items provided by lecturers and organised in the RU archive was very limited. Some additional copies of formal assessments were found in the material provided by students. I have included these in the analysis to expand the sample and supplement what was provided by lecturers¹⁹³. Why this archive is so limited and what can be said from what has been collected will be discussed later in the chapter. For now, I will simply present the items and provide an analysis of them in the same way as was done with the case of CU.

While the number of items analysed is very limited, the examples do give insights into *what* is privileged in the formal assessment of mathematics teachers at RU and *how* the legitimate text for the production of the 'good subject' is constituted within this teacher education programme. A full list of all assessments and the number of items analysed in each is shown in Table 33. The formal assessment items collected from the lecturers only included examples of some tests and examinations, that is, summative assessments. Students provided examples of

¹⁹³ In the Case of CU, all examples of formal assessments provided by students had already been supplied by lecturers.

some additional formal tests and examinations as well. They also provided one example of an assignment (three of the four students provided the same assignment) and an example of a portfolio for a module (two of the four students presented this portfolio).

All examples contained in the archive are considered in the analysis that follows. Full assignments were considered in terms of their constitutive parts and assessment items were identified (in the same way as described for the CU analysis).

Table 33: List of formal assessments collected from lectures and students' selected work at RU

Module name	Assessment type	No	Purpose	Number of Items
Space and Shape	Tests (Sept * 2001)	1	Summative	5
	Exam* (November 2001)	1	Summative	5
Instruction in Mathematics	Portfolio of work*	1	Formative	1
Calculus A	Final examination (2003)	1	Summative	4
Calculus B	June examination*	1	Summative	4
	Assignment*	1	Formative	2
	Test*	1	Summative	6
Preparing to Teach Mathematics	Final examination (2003)	1	Summative	9
Algebra and Statistics	Test (Number Theory; Statistics test)	2	Summative	4
	Examination (Statistics; June 2004)	1	Summative	4

Note: Those items marked with an * in the above list were taken from the material provided by students and not provided by the lecturers concerned

3.3.1 Analysis of formal assessment tasks across RU modules

As noted above the assessment types represented in the archive is limited, mainly to examples of class tests and examinations. In most module outlines provided by lecturers, when assessment processes are outlined, the main forms listed are class tests and examinations. Outlines for Algebra, Space and Shape, Planning for Teaching, and Algebra and Statistics all indicate that the module will be assessed through two class tests and an examination. No other assessment types are indicated. However, at least one module outline indicates that other forms of assessment are used. The module outline for Instruction in Mathematics indicates that the assessment for the module consists of assignments, a presentation, a portfolio, tests and an examination. No outline was provided for the other modules so if other assessment types were used in those modules they are not visible.

All tasks in the archive were analysed using the methodology discussed in Chapter 6. The full analysis of each module and the items within it is summarised in Appendix F.4 Table 10. A

condensed summary of all items analysed is presented in Table 34. The first thing to note in the table is that there is little variation in items. In the sub-sections that follow I discuss (1) this spread of items that the analysis reveals, and, (2) consider whether there is any variation within the item types identified. This analysis is used to provide an interpretation of the legitimate text for MTE at RU, as condensed within these assessment items.

Table 34: Summary of all assessment items analysed across different modules at RU¹⁹⁴

Module (Lecturer: A,B)	No of events	M ⁺	M ⁻	T ⁺ _k	T ⁺ _e	T ⁻	M ⁺ _k	M ⁺ _e	M ⁺ _t	M ⁺ _k	M ⁺ _e	M ⁺ _t	T ⁺ _k m ⁺	T ⁺ _e m ⁺	T ⁻ m ⁺	T ⁺ _k m ⁻	T ⁺ _e m ⁻	T ⁻ m ⁻
Space and Shape (B)	10		10															
% (N=10)	100		100															
Calculus A	4		4															
% (N = 4)	100		100															
Calculus B	12		10															2
% (N = 12)	100		83.3															16.7
Planning for Teaching	9	1	4															4
% (N = 9)	9	11.1	44.4															44.4
Algebra and Statistics	8		8															
% (N= 8)	100		100															
All	35	1	30															6
% (N= 35)	100	2.9	85.7															17.14

1) The spread of items across different modules

It is clear from Table 34 that only three item types were identified across the entire sample. First we note that there are only two modules in which all three types were found. Overall 85.7% of all tasks analysed were of type M⁻, with 17.14% type T⁻m⁻ and 2.9% type M⁺. It is surprising to find that T⁻m⁻ tasks were identified in the Calculus B module (an example of one of these is reproduced in Figure 32 in the following section). However, in that module we do note that the overwhelming majority of tasks (83.3%) were of the type M⁻, which supports a conclusion that in modules focussed on Mathematics the vast majority of tasks are of this type. That is, in the mathematics focussed modules, students are required to demonstrate their procedural fluency in working with the privileged selections of mathematics, and are not required to provide any explanations which demand the production of syllogistic chains of reasoning.

¹⁹⁴ Note: The portfolio assessment for Instruction in Mathematics found in the student work could not be analysed in terms of the model and is therefore not presented in this table.

The only module where there were a significant number of items that had two objects of acquisition was the Planning for Teaching module, which we could expect to focus *more* on T objects than M objects. What we notice about this module however, is that the spread of item types contains just as many items focusing on M^- as on T^+m^- . This is also the only module that has a task that could be identified as of type M^+ . This is a surprise, since one would expect a module with a name like ‘Planning to Teach’ to focus more on practical aspects of MT (or ME).

Overall the analysis of items indicates that while mathematics is the focus of all the assessment items, what is required of the student teachers is that they demonstrate they can reproduce specific mathematical procedures. They are not expected to produce texts which reveal their deeper understanding of the mathematics learnt. We also see that where T is an object of acquisition, whether it is the primary or secondary object, there is *no* expectation that any pedagogic arguments be produced. All these texts require straight forward recall type responses.

It is important to note that while there are sufficient items in the archive from across a number of M focused modules, and so we can feel fairly confident that these are representative of M type assessment tasks across the specialist discourses in the degree, this is not the case with the T objects. The Preparing to Teach Mathematics module, as shown in Section 3.1.1, was not a typical ME/MT focused module. It consisted of selections from school algebra and from official/professional discourses about teaching and was taught by Dr B. The three main modules for developing ME knowledge were those taught by Dr A. No examples of formal assessments from these more typical modules were analysed, and therefore we cannot assume that what is presented here is representative of evaluation of ME texts in the RU pedagogic context.

2) The nature of different assessment items found at RU: Compact tasks

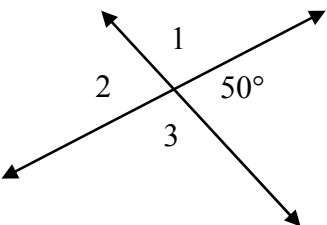
The above analysis does not provide substantial information to enable us to get to grips with the way M, ME or MT is constituted in the pedagogic context of RU. All it could reveal was that there was little variation in task types and that the major expectation of student teachers was that they could reproduce specific texts. In this section I consider some examples of each of the types identified in the analysis in order to see if we are able to get a better purchase on the way access to specialist discourses is structured within this context.

M⁻ type tasks were clearly dominant across all mathematics modules. What was the nature of such tasks? In CU we saw a clear distinction between tasks on the basis of compacting/scaffolding. Does this also appear in the RU tasks? In order to answer this question we need to consider some of the examples from the archive.

Question 1

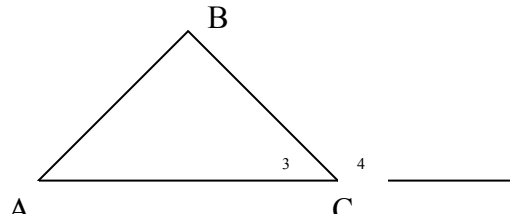
b) Define the following:
 (i) adjacent angles
 (ii) complementary angles
 (iii) ray
 (iv) acute angled triangles
 (v) obtuse angles triangles
 (vi) equilateral triangle (12)

c) Find angles 1, 2 and 3



(3)

d) Prove that:
 (i) The sum of the angles of a Δ is 180°
 (ii) $\hat{C}_4 = \hat{A} + \hat{B}$



(5)

Figure 32: An M⁻ type task (Final Examination: Space and Shape)

When considering the Space and Shape module, tasks such as those reproduced in Figure 32 are typical. This was a complete surprise in a university level MTE mathematics module for FET teachers. In the task we recognise, in terms of the *old* outgoing curriculum, a fairly typical Grade 8 or 9 Euclidean geometry task that requires the reproduction of given forms. Although students are asked to ‘prove’ the two parts in question 1c), they are not required to ‘unpack’ the meaning through providing an argument or reasoned explanation. The type of ‘proof’ required is a fairly straight forward reproductive task, particularly at university level. All the examples in the *Space and Shape* tasks appear to be of this type – either involving a statement of a definition or a relatively straight forward proof that would be considered

procedural at a first year university level. The module thus appears to involve a relearning and reproduction of selected Grade 8/9 Euclidean Geometry theorems.

The example given in Figure 33 is from the third year *Calculus B* module. Here we also see a typical M^- type task. However, the content being assessed here is clearly university level mathematics, typically found in first year calculus modules in pure mathematics courses. The examples shown assess the procedural fluency of students with respect to specific forms of definite and indefinite integrals. All examples of tasks from the second year *Calculus A* and third year *Calculus B* MTE modules are of this type. The contrast between the level of the tasks in the Space and Shape module and the two calculus modules is stark. However the similarity we notice between all M^- type tasks analysed, is that they are *all* provided in a compact form.

Question 3		
3.1	State the Fundamental Theorem of the Integral Calculus	(2)
3.2	Evaluate the following integrals:	
3.2.1	$\int_0^{\pi/4} (2 \sec x \tan x - 5 \sec^2 x) dx$	(7)
3.2.2	$\int_0^1 (4 - x)^{-2} dx$	(7)
3.2.3	$\int x \cos \pi x^2 dx$	(7)
3.2.4	$\int_2^{5/2} \left(\frac{3}{(x-1)} - 4x \right) dx$	(7)
		[30]

Figure 33: An M^- type task (Final Examination: Calculus B)

Across all the assessment items in the archive I found one example which could be considered an M^+ type task. This is shown in Figure 34. This task has been recognised as an M^+ type task since it requires students to motivate their answer in 3(i). This would, at a minimum, require the ‘unpacking’ of the symbolic form involving the square root sign and the production of a reasoned argument to motivate their response. The task itself does not require any pedagogic argument, nor is there a virtual pedagogic subject visible in the question. This is interesting

since the task is in an examination assessing the *Preparing to Teach Mathematics* module.

Question 3

Given $\sqrt{5-2x} = \frac{x}{2} + 4$

- (i) Without solving the equation, determine limits between which possible solutions for x must be and motivate your answer. (5)
- (ii) Solve the given equation and determine the exact value(s) of x (8)

Figure 34: The only example of an M^+ type task found in an RU assessment (Final Examination: Preparing to Teach Mathematics)

It is noted that while the M type tasks found in the archive are all of a relatively ‘compact’ form, the criteria for the production of the legitimate text are clear since they are referenced to the field of mathematics which itself has a strong grammar. This cannot be said for the examples of tasks containing a T object, which were also all in a ‘compact’ form. For example, Figure 35 reproduces an assignment task in which students were asked to plan a lesson. No specific details are provided with respect to what is required. The task is presented in a very compact form. It is assumed that the students know what is required in the production of such a calculus lesson. This is clearly a T^-m^- type task. There is no demand for any pedagogic or mathematical explanation or argument in the production of the lesson.

Assignment Task 1

Produce a detailed plan for a Grade 12 Calculus lesson.

Figure 35: An example of a T^-m^- type task (Assignment: Calculus B)

It is interesting to note that this assignment was part of the *Calculus B* module and not the *Preparing to Teach Mathematics* module. It is also noted that the evaluation criteria for the task are completely obscure. No indication is given as to what criteria will be used to judge the production. This could have been done either through referencing the task to a specific discursive resource from the field (of MT , ME , T or E), or through a clear scaffold providing details of expectations. The framing with respect to evaluation in the task is very weak. This is a characteristic of all six T^-m^- tasks found in the archive. We see the same format in a second assignment item in the same assessment shown in Figure 36. Note the compact way in which the question is asked. This makes the evaluative criteria invisible.

Assignment Task 2

Design a 50 mark Grade 12 Calculus test.
Submit the test with a full memorandum showing how all marks are allocated.

Figure 36: An example of a T⁻m⁻ type task (Assignment: Calculus B)

We note that this task is also identified as a T⁻m⁻ type task since its major object is apparently the production of a pedagogic text – in the form of a Calculus test for Grade 12 learners. While it has a primary pedagogical object (an assessment for Grade 12 test), no justification for the structure of the assessment nor for the selection of specific test items is required by the task.

There appear to be no discursive grounds/ authority to which the student should appeal to produce this test - it is left up to their individual practical experiences. That mathematics is also a focus of the task is clear – the student has to produce a series of calculus questions and model answers (memorandum) for these. The criteria for evaluating the task are obscure. No indication is given as to how the T object (the class test) is to be evaluated. It is of interest that three of the students produced this task as an example of an assignment which they found useful for their development as mathematics teachers. In examining the specific examples produced and marked it was still not clear how the assignment was evaluated. All three students produced different lessons and different memoranda however they all achieved the same mark. No comments were visible on their assessed assignments to indicate how these marks were allocated.

It appears that a common characteristic of all the tasks in the RU archive is their compact form. This is also seen in the examination questions available in the archive. The majority of these are of the form seen in Figure 37 and Figure 38.

Question 3
Discuss the 'hands on' activities for mathematics learners (12)

Figure 37: An example of a T⁻m⁻ type task (Final examination: Preparing to Teach Mathematics)

Question 4
Discuss the strategies of problem solving in mathematics (9)

Figure 38: An example of a T⁻m⁻ type task (Final examination: Preparing to Teach Mathematics)

The task in Figure 37 requires a fairly unspecified discussion of 'hands on' activities – the only clue here seeming to point to the need for these activities to be practical. There is no requirement that the discussion be based on any discursive resources, nor is there any

indication of what area of M should be considered in producing the response. The example given in Figure 38 may reference a specified field – strategies for problem solving – which could be based on a discursive resource¹⁹⁵, although this is not necessarily recognisable in the wording of the question. It is noted that the ‘compact’ form that the task takes obscures the criteria for evaluation. The examples discussed above cover all the types of tasks found in the RU archive.

3.3.2 Some conclusions from the analysis of formal assessment items from RU

It is interesting that the M assessment items found in the RU archive which typically were of type M⁻, fits with Adler and Davis’ (2006) study which found that this was the norm across the various INSET mathematics modules in their study. It is noted that the majority of modules for which formal assessments were provided are mathematics focussed modules so it is not surprising that these mostly focus on M as the primary object. However it is a surprise, given that this is a teacher education degree and that all the modules are taught by members of the mathematics education division in the Education faculty rather than by mathematicians in the Mathematics Department in the Science faculty, that so few of these tasks have any pedagogic focus at all. For example not one of the tasks had a virtual pedagogic subject (t⁻) to which a mathematical explanation needed to be given. This indicates that across all M focused modules, there was no expectation that student teacher’s produce explanations of mathematical ideas/ objects/ operations/ procedures etc for any other person (learner), that is there was no evaluation of their ability to explain from the position of a teacher. All assessments evaluate their fluency in using mathematics.

As indicated above, T assessment items in the archive were extremely limited and cannot give a reliable picture of formal evaluation of these discourses within the context. I needed to expand the view to get a better picture of how T objects were constituted at RU. Earlier I indicated that I had found examples of portfolios submitted by students for the *Instruction in Mathematics* module. I had intended to include it in the overall summary given above, but found that when I attempted to analyse its contents it was not a simple matter to identify the various aspects in terms of the categories I was using. Two students presented their portfolios as part of their selected work. They provided different material including solved problems and class notes (mostly photocopies). No formal instructions were provided with their portfolios. I

¹⁹⁵ This is speculation based on some class notes provided by students in which problem solving was a focus and in particular George Polya’s problem solving heuristic was mentioned. However, these were a focus in the *Instruction in Mathematics* Module, which had been studied the year before, so there is no guarantee that this is what was expected.

found it difficult to accurately identify separate evaluative items. I noted that all written work (student work) appeared to be in the form of solved problems, none of which required the production of mathematical or pedagogical arguments as described in the methodology. Therefore there is some support for a conclusion which suggests that most tasks in this module would also have been identified as reproductive.

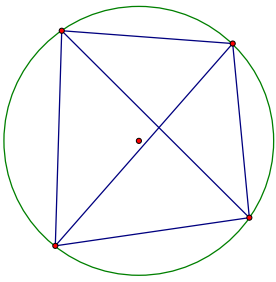
In reflecting on why this case showed such little differentiation between different assessment types I needed to question what the analytic model (external language of description) was able to reveal, or rather, what it might obscure. Recall that the tool itself discriminates between those tasks which indicate a form of ‘unpacking’ in the sense that they demand explanations or arguments (chains of syllogistic reasoning) that reveal some form of understanding of the underlying meaning of the particular object of acquisition (that is, they focus on revealing principled knowledge) and those that do not require such ‘unpacking’ and could be successfully completed through applying specific procedures, rules, or strategies¹⁹⁶. This is a fairly blunt instrument, yet it was found to reveal an aspect of Mathematics for Teaching that had been recognised in the mathematics teacher education literature. The analytic tool works to distinguish types of tasks that would be differentiated in terms of the privileged indicator of procedural/ principled knowledge in mathematics (Dowling, 1998) which had been linked to the idea of compression/ unpacking as a difference between mathematical practices of mathematicians as opposed to mathematics teachers (Ball & Bass, 2000), rather than other indicators which may underlie the selection in the RU context. That the model was not able to reveal distinctions recognisable in terms of these forms may simply indicate that this is not privileged in the RU context.

The next question was to consider what the tool obscured and whether a refinement of the tool would assist in discriminating between the tasks found in the RU archive. It was suggested earlier in Chapter 7 that the tool could be extended to increase its powers of discrimination, in particular by distinguishing between those forms that were more ‘compact’ and those that provided more ‘scaffolding’. When considering the examples of items in the RU archive, it was clear that *all* were of a compact type, and so this extension of the model did not assist with interpreting principles condensed in the RU assessment items.

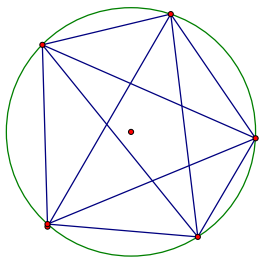
¹⁹⁶ It is important to note that if a task is recognised as an M⁺ type this does not say anything about the specific understanding/ skills/ values or level of cognitive demand that the student doing may/ may not have acquired. All we can say is that they are expected to produce the required mathematical solution by choosing and applying the correct procedure.

Considering the summary of results once more, and noting that the vast majority of the tasks were of the M^- type (86% of all tasks), I wondered if I could re-examine these to see whether there could be any further way of discriminating between them. Clearly the ‘compact’/‘scaffold’ distinction did not do the job. Was there some other distinction that was recognisable? When looking at the M tasks in the main archive again, I was unable to see any distinction between the different tasks, apart from the level (e.g. Grade 9 type exercises in the Space and Shape module, i.e., NQF level 3 as contrasted to University level 1 exercises in the Calculus modules, i.e., NQF level 5). However when I considered the work in the Instruction in Mathematics portfolios I did recognise some differences. For example the problems shown in the worksheet (Figure 39), which were included in the portfolio, could not be described as M^+ tasks since they do not demand any explanations or arguments, yet they are clearly different from the M^- types shown in Figure 32 or Figure 33.

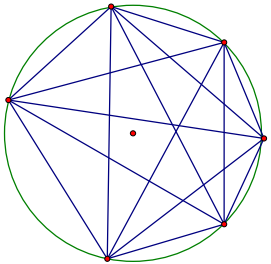
Instruction in Mathematics
1.



4 dots - 8 regions



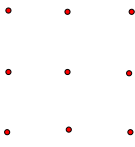
5 dots - ? regions



...

a) Draw as many as you can
b) Tell what strategy you used
c) Did you spot any pattern? (e.g. How are the dots and the regions related?)

2.



Use only four straight lines. Connect the dots without lifting your pen.

3. Four soldiers have to cross a river. The only means of transportation is a small boat in which two boys are playing. The boat can carry at most two boys or one soldier. How can the soldiers cross to the other side?

Figure 39: Problem Set (Problems from the Instruction in Mathematics student portfolio – Piri and The Minister)

While these problems may not be recognised as *MfT* problems that require the kind of ‘unpacking’ described by Ball and Bass, they would certainly be recognised as problems that a mathematics teacher might use in a school classroom, specifically when focusing on learning strategies for problem solving and investigations. These types of problems are often described as ‘non-routine’ problems in mathematics teacher education circles. Thus within the tasks contained in the Instruction in Mathematics portfolio a number of mathematical problems that could be described as ‘non-routine’ problems as well as others that could be described as ‘routine’ were recognised.

This does give a new insight into what was being constituted as *MfT* within the Instruction in Mathematics module, and this was significantly different from the types found in the other mathematics modules where all problems were of the more ‘routine’ type. It is noted that while the portfolio was clearly a requirement in terms of formal assessment and had been submitted, the work was not marked. No symbol or mark was given for any aspect of the portfolios provided by the students. We have no way of knowing whether or not this aspect of ‘problem solving’ was substantially assessed in any formal assessments for the modules (none were supplied by the lecturer). However, it is the case that no such problems were found in the formal assessments that were provided. It is therefore likely that if such tasks do form part of any formal assessments they would be within the ME modules.

A further aspect that I considered in my attempt to see whether there was some other kind of discourse informing the structuring of assessment tasks was the place of the ‘everyday’ and/or other applications to problems. However, I found that not a single item in the archive recruited or mentioned any context outside of mathematics. All items could be recognised unambiguously as belonging entirely in the mathematical domain.

To summarise, the analysis of formal assessment items at RU assists in deepening the interpretation with respect to the constitution of knowledge and practices for mathematics (M) for teachers within RU’s pedagogic context, however it is very limited with respect to the constitution of valued knowledge and practices in ME and MT.

In terms of mathematics for teachers, it is clear that in this context, what is valued is that teachers demonstrate their acquisition of M texts through showing their fluency across the various selected mathematical topics (Grade 8/9 Euclidian Geometry; Grade 10-12 Algebra; and some university level Calculus). They are required to demonstrate that they can

adequately reproduce given texts. That there is a wide variation in levels of tasks is also a feature of this acquisition of M. It ranges across the (old) secondary school mathematics levels and into some university level mathematics. Students' ability to work with school mathematics through solving typical problems/ exercises is valued. They are evaluated on their acquisition of both the recognition and realisation rules for the various aspects of M that are privileged (since all tasks are in compact form they are given little assistance to recognising the contextual requirements of any particular task). The constitution of M within this context is firmly embedded within mathematics itself – no contexts from outside of the field of M are brought into any of the assessment tasks – all tasks focus entirely on facts/ methods etc located within the discipline itself.

There are two immediate conclusions that can be made with respect to the above. Firstly that the orientation to mathematics that is being specialised within this practice is one which sees mathematics only in terms of Orientation 4 identified within the NCSM in Chapter 4 (as involving mathematical structures, conventions, skills and algorithms to master in order to gain access to further studies). Knowing and understanding mathematics from this perspective involves knowing the facts/ methods/ skills etc required to fluently solve given problems/ exercises. No other orientations seem to be specialised in this context. This suggests that the products of this institution (novice mathematics teachers) may find it challenging when they go out into the schools to work effectively with the new NCSM in practice. They may have reduced possibilities of being in a position to interpret and implement the new M curriculum from a perspective which is productive for the discipline.

Secondly, it is clear that what is valued is the learning of and reproduction of specific M texts characteristic of a performance-based pedagogic mode. This is in contrast to the competence mode identified in the ME lecture in the previous section, suggesting that within this curriculum different modes work together to produce different possibilities for specialisation across different knowledge discourses and their practices selected into the MTE curriculum.

4 The characteristics of the institutions 'good' subject

The analyses of curriculum, pedagogy and assessment that have been in focus in this chapter provide the basis for an interpretation of the principles which structure the selection, recontextualisation and evaluation of pedagogic discourses, for specialising the consciousness and conscience of mathematics teachers within the pedagogic context of MTE at RU. Here I used this to produce a summary of the characteristics of the 'good' subjects (knowledge

discourses and their practices in terms of M, ME and MT) and of the ‘good’ pedagogic subjects (novice mathematics teachers), projected by the institution.

4.1 M, ME and MT (for mathematics teachers) at RU

Mathematics is presented as a practical activity that is based in problem solving/ doing mathematics exercises. There are two experiences of doing mathematics at RU – firstly as a relearning of a limited selection of school mathematics (which was not well learnt while the students were at school), and secondly a learning of some selections of university level mathematics recognised as typical of a first year university Calculus course.

Students are required to re-learn school mathematics in order to change their view of what learning mathematics is all about. There is an assumption that most of the students would have been taught mathematics through being shown specific examples that they would then have to reproduce in fairly meaningless ways. In relearning at the university, they are inducted into a way of working which shows them that mathematics is learnt through ‘doing’ (not through listening and following). They are not re-taught school mathematics – they must relearn it. They are required to use texts, to work co-operatively and to see mathematics as a practical subject. They are expected to work with its facts and methods to solve problems and exercises for themselves. In learning Calculus students are introduced to some new mathematics that is demanding – here they are taught skills to assist them in understanding the language of calculus and methods for solving calculus problems. While the relearning of school mathematics and the new learning of calculus are distinct mathematical contexts within the RU MTE curriculum, both practices emphasise the same orientation to mathematics (using the categories discussed in Chapter 4). Mathematics is seen primarily in terms of Orientation 4: mathematics involves conventions, skills and algorithms to master, and to use in solving given problems, most of which are well formulated exercises.

Thus within the context of RU, mathematics is presented as a body of knowledge to be acquired through mastering specific facts, skills and methods for solving problems: and the best way to master these is to work through problems and exercises, to share and discuss solutions and methods so as to come to know mathematics better and develop a knowledge base for teaching it.

The analysis shows that **mathematics teaching** at RU is seen as a practical accomplishment – it is learnt through teaching – which is unproblematically constituted as ‘presenting’. MT is

seen in terms of presenting facts, definitions, explanations and so on to others, using teaching aids such as charts. The most important aspect is to *develop confidence* in standing up in front of a class to deliver (present) some mathematics in English. Developing confidence in doing the mathematics oneself and then in presenting the examples to peers is a major aim. To learn MT is therefore constructed in terms of developing presentations, using various aids, and developing the confidence to stand up in front of a class to do the presentations in English. There is no discursive basis for MT, although **mathematics education** is presented as providing a basket of ‘tools’ for use in the classroom to assist in teaching.

Mathematics Education is constituted mostly as a collection of horizontal discourses. ME integrates practices of MT and appears to consist of an eclectic mix of tips, methods, ideas and so on constituted on the basis of consensus, after reflections on and discussions of ideas relating to a specific issues in teaching. The issues are introduced by the lecturer and focus on learner’s thinking, and assessment. While there is a clear orientation which suggests that there is no right or wrong answer in this field, there are some specific underlying beliefs about learning and teaching implicit in the context. In particular that error analysis is productive in mathematics teaching, that it encourages teachers to listen to their learners and understand their thinking, in order to assist them to learn better. We see here that ME is not constituted in terms of symbolic resources from the field of mathematics education research, yet its constitution is clearly influenced by ideas that are to be found within the field.

4.2 Identities of good pedagogic subject(s) projected from RU

On the basis of the analysis presented, and the description of what would count as the legitimate texts for M, ME and MT within the MTE context of RU, we can make some inferences about the ‘good’ pedagogic subject of RU. Sh/e would be expected to be able to work effectively with selections of school mathematics and university level mathematics: to have mastered definitions, facts and a range of methods for solving problems within these topic areas. S/he would be expected to read symbolic forms and recognise legitimate ways of solving problems within these topics. This good pedagogic subject, would value working with mathematical exercises and problems in a practical manner – s/he would know how to learn mathematics fairly independently, using texts and exercises for guidance; s/he would be prepared to discuss her/his solutions with others and correct errors; and s/he would be able to use her/his mathematical knowledge to fluently solve a range of problems. Her/his mathematical identity would be connected to ‘doing’ mathematics and her/his satisfaction would come from mastering the methods for solving a range of problems. Her/his

mathematical consciousness would be rooted in a knowledge discourse dominated by Orientation (4).

The good subject of RU would use their mathematical knowledge to prepare for teaching. They would strive to present their mathematics lessons in ways which would assist learners by providing clear explanations and they would use teaching aids, particularly charts, to enable clear explanations and presentations of examples. They would present explanations as a basis for learners to gain access to the facts and methods that they would need to use to do mathematics. They would provide opportunities for their learners to work through problems themselves, to practice and discuss their solutions so that they could learn mathematics. They would be the kind of teacher who would consider learners' errors and misconceptions as opportunities to understand their thinking and to assist them in finding better methods for doing mathematical problems. They would be confident in their ability to stand up in front of large groups of learners and deliver their lessons in English, and would attempt to build confidence in their learners self belief in their ability to do mathematics.

The good subject of RU would recognise that they need to be 'researchers, scholars and lifelong learners', and would, when they come across aspect of the mathematics curriculum that they do not know, be expected to be able to deal with this lack appropriately. They would approach colleagues and other resources in order to find out more. They would not simply pick up a text book and attempt to teach the examples without first working through the materials themselves. They would be confident that they could learn it, even if it seemed difficult at first. They would strive to find out what they need to know and to master the topic so that they could teach it well. They would recognise that their greatest resource for teaching mathematics would be their own knowledge and ability in mathematics, and they would see this as being enhanced through practice and problem solving.

They would not necessarily have a strong ME identity, however they would be confident in their own ability and thinking, and would be confident to choose a method or idea for any specific teaching task that would be appropriate for their context. Overtime they would build up a reservoir of teaching ideas and methods that they would use effectively in contextually sensitive ways.

5 Conclusion

In this chapter I provided an in-depth analysis of the three message systems (curriculum, pedagogy and assessment) operating within the institutional context of RU. I systematically worked through three layers of analysis and interpretation, describing the contents of the curriculum, the classification and framing of knowledge discourses and practices, and the pedagogic mode operating within the MTE context. I have considered the way in which formal assessments are constructed and used within this context to produce what can be considered as the description of the legitimate text for M, ME and MT at RU, and in relation to this, a description of the projected ‘good’ mathematics teacher (pedagogic subject) of the institution.

I have shown that at RU while there is a low matric entry level of students into the programme, students are constructed as able to learn – their problem is that they just do not know mathematics as they had a lack of opportunity to learn mathematics properly while at school. Given the constraints in the curriculum and the lack of contact time, students are given the major responsibility to relearn school mathematics, particularly some aspects of HG mathematics that they probably did not have good access to while at school. They are expected to work co-operatively outside of the lecture theatre to achieve this. They need to learn how to teach in ways different from their experiences at school, and they are provided the opportunity to develop their presentations skills during their mathematics lectures, and are evaluated on these practices. I have shown that the curriculum provides opportunities to study a limited selection of mathematics. However, the context of general university campus and the timetable does provide opportunities for learning outside of contact time. The lecturers hope that they will produce the kind of teacher who will be motivated to continue learning, be a lifelong learner, and will independently gain access to those areas of mathematics that they do not know, and that they will have the confidence in themselves and their abilities to manage this.

In the chapters that follow I will move the focus from the institutional context, to consider the students and their experiences of learning to become mathematics teachers within the two case study institutions. In the next chapter I discuss the methodological approach taken as I move from considering the cases from the point of view of the institution to the perspective of the student teachers. The methodology for analysing the pedagogic identities that student teachers project in their writing and talk is presented. This is then followed by Chapters 10 and 11 where I return to the cases of CU and RU respectively to consider the experiences of the novice teachers and the development of their identities as mathematics teachers.

Interlude

At this point in the thesis, I ask the reader to recall the introduction to this thesis. I described the research questions and the structure of the study. I attempted to explain why the thesis was so long, and indicated that after completing the analysis of each institution's projected 'good' subjects (disciplines and persons), I felt compelled to complete the study and to include a focus on the identities of the pedagogic subjects in the study: the student teachers whose consciousnesses and consciences were being specialised as they studied to become mathematics teachers.

As I write up the final draft of the thesis, I realise that, having completed the institutional analysis, it would have been quite possible to draw the thesis to a close. I could have reflected back on the account produced over the first 8 chapters. This certainly would have provided some insight particularly in relation to the differences seen in the way in which the two case study institutions approach the work of MTE within their context. By focusing on the similarities and differences in the analysis of curriculum, pedagogy and assessments at each institution, a cross-case analysis could have been completed to produce insights into the possible spaces opened and closed for the specialisation of consciousness and conscience within these institutional settings. The comparative advantage produced through the selection of the two empirical sites would have enabled some general comments to be made with respect to the design of initial mathematics teacher education curricula and the organisation of knowledge(s) and practice(s) within these settings.

However, as explained in the introduction I was driven by an interest in how different organisations in curricula might differentially specialise the pedagogic identity of the students learning through the programme. By the time I came to writing up the complete thesis I had already worked through the student interviews and had done considerable work towards producing the account of the pedagogic identities of the 'good' pedagogic subjects. Closing the thesis at this stage would have meant letting go of this work, which had become my central driving interest as the study had unfolded. Had I closed the thesis I could not report on what I had found as I worked with the extended methodology to try and understand the pedagogic identity construction of these good subjects.

In a sense I have gone too far along the road not to report on the next stage of the study in this report. Thus I do not try to consolidate the findings at this point in the process. Rather I do continue to the logical end. The result is a much longer and extensive thesis than would strictly be necessary for the award of a doctorate.

Getting to this point in the final write up and realising how long the thesis is, I realise that I need to publish it in two volumes. This point seems to be a logical point to split the work for printing. I do not attempt to write up a conclusion for the first part of the case studies at this point, rather I end volume one with this interlude and then in volume 2 move directly into the extended methodology chapter and from there into the extended case studies. I then bring the entire thesis to a close through a cross-case analysis which focuses on the similarities and differences, absences and presences across both cases, synthesising the findings of the analysis of the projections of identity from the institutions and from the good pedagogic subjects. The final chapter concludes by looking back across the entire thesis drawing it to a close.

VOLUME 2

Chapter 9

Methodology 2

Researching an institution's 'good' subjects

Identity arises out of a particular social order, through relations which the identity enters into with other identities of reciprocal recognition, support, mutual legitimisation and finally through negotiated collective purpose (Bernstein, 1996: 73)

1 Introduction

In the previous chapters I used conceptual frameworks derived from Bernstein (1996; 2000), Hegel as recontextualised by Davis (2001; 2005) and a range of methodological resources based on work produced in the QUANTUM research project (Adler & Davis, 2006; Davis et al., 2007; Davis et al., 2003) to analyse and describe the three message systems (curriculum, pedagogy and assessment) operating at the institutional level in the two sites of teacher education practice in focus in this study. I used a general methodological approach that was derived from Thompson's (1990) methodology of interpretation, arguing that these symbolic systems could be invested with meaning and therefore understood, at least partially, through a systematic unpeeling of layers of the forms in which they are (re)presented in the research context. This layered approach produced interpretations of the three message systems in operation within each case study and hence a description of the 'good pedagogic subject' of mathematics teacher education projected by the institutions.

In this chapter I move to the acquirer within the teacher education context – the student teachers who are both the 'consumers' of what is offered at the institution and examples of 'good products' produced through the teacher education programme offered. The unit of analysis changes from the symbolic message systems that work to transmit the 'legitimate texts' to the *internal* pedagogic specialisation of the subjects of the institution. I address the second description mentioned in the introduction to this thesis, that is, mathematics teacher identities of successful mathematics student teachers ('good subjects' of the institution) projected through writing and speaking themselves. The final two research questions mentioned in Chapter 1 form the focus:

How do student teachers at each of these institutions project themselves? (What mathematics teacher identities do they project?); and,

How do these identities differ over the two contexts? (What is similar/ different about them?)

In this chapter I begin by describing the nature of the evidence collected for this part of the research project. This is followed by a brief overview of the general methodological orientation adopted in the thesis and an extension of the languages of description presented in earlier chapters to enable the production of accounts of the identities of the pedagogic subjects in focus.

2 Nature of the evidence collected through the data collection instruments

At each *case study institution* four student teachers, identified by their lecturers as being successful beginning teachers/ products of the institution, were selected to take part in the study. Four types of evidence relevant to this part of the thesis were collected from these selected ‘good’ subjects. The nature of this evidence is briefly elaborated in the following subsections.

2.1 Student teachers biographical writing

The first type of evidence, student biographical writing, was elicited through a biographical questionnaire which focussed the student teacher’s attention on their motivations for entering the teaching profession and their knowledge careers as they moved through different locations in their personal histories, from school through to their present situation as learner mathematics teachers. (See Appendix G.1 for a copy of the biographical questionnaire given to the students) All the students in the study provided fairly detailed written descriptions in response to the questionnaire.

2.2 Individual interviews with student teachers

The second type of evidence was collected through individual open-ended interviews with the learner-teachers. The interviews were conducted across three or four separate sessions¹⁹⁷. The questions were divided into different categories that focussed on:

1. *Imagined practices*:

The student teacher was asked to imagine him/herself as a mathematics teacher and discuss their practices in relation to mathematics, mathematics education and mathematics teaching.

¹⁹⁷ Four hour-long interviews were held with the students at RU. This was the first institution visited. In reflection at the end of the visit I realised that one section of the original schedule (focusing on different types of alternative assessment forms) could not be effectively used in an interview context and within the time frames available and so they were cut out of the subsequent visits to the other institutions. Thus only three hour-long interviews were held with students at CU. I have excluded the alternative assessment discussion held with the students at RU from the data sources utilized in the analysis.

2. *The school curriculum for Grade 10 – 12 mathematics (NCSM):*

Prior to the interviews, the student teachers were given a copy of the NCSM and a copy of the old Grade 10 – 12 syllabus document¹⁹⁸ as focus material and asked to discuss specific statements and ideas within the documents. They were asked to briefly compare the two documents and imagine how they might use them. The focus of the interview then ranged across the various sections of the NCSM, including,

- a. a discussion of the general chapter of the NCSM (common to all NC statements) which focuses on the overarching aspects of the new school curriculum design;
- b. a discussion of the scope and purpose of mathematics in the NCSM;
- c. a discussion focussed on probing selected assessment standards and contents of specific outcomes in the NCSM.

(See Appendix G.2 for an outline of the questions used to guide Interview #1 which focussed on 1. and 2. above)

3. *Imagined and actual learner productions:*

Prior to the interview, students were given copies of past examination papers and examples of student work on some of the questions as prompt material. The interview included:

- a. a discussion focussed on selected items from the past matriculation examination paper eliciting imagined learner productions;
- b. a discussion of examples of actual learner productions produced by school pupils on questions from past matriculation examinations in preparation for their 2004 examinations.

(See Appendix G.3 for the schedule for Interview #2. This includes the examples given to the students prior to the interview and the questions used to guide the interview).

4. *Reflections on their University Career:*

The student teacher was asked to reflect on their experiences of learning M, ME and MT during their university career.

(See Appendix G.4 for the schedule for Interview # 3 which focussed on the students' university careers)

The purpose of these interviews (in the research design) was to elicit information that would enable me to trace the various mathematically orientated knowledge discourses and practices

¹⁹⁸ At the time that the site visits were carried out the NCSM had been published but was only due to be implemented in Grade 10 in 2006. The old curriculum statement was still in use. The final matriculation examination using the old statement would be in 2007.

circulating within the student teachers contexts (M, ME and MT) and through this to get some purchase on how these may be working to specialise the pedagogic identities of these novice teachers. I had hoped to use the interview transcripts to get some purchase on the recognition and realisation rules at work at the level of the acquirers.

Each section of the interviews was designed to probe the student teachers in a way that would require them to position themselves in relation to the various discourses operating within the teacher education context. The prompt material (NCSM, matric exams, learners work) was used to provide direction for the interviews and enable me to push them to reveal their underlying thinking in relation to specific material. In some senses I had designed the interviews to try and get ‘into their heads’.

All interviews were transcribed to be used as raw material for producing data.

2.3 Field Notes

At each institution I kept a journal in which field notes were recorded on a daily basis over the duration of the site visit. After each interview, I recorded impressions and initial interpretations of what had been said in the interviews and reflections on my observations of the practices at the institution.

2.4 Examples of student work

During the first focus group interview, at the beginning of each site visit, the student teachers were asked to reflect on their education as mathematics teachers and their experiences of the various mathematically related courses that they had taken over their university careers. They were asked to select items from the work they had produced (e.g. assignments, tests, lesson plans, etc from a range of courses including those focused on mathematics, mathematics education and mathematics teaching). The criteria for their selection were to be items they felt were significant in their personal development in becoming mathematics teachers. They were asked to write brief notes explaining why these were significant and to allow me to make photocopies of their work. They were also asked to orally present some of these items to the final focus group interview reflecting on the research process. This was held on the final day of each site visit.

The material provided by the various students is variable. Some students produced huge files of work while others selected only a few items. Very few of the students gave any justification

for their choices. When I had requested students to produce these examples I had imagined analysing them systematically in an attempt to see what recognition and realisation rules relating to the three discourses had been acquired. Once the material had been archived, that is, systematically organised in files with an inventory and descriptive log, I realised that the implicit rules for selection of the material by the students may not have been consistent and that while the material might be used to assist with providing supporting evidence for findings it would not be sufficiently robust to be considered as reliable sources for data analysis and interpretation.

Having described the evidence collected, I now turn to discuss the methodological issues that arose as I attempted to organise the evidence and produce data for analysis and interpretation.

3 General Methodological orientation

As discussed in Chapter 6 (Methodology 1) I continued to work with Thompson's methodology of interpretation as a general methodological orientation, and with Bernstein's notion of languages of description.

Recall that Thompson's methodology involves layers of interpretation. The raw material or evidence that I have to draw on in producing the accounts for this part of the study are the stories that the students write and tell about themselves, i.e., the doxa, or the pre-interpreted domain. While the student stories are a necessary starting point, they cannot be taken-as-is. Layers of interpretation are required to move beneath the surface of the stories. As a first step the stories need to be interpreted within their socio-historical context. A second step (although not necessarily independent from the first) is an interpretation that involves a more formal discursive analysis which is concerned with the internal organisation of the student teacher stories, that is, with their structural features, patterns and relations. An appropriate theoretical framework needs to be selected to illuminate this organisation – that is a language of description needs to be developed. In this way, features hidden below the surface of the words can be identified and reorganised in terms of a theoretical gaze. The third layer involves interpretation and re-interpretation. Interpretation proceeds by synthesis, by creative construction of possible meaning, that goes beyond the analysis produced by the interpretation of the doxa within the socio-historical context and the field of differences produced through the formal discursive analysis. The field of differences here refers to patterns in terms of similarities and differences between, and presences and absences within and across the second

level analysis. The interpretation is at the same time a synthesis and a re-interpretation of the various layers as they are rubbed up against one another to produce meaning.

In the sections that follow I will show how I attempted to use this general methodological orientation to work with the evidence collected from the successful student teachers (the institutions good pedagogic subjects) at each site in order to produce an account of their pedagogic identity construction.

4 Towards developing an external language of description to produce an account of the ‘good’ pedagogic subjects

This section describes how I was able to work at the first level interpreting the data using an organising principle based on Bernstein’s conception of a teacher’s career. This will be followed with an account of the difficulties I encountered as I attempted to produce the formal discursive analysis for the next level of interpretation. I will describe the processes, the theoretical resources I drew on, and the analytic tool I developed to organise and produce data that would enable me to move to a more abstract level of interpretation. I will show how my initial attempts failed and try to give a coherent explanation for why it failed. This will be followed, in the following section, by an outline of how I proceeded with the study.

4.1 The first level of interpretation: interpreting the pre-interpreted student stories within the context of individual teacher careers

In terms of the methodological approach the first layer is the interpretation of the doxa. The main evidence for this level of interpretation comes from the student stories written in response to the biographical questionnaires. Supporting information is also found in their interview responses. When the students construct their stories for the research they present an interpretation of their context and histories. In this sense the evidence they produce populates a pre-interpreted domain that is presented for interpretation in the context of the research. This (re)presentation of their stories is partially structured by the biographical questionnaire and the interview questions.

The design of the biographical questionnaire was framed through a gaze that took seriously Bernstein’s proposition that teacher identity

emerges from the dynamic interface between individual careers and the social or collective base ... [I]dentity arises out of a particular social order, through relations which the identity enters into with other identities of reciprocal recognition, support, mutual legitimisation and finally through negotiated collective purpose (Bernstein, 1996: 73)

and, that the career of a student teacher is a “knowledge career, a moral career and a locational career” (Bernstein, 2000:66).

From this perspective, the (student) teacher’s career is *locational*: it has a historical existence across specific locations (places/contexts), for example, in the home, the school classroom as a learner, after school in the playground/ study group, at the university, out on practice as a teacher in different schools etc. Each of these particular locations has a number of dimensions, for example, geographical (in a town/ city/ on a farm/ mountain/ by the sea), economic (wealthy/poor neighbourhood, well resourced /poorly resourced schools or university), social (specific social groups of people within the context with whom the identity interacts and negotiates his or her place in the world and as a teacher; social groups that have access to different forms of capital – e.g social, economic and academic). In each location there is a history of interaction and identification. The internal construction of the specialised consciousness (pedagogic identity) is connected to the geographical, social and economic context of the various locations, as well as to the influences of significant others at those sites – e.g. family/ teachers/ peers - who interact within these locations to negotiate what it means to learn (mathematics) and to be a (mathematics) teacher. Across these various locations the career therefore has *knowledge* and *moral* dimensions.

The student teachers’ career is a *knowledge career* – so in each of the locations and sites certain orientations to knowledge become naturalised (for example, various specialisations into the three discourses identified earlier – M, ME, and MT). The student teacher’s career is also a *moral career*. Throughout the career social practices are instilled and values are developed that regulate their ways of being in the world – both in terms of the general rules of behaving, acceptable ways of interaction and values of the individual in the collective setting, as well as particular habits of mind and dispositions towards the various knowledge discourses circulating and within which the individual participates.

The biographical questionnaire was constructed to elicit writing in relation to the selected students’ careers: a re-telling of their mathematically related histories through their memories of school and university learning. In particular it was structured to elicit information about the student teachers’ careers in terms of the three specialised knowledge discourses and their practices (M, ME and MT) and the associated pedagogic identities¹⁹⁹ that I had theorised

¹⁹⁹ An identity as a student of mathematics (becoming an able mathematical learner, thinker and actor); an identity as a student of mathematics education (becoming someone interested in learning from research in the

previously may develop through any four-year teacher education programme. Thus the questionnaire attempted to elicit information related to each of these discourses across their careers.

As I worked with the evidence, I found that mapping each student teacher's career in terms of its locational, knowledge and moral dimensions, was useful for structuring a first level interpretation of each student's story within a socio-historical context. This provided an introduction to each of the good subjects in the study providing relatively thick descriptions through their personal stories and mathematical histories, and provided a starting point for working with the archive of evidence more discursively. However, while the first level stories begin to reveal something of the way in which the good subject's pedagogic identities are constructed over their careers and provide some insights into their experiences in the institution, the stories remained at the surface level. In order to get below the surface I needed to draw on additional resources and move to the next level of analysis.

4.2 The second level of interpretation: finding resources for the formal discursive analysis of the evidence

In the biographical questionnaires and in the interviews student teachers project a particular image of themselves. What they write and say (their utterances) is the major evidence that I had access to and that I needed to organise and interpret in my attempt to map an account of the specialised construction of their consciousness and conscience as 'mathematician', as 'mathematics education scholar' and as 'mathematics teacher' across their careers and within the institutional contexts in which they were educated as mathematics teachers. I had the idea that I could trace the discourses circulating in their talk (as generated in the context of the interviews) to build, at least on some level, a picture of this internal construction of the pedagogic subject in the context of their university career. This could then be rubbed up against the institutional context to get some purchase of the way in which the teacher education programme, through its message systems of curriculum, pedagogy and assessment, worked to specialise their consciousness and conscience. I was well aware that these would not be one-to-one relationships and the connections would be complex. However I had hoped by mapping these discourses I would, at the very least, get some meaningful insights into the way in which the pedagogic subject (novice mathematics teacher) was being constituted within the teacher education context, what discourses they had access to, how they identified with these and how

field of mathematics education); and an identity as a mathematics teacher (becoming someone who can utilise and transform their knowledge for learning in order to help learners at the classroom level develop productive mathematical identities and motivate them to learn the discipline at higher levels).

they used these to argue for their positions in the context of the open interview discussion that had produced the evidence.

4.2.1 Analysing the contents of student utterances

The theoretical work of Basil Bernstein that had sparked my interest in the notion of pedagogic identity and its relation to the developing consciousness and conscience of the novice mathematics teacher had led me to this point and was my major theoretical resource. In my first attempts to work at the level of the individual subject, I attempted to analyse the contents of the student utterances (U) through organising them in an analytic space structured around Bernstein’s distinction between academic, official and local knowledge (K) discourses circulating in the recontextualising field of teacher education practice. This space is represented in Figure 40.

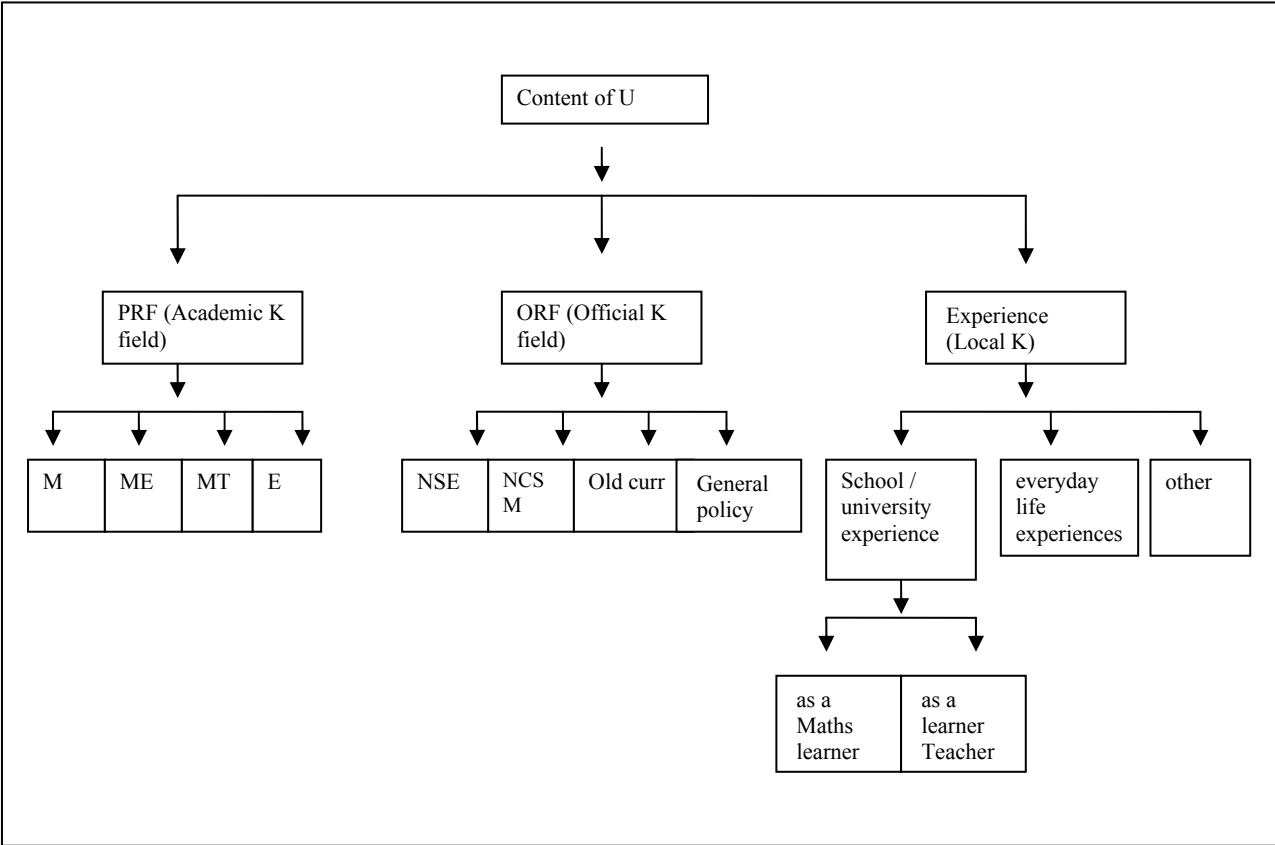


Figure 40: Analytic space for identifying knowledge discourses circulating in student talk

The process through which I intended to use this to analyse the contents of the students talk is described below.

The transcripts were numbered using each interaction between the interviewer (myself as researcher) and interviewee (the students in the sample) as markers. Each of these interactions

was identified as an utterance. In each transcript the ‘utterances’ were numbered sequentially from #1 (the first interaction in the interview). The utterances were grouped in relation to shifts in the focus of content to form “chunks” which were analysed to produce the data. These ‘chunked’ utterances, or episodes in the talk, were recognised by a change in the topic under discussion.

For example, the focus of the interview discussion might move from a general discussion of the teacher education programme to focus on what the student teacher considered to be ‘the four most importance aspects of being a good specialist mathematics teacher in South Africa²⁰⁰’. The utterances that focussed on this question would be ‘chunked’ into a unit and its contents analysed in terms of the type of discourse (academic, official or local) underpinning what the student teacher said. If, for example, the content was recognised as being underpinned by an academic knowledge field within the PRF, I would identify it as originating from one of the three mathematically focused specialised discourses (M, ME or MT) or from one of the discursive fields/ disciplines underpinning the field of education (E)²⁰¹ more generally. If it were from an official knowledge field within the ORF, I would identify it as originating from a specific piece of new policy (NSE, NCSM), the old curriculum, or policy discourses circulating more generally. If the position was not clearly linked to discourses circulating in the PRF or ORF and appeared to be based on localised experiences, then it would be identified as a form of local knowledge. In this case it would be linked to experiences as a learner of mathematics, as a learner teacher, or more general everyday life experiences. If I could not locate the experiences in these three categories then it would be identified as ‘other’. So for example, if a student were to say that one of the most important aspects was that the mathematics teacher must be able to analyse student mathematical errors/ misconceptions in order to understand the learners thinking, this would be recognised as originating in PRF within the discursive field of ME; if they suggested that the most important thing was to be an assessor, this would be recognised as originating in the ORF as one of the roles from the NSE; and so on. The analysis done in this way would be recorded in a table form using a ‘1’ to mark the presence of a discourse and a ‘0’ to mark an absence. The recording grid designed for this purpose is shown in Figure 41 below.

²⁰⁰ This was one of the questions asked in the section of the interviews focussed on eliciting the students teachers imagined practice.

²⁰¹ I recognized here that this was very broad, and that I had to guard against misrecognition, for example an utterance that drew on the Psychology of Education (e.g. a general comment that draws on Vygotsky’s ZPD) and was not recontextualised into mathematics education would be identified as E rather than ME. It would only be recognized as ME if it were specifically connected in the talk to aspects that were specialized/ recontextualised into ME. However I also recognized that in some cases there would be overlap and I might recognise both ME and E as underpinning the same chunk of utterances in which case both would be marked as present.

Utterance	Content of utterance											
	PRF (discursive K field)				ORF (official K)				Experience (local K)			
Chunk/episode	M	ME	MT	E	NSE	NCSM	Old Curr	gen policy	school or university learner	as learner	everyday L	Other
									teacher	as math learner		

Figure 41: Table for recording the content analysis

I hoped that by working through the transcripts systematically, chunking the utterances and analysing the content, I could get to some description of the pedagogic identities of the student teachers in relation to the different knowledge discourses that intersect in mathematics teacher education practice (M, ME and MT). I wanted to be able to describe the discourses which the student teachers drew on to legitimate their projection of themselves in relation to the specialist discourses intersecting in the teacher education context (that is, projections of themselves as mathematicians, mathematics education scholars, or mathematics teachers).

However, while working with the transcripts I realised that identifying the contents of the utterances to come up with tables of presences and absences, while giving me some idea of the discourses circulating in the teacher education context, was not very helpful if I wanted to get to the level of identity. To do this I needed to get behind the talk in order to identify how the student teacher was positioning him/herself with respect to the discourses that they were using to respond to the questions and prompts. I needed to find a way of recognising what discourses they were identifying with (internally), what they were invested in and how they recognised themselves within these.

I realised that while Bernstein's concepts enabled me to identify the knowledge discourses, they did not provide me with a gaze that would enable me to get below the surface of these discourses. I needed to find additional conceptual and theoretical referents to enable me to find ways of doing this.

4.2.2 Extending the analytic frame

I had been introduced to Lacan's notion of Imaginary and Symbolic *identification* through the QUANTUM project as we were working to develop a language of description for understanding how various modes of pedagogic practice were constituted in INSET programmes (see Davis, Parker, & Adler, 2005). I was attracted to the possibility of using these theoretical referents to link the content analysis (recognition of discourses used in the talk) to the subject positions that the student teacher adopted (in terms of the division of labour and the external position they appeared to speak from) and the internal place from which his/her justification for the use of the discourse to argue the position originated (the Symbolic, Imaginary, Real).

I was already well aware that

(t)he reworking of memory into a story is not the memory of a linear narrative "as it was" but rather a probing that creates something new; a present day building of the past, shaped by current motives, but perhaps also distorted by things the student would rather not confront". (Brown, Jones, & Bibby, 2004, p. 166).

I found it useful to consider Brown et al.'s (2004) suggestion that identity should be seen as something that people *use* – to justify, explain and make sense of themselves in relations to other people, and to the contexts in which they operate. This is derived from McLure's (1997) idea that 'Identity is an argument'. The identity is continuously being produced anew within different and competing discourses. From this perspective teacher identity can be seen as the continuously evolving outcome of attempting to reconcile complex demands (personal and internal, as well as external). At a particular time, a teacher may *use* a particular account of this reconciliation according to the demands of a specific domain. The argument of one's identity is entwined with an assertion of how one fits in/ or does not with one's perceived community.

This fits with the idea that

as individuals we are forever trying to complete the picture we have of ourselves in relation to the world around us and in relation to others who inhabit it. We respond to the fantasy we have of the big Other (the external world shaping my actions) and the fantasy we imagine the Other having of ourselves. (Brown, Atkinson, & England, 2006, p. 36).

From this perspective what the student teachers say in the context of the interview is an account of themselves that they project for a particular purpose. When student teachers 'speak and write themselves' in this context they are providing a particular set of images, a story for a particular audience. In a sense the self that they present is a fantasy that projects an image of coherence they hope will meet with approval. The stories that the student teachers tell about themselves are likely to be populated with images that they construct to project themselves, to argue for a self that they believe will be the *kind* of self that is required by their lecturer (who

has ‘chosen’ them as a ‘good’ example of what they were trying to produce through their course), and the researcher from another university who is asking a particular set of questions to elicit projections of their pedagogic identities, in particular internalised understandings of mathematics, mathematics education and mathematics teaching. This is not to say that the student teachers will necessarily be fabricating their stories for the sake of *consciously* projecting a particular image – they may very well be convinced that they are being entirely truthful. All the students that were interviewed as part of this research project appeared to engage with the interviewer in very genuine ways, becoming invested in the process, especially in the discussions over the mathematical selections in the new curriculum statements. In the final group presentations the general sentiment was that the discussions really made them think and reassess their thinking about themselves as novice mathematics teachers in profound ways.

Nevertheless it is possible the students’ utterances produced for the interview present an argument for a self that is structured by what they perceive is socially acceptable with respect to the dominant discourses circulating within the current educational context that are presented as ‘good’ (e.g., traditional large class teaching is necessarily bad and learner-centred activity-based small group teaching is necessarily good). In other words, they do not ‘speak and write themselves’, rather they are ‘spoken’ (by the dominant discourses circulating in their contexts).

This is captured by Brown et al.’s suggestion that in the context of teacher education,

Trainees and teachers seem to be increasingly *interpellated* by multiple discourses and risk ending up speaking as if they were ventriloquists’ dummies. Immersed in socially acceptable ways of describing their own practice, the obligation to identify with these ways can generate resistance to the desire to produce an identity of their own. [...] In a professional environment increasingly governed through ever more visible surveillance instruments, [...], there is a sense of needing to be what one imagines the Other wants you to be. (Brown et al., 2004, p. 177, italic in original)

At this point I will cease the theoretical discussion and take an example of a chunk of utterances from one of the transcripts to explore some of the ideas presented in this section for the purpose of illustrating the complex web of connections that are revealed by considering them within the context of this study. I then move on to discuss an extended analytic frame.

In a discussion with Phiri²⁰² on the most important aspects of being a mathematics teacher he suggests:

I think I have to be an **assessor**, in that sense. A **good assessor**. Then after being an assessor I have to continue to **be a researcher**. I have to get more research about what I am teaching as a mathematics teacher. So, and also to **be a lifelong learner**. (IAT-P1, U # 21, emphasis added)

²⁰² One of the successful RU student teachers.

He *argues* for this image of himself by continuing:

Because the content it keeps on changing, so **I** have to know the changes, the changes that take place when **you** are teaching that particular subject. **You must not dwell much on the old system.** **I** must know all the changes that are taking place. And also, **I have to be a scholar**, because those who know simply say “there is no old person in education”. So **I** have to be always a scholar, **and learn more changes that are taking place in mathematics.** And there are some **forms of assessment** – they are changing – **they keep on changing.** So **I** have to know the new things that are taking place. (IAT-P1, U # 21 continued, emphasis added)

Here Phiri identifies himself with four aspects of the ‘roles’ of a teacher that appear to come directly from the discourse within the NSE (from the ORF): what he must be is an assessor; researcher; lifelong learner; and, scholar. All these aspects originate from two of the seven roles²⁰³. It appears that he is speaking as a ventriloquists’ dummy, repeating the roles expected by the external demands of the NSE policy. However, we note, that as he argues for the selection he made, *his* focus is on what *he* needs in order to cope in a context of change. This is not an internalisation of these roles grounded in the policy statements. For Phiri his experience is that in SA education everything keeps on changing – so he must be forward looking and not dwell on the past. He must always be ready to change in response to changes taking place in mathematics – whether he is referring to the discipline of mathematics, mathematics education or the official school mathematics of the curriculum is not clear. He continues to elaborate his justification,

I must not follow the syllabus, or follow the curriculum. **I** have to go hand in hand with that particular thing as a mathematics teacher. **I** have to know even the changes that are going to take place before it comes. **I** have to know them. (IAT-P1, U # 21 continued, emphasis added)

Here we hear the echoes of the discourses that were circulating widely in South Africa in the early days of Curriculum 2005 in which teachers are seen as curriculum developers, not following a blue print, but constructing their own paths to the specific outcomes provided within the curriculum statements.

We notice that Phiri does not mention learners in this explanation of himself. He uses the pronoun *I* throughout most of this piece of the transcript, and only shifts to use *you* at one point where he says “the changes that take place when *you* are teaching that particular subject. *You* must not dwell much on the old system.” We also notice that Phiri is *not* focused on learners or learning in this argument for what he must be as a mathematics teacher. He is not focussed on making things understandable to learners etc. Learners are absent, he is focussed on himself. This is about him learning more and more about teaching and about education so that he can fit into and cope within this context of constant change.

²⁰³ These seven roles were discussed in some detail in Chapter 4.

The image Phiri is projecting in this part of the transcript is one that has two aspects – *I must be* an assessor, researcher, lifelong learner, scholar AND *I must not be* a follower of the syllabus/ curriculum: *you* must not dwell on the past. The description has both a positive and a negative focus. Both of these could on the surface be seen as coming directly from recontextualised official discourses circulating generally within the South African education community – be like the new policy tells you to be; don't be like in the old days when teachers followed syllabuses. However, in the conversation that follows the initial assertions (I must be an assessor, researcher and lifelong learner) he justifies his truth. While he is using the language of the NSE, we see that he has recontextualised this for *his own purposes*. That is he has not internalised the logic of the official documents. In the explanation he gives he is attempting to reconcile this image of *himself* within a context of educational change. This reasoning for the importance of these 'roles of a teacher' cannot be found within the official discourse. It is an interpretation of the official discourse from a place where Phiri is positioned as a teacher who has to cope with constant change and who cannot take anything for granted.

On the one hand he appears to be dominated by aspects of what is presented to him through the official discourse, but on the other hand he is appropriating this for his own use – in order to cope within a social context where things appear to be changing all the time. So he reinterprets himself as a powerful agent within a situation of change. He is not a victim – he is always ahead of the game, not being forced into things, but rather changing what he is doing in response to the contexts in which he finds himself, even before he is told he should change. In this way he positions himself as forward looking.

From examining the transcript of Phiri's U#21, we see that the content appears to be located mainly within discourses circulating in ORF, and specifically recontextualised from the NSE and general policy reform statements. Filling in the grid shown in Figure 41 would result in 1's in the NSE and Gen Policy columns, but this would not capture the way this has been *used* to argue for the identity. Nor does it capture *how* Phiri identifies with these discourses. The specialisation of Phiri's consciousness that appears²⁰⁴ visible with respect to this particular utterance is contained in the way he uses the discourses and what he means when he uses them: how he positions himself in relation to the discourses and what resources he uses to do this. We see him speaking as if he were a teacher (not a student teacher) coping with a transforming system. His recontextualisation of the discourses in the ORF is based not on

²⁰⁴ Clearly this is not to suggest that this one utterance gives any coherent account of his pedagogic identity.

discursive resources, but rather on images produced through his experiences of how things keep changing and his worry about the consequences if does not know what to do.

Clearly the analysis of content as suggested in Figure 40, while identifying discourses circulating in the student teacher's talk, is completely insufficient for producing data that could be productively interpreted to provide insights into the pedagogic identities produced within the different contexts. There is a need to expand the framework so as to include the possibility of linking the discourse to its use in justifying an argument for a projected identity.

I turned to Walshaw's (2004) reading of Lacan as providing important insights into the development of 'identity' or the production of a subject (person), or group of subjects/ persons, taking on particular positions with respect to the discourses circulating in society. Walshaw's interpretation of the Lacanian theory, describes three psychic registers of subjectivity: the Symbolic, the Imaginary and the Real each of which produces a different type of subjectivity which work together to inform a person's experience and sense of perception. Each register is responsible for processing its own set of "data": concepts, percepts, and affects. It is up to the learner to "make peace" with the conflict among the forms of recognition that each offers. These 'registers' and their 'data' are related to different forms of identification in which the subject is to recognise themselves, in particular imaginary identification (based on visual images) and symbolic identification (based within discursive fields).

The *Symbolic* register is the domain of laws, words, letters and numbers that structure our institutions and culture. It is through this register that concepts are processed (through discursive fields of knowledge). The *Imaginary* is the domain of the visual-spatial images and illusions of self in the world. It lies at the limits of perception. The Imaginary order is produced from the conflict between perception and misrecognition that occur initially in the 'mirror stage' when the infant sees the first image of self in a mirror and is split from his/ her self-perception. It is through the Imaginary that percepts are produced. The *Real* can be thought of as an 'extra-discursive site' that holds all things that the Symbolic and the Imaginary cannot contain. The Real register points to a "lack of a lack" – it is an indicator of 'sociophysical growth'. Desire for recognition in the Real register is expressed through the mirroring of affect and emotion. This is the register that processes affects.

In this study I am asking: How do the student teachers project themselves as mathematics teachers"? When they 'write and speak themselves' what do they draw on? It now seemed

fruitful to ask: How do the three registers, Symbolic, Imaginary and Real work together in the construction of these students as mathematics teachers? What identification is projected through their talk? What do they say (content) and where does the argument for their position in relation to this come from (which register and what type of “data” – concepts/ percepts/ affects)?

From this perspective it seemed fruitful to try and identify the ‘place that any particular utterance comes from’ in terms of the registers. So any utterance relating to a students’ self-image as a becoming mathematics teacher could be identified in terms of its *content* as originating within a particular discourse circulating within society (in this case emanating from the recontextualising fields (PRF, the ORF), or from local knowledge produced through their experiences within a school (the field of reproduction) or in life more generally. However, identifying this source of content would not enable us to see the psychic register which processed the utterance – i.e. whether its data are concepts, percepts or affects. The way to see that would be to trace the way in which the student teacher ‘argues their identity’ – i.e. how they *justify* the subject position they are taking, or in other words, how they justify their truth. In this way I could attempt to get ‘beneath’ the surface of their story that may become visible from the content analysis, to the place from which their consciousness as a mathematics teacher is being produced. They may consciously be ‘writing and speaking themselves’ for a particular audience, however, the resources that they draw on and the register from which they speak, cannot be consciously controlled.

Referring back to the example above, we see in Phiri’s discussion of himself that the *content* of his utterances (what he says) is described by language that can be traced to the official discourses of the NSE and general policies surrounding the initial implementation of C2005 (i.e. Official knowledge produced within the ORF). When we consider what position he is speaking from we see that he identifies himself as a mathematics teacher who has to cope with change. He argues for his position and this imagined self, not by drawing on any particular discursive knowledge resource (that is, not symbolic identification), but rather on an *image* of teaching that while being structured by knowledge produced within the official (changes in the mathematics curriculum and assessment methods implemented in the official domain) and pedagogic (changes in mathematics education) recontextualising fields, is not articulated in any principled way. They are *percepts*. Thus the image projected is one that is primarily located in

the Imaginary²⁰⁵ - it is an imaginary identification. We also note that Phiri's argument for himself also projects a particular character or orientation to being in the world (internal regulation) – that of an active agent taking charge of his life.

I was initially attempting to understand the way in which the student teachers' pedagogic identity was being constructed in terms of the institutional context in which they were being educated as a teacher. How did they recognise themselves within the particular B.Ed curriculum they were experiencing and in the pedagogic identity projected from the institution, in terms of their careers as 'mathematicians', as 'mathematics education students' and as 'mathematics teachers'? In the light of the above discussion this could now be re-described as trying to identify *what* the student teacher identifies him/herself with in terms of the image they are projecting as a mathematics teacher, and then linking this to *how* they justify that self-image (through percepts (Imaginary)/ concepts (Symbolic)/ affects (Real)).

An expanded analytic space (from the one shown in Figure 40) can now be constructed by linking the content analysis which identifies discourses (in terms of PRF, ORF and Local K discourses) within the student talk to the self image they project (in terms of their subject positioning and character) and their justification for that image (the psychic register from which it is argued – through the use of concepts, percepts or affects). The resulting analytic space is shown diagrammatically in Figure 42 below. It is noted that while the spaces are identified, the set of moves that links the content of the utterances to the place that it comes from, are still underspecified. A way of clearly recognising these links still needed to be found, that is, a set of stable moves that would unambiguously allow me to analytically link the content of each chunk of utterances to the place from which the 'truth' being projected was being argued. If this could be done, then I could systematically work through the transcripts to produce a set of data recorded in a new table that was an extension of the one suggested in Figure 41 to include these new categories. This data could then be interpreted to give valid and coherent insights into the pedagogic identity construction of the pedagogic subjects in my sample.

²⁰⁵ It is important to realize that empirically these registers do not operate in isolation – the Symbolic and Real are always figured – and in this example the Symbolic is embedded within the official and pedagogic discourse that produce the Imaginary and the Real is embedded in the fear of being unable to cope with the changes that are going on all the time.

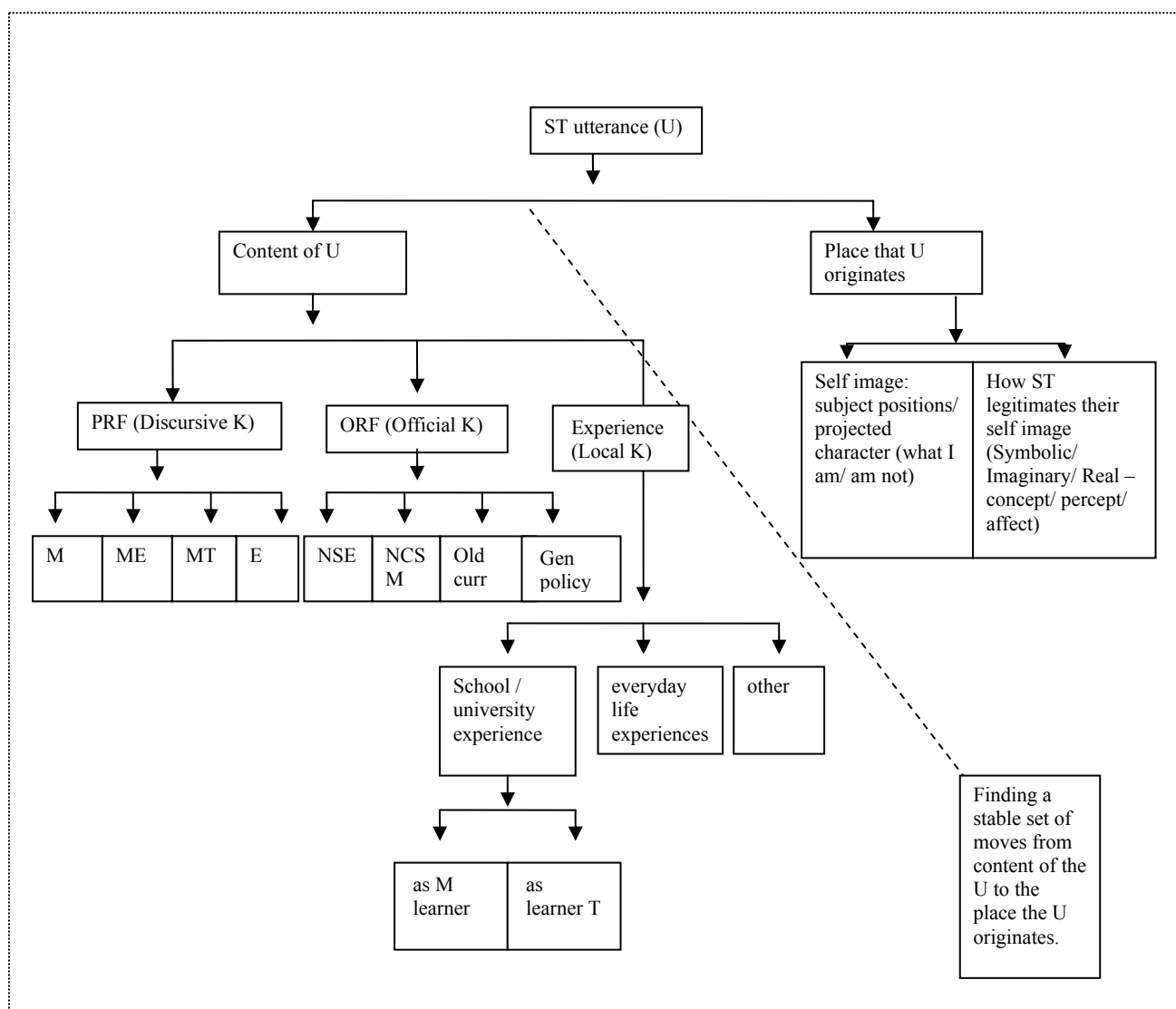


Figure 42: Linking the content of utterances to the place from which the utterance originates.
The process through which I imagined I could do this is described below.

The first step would be the same as described in the previous section – the transcripts would be chunked. Each chunk would first be analysed in terms of its contents, whether the discourses spoken originated in the PRF, ORF or in localised experiences.

The second step would be to fix the way in which the student teacher tries to guarantee this truth (how they justify themselves/ their use of this content). This would be done through asking the following questions:

- How do they position themselves within the division of labour (as a learner of school mathematics/ as a learner (novice) teacher/ as a competent (experienced) teacher/ as a mathematician/ as...) and how consistent is this positioning within the chunk of talk?

- What oppositions are set up within this positioning (what I am and what I am not) and what characteristics of self and self regulation does this convey?
- How does the student teacher legitimate who they are/ would like to be/ should be as a mathematics teacher? Is the justification expressed in terms of concepts, percepts or affects? These can then be mapped back to the place that these justifications originate (Symbolic, Imaginary or Real).

I hoped that by sifting the chunks of utterances through such questions I could get some description of the evaluative criteria the student attempts to apply to him/herself in producing their truth (i.e. the self-image that they produce through their talk). These questions would also be used to identify the regulative ideals used by the student teacher to construct themselves in a way that they imagine is legitimate and would go some way to describe the way in which the 'legitimizing domain' for their projection of what they are/ are not is organised.

I imagined that data would be recorded in an extended table, an example of which is given in Table 35 on page 387. Presences and absences would once again be recorded with 1's and 0's which would enable me to quantify the way in which the discourses were being used, and their justification for this use, by the individual teachers in the sample. In the next sub-section I describe how I used the framework in an attempt to comprehensively work through one student's story, and some of the problems encountered in doing so.

4.2.3 Testing the analytic framework: Sonny's Story

Sonny is a 'good subject' of CU in his fourth year of study at the time the evidence was collected. In this section I present the way in which I attempted to use the analytic framework given in the previous section to systematically code the transcripts of the interviews with Sonny in order to produce data for the second layer of interpretation as described in the general methodology.

I systematically worked through all the sections of the interviews recording presences and absences as described above. The tables of data for Sonny's story that were produced by working through this process are reproduced in Appendix G.5. The first column of the table indicates the chunking of the utterances. These are named according to the focus of the episode in the interviews and can be mapped onto the description of the different categories that the interviews focussed on (see Section 2.2 above). 1's and 0's are inserted into the various columns of the table to indicate either the presence or absence of a discourse, position or type of justification.

For illustrative purposes I will discuss the process for producing the first table of data. Table 35 summarises Sonny's responses across the first interview category: imagined practices. To illustrate I will use the chunk/episode marked by U# 21 – 25 (image of self as a mathematics teacher). I will first present the transcript, emphasising certain sentences within it using bold type. I will then give an explanation of the coding into the table and discursively discuss an interpretation of the chunk. This will be followed by a more general discussion of all the tables of data produced from Sonny's transcripts.

The transcript of Interview # 1 - Chunk 1.3: utterance# 20 – 25

- U# 20: Di: Ok, now I want to know, this is the next one and it is much more fun than that one (laughing).
 S: Ok (laughing).
- U # 21: Di: I want you to imagine that you are a grade 10 or 11 teacher in a school. You are working in a school. What image do you have in your mind of yourself as a teacher in that classroom and in that school? What is your image of yourself, how would you be acting, how would you be?
 S: I'm looking at myself as this **active teacher** first of all that **doesn't spoon-fed learners**. Ok, that **prepares lessons well**, that **takes into consideration learners** and when, when preparing lessons, so which means lessons have to be **learner centred**. And I see myself as **a mediator** while walking around the classroom **helping learners in groups, report back**, eh, from learners and, eh, **discussion going on** in the classroom. Well in the school **I would like to be seen by my learners as that teacher who makes a difference in learner's lives and who's sensitive to learner's problems and who's always willing to help learners, eh, eh, with whatever problems they have in mathematics**.
- U# 22 Di: Ok that sounds good. So now suppose I'm a fly on the wall in your classroom?
 S: You are?
- U#23 Di: A fly on the wall.
 S: A fly on the wall? (laughs)
- U# 24 Di: I'm a little fly on the wall.
 S: Ok.
- U # 25 D: I'm looking down on this classroom, what it's going to look like, what would I see?
 S: You'll see this, this, I don't know it's, ok. It's gonna be funny, you gonna let me be funny. (laughing) But you'll see with, you'll see this classroom with **little groups, and groups, groups, groups, groups, groups, groups, because I believe that wherever you go you gonna be working, you gonna be working with other people**. Obviously you need, you need other people somehow in life, in life just in general you need other people. Whenever you are presented with a problem, well sometimes you can solve it on your own but **you need to share ideas in order to solve a problem**. So **my classroom will be this classroom with small groups, groups, groups and learners discussing things maybe, maybe 3, 2, ok and 4 maximum. Learners discussing problems, sharing ideas and all that stuff so the little, little fly on wall will see that** (laughing).

Reading through the transcript, we can recognise the dominance of discourses circulating in the ORF through the general discourse of 'learner-centred teaching is good = group work = discussion and report back' as well as mention of the NSE role of teacher as 'mediator'. However, we also recognise aspects that would be based within the ME (sharing ideas to solve a problem) and E (description of appropriate group size). It is also clear that he is not saying anything that appears to originate within his own experiences of teaching or learning. Thus columns ME, E, NSE and Gen Policy are all marked with 1. The image that Sonny is

projecting here is of himself as a learner-centred teacher in the classroom, and he presents himself as a teacher (not as a learner-teacher). His character as a teacher is emphasised as someone who is active (walking around helping learners) as well as caring, sensitive, helpful, diligent, well prepared and making a difference in others' lives. The cell of Teacher is marked with a 1 and the characteristics mentioned are recorded, as shown in Table 35.

Sonny justifies each image: learner-centred (because he takes learners into consideration); active (because he does not spoon-feed and walks around the class); mediator who organises teaching in groups (because in life “you gonna be working with other people” and “you need to share ideas in order to solve a problem”). My next step is to try and recognise what type of identification this argument indicates – is he using concepts, percepts or affects to argue for this self?

How is identification at work in this example? I now find myself in a situation where I can't be sure. It may be Imaginary identification, taking up an (official) image of small group teaching as good, rather than taking a position which is supported by concepts of teaching and learning originating within a discursive field of knowledge. However I am not entirely sure. Sonny may in fact be weakly articulating an argument based on conceptual ideas based in E or ME, but he may not be in a position in the context of the interview to articulate this. How can I be certain? What rules would enable me to code this with confidence?

I found after working through the data that there were a number of places throughout the transcripts where I could not unambiguously recognise an absence or a presence, even after a number of parses through the transcripts. My own rules of recognition, particularly in relation to concepts/percepts/affects as ways of identifying the Imaginary/ Symbolic/ Real registers, were not robust enough. In the end I marked all the ambiguous cells with a question mark (?), as is seen in the tables in Appendix G.5.

I also found that having coded the chunk of transcript (U# 20 – 25) in terms of presences and absences, when I looked back at the table, I found myself unsure of what the 1's and 0's in the table actually showed/meant. The meaning came through the texture of the relationships I saw in the text, and these seemed to be lost as soon as they were transformed into 1's and 0's in the table.

Table 35: Data produced from Interview focus 1: Sonny's imagined practices (Utterances: #5 to 35)

Utterance	content of utterance												Place utterances come from								
	PRF (discursive K field)				ORF (official K)				experience (local K)				projected identity - subject positioning - image of self						how self image is legitimated		
chunk/episode	M	ME	MT	E	NSE	NCS	Old Curr	gen policy	school or university		everyday L	Other	within division of labour				individual character	type of data (psychic register)			
									as L in past	as T			Learner		Teacher	Mathematician		Other	Concept (Symbolic)	Percept (Imaginary)	Affect (Real)
											school M	Teacher									
U # 5 to 9 (four NB aspects of good MT)	0	0	0	0	1	1	0	1	1	0	0	0	1	1	0	0	0	Self reflective	0	1	0
U# 10 to 19 (four NB aspect of M)	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	critical / systematic thinker	?	1	0
U# 21 to 25 (image of self as MT)	0	1	0	1	1	0	0	1	0	0	0	0	0	0	1	0	0	caring, sensitive, helpful, diligent, well prepared, makes a difference	?	1	0
U# 26 to 28 (self in relation to other T)	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	open, shares ideas, learns from others, humble	0	1	0
U# 29 to 31 (a good M Learner)	0	1	0	0	0	0	0	1	1	0	0	0	0	1	0	1	0	listens, share ideas, respectful, diligent, argues convincingly	0	1	0
U# 31-32 (the most NB to know abt M Learning?)	0	1	0	1	0	0	0	1	0	0	0	0	0	1	1	0	0	shares ideas, listens and learns from others;	1	1	0
U# 33-35 (what is NB to K abt assessment?)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	—	1 (?)	0 (?)	0
totals for Int #1 (7 chunks)	1	4	0	3	2	3	1	4	2	0	0	0	1	3	4	2	0	shares ideas, listens to and learns from others; respectful of other's ideas; diligent, systematic, critical thinker.	1 (4)	6 (7?)	0

Having worked through the transcripts I could summarise the story Sonny projected of himself: an active teacher; does not ‘spoon feed’ and expects learners to work through problems; prepares with his learners in mind; is ‘learner-centred’; a ‘mediator’; uses group work that involves discussion and report backs. But more than this he sees himself as a teacher who makes a difference in his learners’ lives, is sensitive to their problems in mathematics and is always willing to help them in their learning. However, this story is still in the terms that Sonny used to present himself. It is simply a retelling of the pre-interpreted domain (that is, it is part of the doxa). The purpose of the coding was to get behind the story, to see where it comes from. Does the table help with that? The process of working through the utterance certainly assisted with the identification of discourses and the dominance of the ORF in its contents and to see what the contents of the argument for this position were. However the table produced does not seem to capture in any clear way what lies behind the use of these discourses, or how specialisation of consciousness/conscience works. It may be that it will only be by looking across the full data set that I will start to be able to see patterns that can be usefully interpreted and in terms of the theoretical field.

Having shown how individual chunks were coded and discussed a central problem with my recognition rules, I will now look across all the tables of data produced from working through Sonny’s transcripts to see if they were useful for identifying patterns/ internal structuring of the talk that would enable a more robust (in terms of this research) interpretation of the student teacher identity and its relationship to the institutional settings in which it has become specialised. In the detailed form showing all chunks and the coding of chunks (as in Appendix G.5) it was difficult to see any relationships. I therefore summarise each table: this was done by totalling the various columns to get an idea of the presences and absences in relation to each interview focus. I converted these into percentages so that they could more easily be compared. A summary of the outcome of an analysis of each interview is reproduced in Table 36 below.

The first thing to note from Table 36 is that there are a number of places where two percentages are given – the first are the totals of all the presences marked with a 1 in the table; the second also count in the question marks where I was not certain, but where I felt that a presence might be lurking. I note that in the analysis of contents this uncertainty is negligible. *It is in the interpretation of the place from which the argument for self is located that there is more uncertainty, and particularly in the columns identifying the psychic register where it is the largest.*

Table 36: Summary table of data produced from working through all transcripts of interviews.

Table 55: Summary table of data produced from working through all transcripts of interviews.																						
Utterance		Content of utterance											place utterances come from									
		PRF (discursive K field)				ORF (official K)				Experience (local K)			Projected identity - subject positioning - image of self					how self image is legitimated				
chunk/episode (excludes Housekeeping)	M	ME	MT	E	NSE	NCS	Old Curr	gen policy	school of university as M L in past		everyday L	other	within division of labour				Individual character	type of data (psychic register)				
									as learner T	Learner			Teacher	Mathematician	Other	Concept (Symbolic)		Percept (Imaginary)	Affect (Real)			
										school M										Teacher		
% of 7 chunks Focus 1 (to nearest whole)	14	57	0	43	29	43	0	57	29	0	0	0	14	43	57	29	0	*	14 (43)	86 (100)	0	
% of 15 chunks Focus 2 (to the nearest whole)	80	7	7	0	0	7	0	7	33	7	7	0	7	20	13 (20)	60 (73)	7 (20)		73 (80)	27 (33)	20	
% of 4 chunks Focus 3 (to the nearest whole)	75	50	(25)	0	0	0	0	0	50	0	0	0	25	0	100	0	0		75	75	0	
% of 8 chunks Focus 4 (to the nearest whole)	13	25	25 (38)	13	0	0	0	0	13	63	(13)	0	0	88	13	0	25		(13)	88 (100)	0	
% of all 34 chunks	50	26	9 (15)	12	6	12	0	15	29	18	3 (6)	0	9	38	32 (35)	32 (38)	9 (15)		44 (56)	59 (68)	9	

* Individual character: The lists of imagined and reported characteristics can be found in the Tables of data reproduced in Appendix G.5.

Bringing together all 34 chunks and summarising them does not seem to be useful as it distorts the overall picture. For example looking at the percentages in the first column (M), the overall picture suggests that in 50% of the utterances mathematical discourses are in focus. However this hides that the structure of the interview determines the focus of content.

We see that for Focus 1 (imagined practices) M is drawn on in only 14% of the chunks, whereas in Focus 2 (curriculum discussion) it is drawn on in 80%. Clearly the content of utterances is determined by the structure of the interview – so in Focus 1, on imagined practices in M, ME and MT, there is a spread of discourses located in the PRF, ORF and local experiences that are visible. ME and E are the dominant forms from PRF, Gen Policy is dominant from the ORF, and, experiences as a mathematics learner in the past dominate local knowledge forms. When focusing on the mathematics curriculum statements and learner productions M is dominant, which is not surprising since the interview questions probed understandings of specific mathematical contents and mathematical productions. When focusing on the university career there is a spread across all discourses in the PRF, which is also unsurprising, since the focus of the interview questions was on what was learnt in the teacher education context across the different aspects of the curriculum.

This suggests if the tables are to be useful the different interview categories should be considered independently. It also suggests that the discourses present in the content are brought into focus by the interview questions and that if the tables are to have any significance it will be through interpreting the link between the discourse and its use in arguing for a particular identity. It is also clear that the tables provide a set of data that hide the texture of the way in which the discourses are used.

In assessing how useful the tables might be for interpreting the links between the content of utterances and the place that the utterances come from, in terms of the identity construction of the good subject Sonny, let us consider the summary of interview Focus 1.

As indicated in the example above, the spread of discourses present covers all three fields (PRF, ORF and local experience). Sonny appears to speak these contents from a variety of subject positions (presumably depending on the way the questions position him), including as learner of mathematics, a learner teacher, a teacher and a mathematician. The dominant positions are as a teacher and a learner teacher. The type of data that he uses to justify his position appear mostly to be percepts, images of completeness that appear to be outside of

himself (although, as was indicated above, this may not be very reliable), which would indicate that identification is mostly imaginary. What would this mean? One interpretation is that while Sonny has been introduced to a variety of different knowledge discourses within his career thus far, his self construction in terms of his imagined practices across M, ME and MT are recognised in whole images of what he perceives as acceptable practice and not necessarily grounded in principled knowledge forms.

Going back to the disaggregated table for Focus 1 (that is, Table 35) and looking across the seven chunks we could give a more detailed and textured description by linking back to the contents of the transcripts for each line. However, that in the main simply gets us back to an interpretation that could just as easily have been produced without the tables. It is noted that while parsing through the data a number of times in my attempts to produce the tables a number of insights were gained. However these are not necessarily revealed by the tables and could have been gained by working with the data in a more creative and less linear way.

5 Moving on: going deeper and narrower

In the previous section I showed that while the instrument I developed to produce the student data appeared fairly clean and sophisticated, I could not use it to produce unambiguous and reliable data, nor could I meaningfully interpret the data so produced to get to the depth I had intended. This was not simply a result of the recognition and realisation rules for producing data, closing down the openness of information in the empirical field (c.f. Dowling), but rather a problem with the model, the external language of description. In reflection, I realised that my attempts to fit complex and contingent relationships into neat tables was inappropriate, and possibly, a result of applying theoretical resources in a naïve and fairly shallow manner. In reflecting on these attempts and processes I now, disturbingly, see a lack in my understanding of the theory, and recognise a resistance to forms of knowledge that do not result in neat tables through which clear unambiguous distinctions can be recognised and evidence based (relatively) objective statements can be produced.

In the previous chapters of this thesis, it was possible for me to use such instruments as the basis for producing data. This was because, for the most part, I was examining *external* texts: curriculum documents, video records of pedagogic practice within the teacher education context and examples of formal assessments. The analysis of these external texts, representing the three message systems (curriculum, pedagogy and assessment) operating at the institutional level, while requiring hard intellectual work, involved observations and

distinctions that could be reliably fixed into analytic frameworks. However when turning to focus on the student teachers in the sample I was attempting to get into the *internal* specialisation of their consciousness and conscience, something that is impossible to directly observe and map in a straight forward way. I was attempting to use the transcripts as a proxy for this internal construction, yet I knew these texts were produced through discussions that were framed by the interviews and the positioning of the student teachers relative to myself as the researcher, with the Other (represented here by the students' lecturer who has chosen them as good subjects) standing in the shadows.

In a sense I had set myself an impossible task. After producing the tables I could re-tell the stories, the narratives that the student teachers told. I had a good feel for the individual orientations to forms of knowledge and practice projected through the descriptors of 'individual character' I had sifted out as I worked through the transcripts. I could identify many of the discourses circulating in the talk. However, when I attempted to systematically get behind these narratives to mark the links to the places that their arguments for self came from and to link this into the discourses circulating more broadly, things came unstuck. Over many parses through the interview data, a stable set of moves to analytically organise the evidence with the tool were not produced. My insistence on sticking to it in the hope that something useful would be revealed resulted in greater and greater discomfort, particularly as I considered the ethical consequences of reporting the research, that is, my duty to get the description right and make it count (Adler & Lerman, 2003) in the South African context where the two institutions that were my empirical sites represented stark examples of advantage and disadvantage that were part of the legacy of Apartheid.

The easy descriptions of Lacan's Imaginary, Symbolic and Real though the secondary source of Walshaw (2004) was part of my problem. I had instinctively identified with the 'whole' coherent account of the three psychic registers and their data (as related above) and hooked into what can only be described as a naive interpretation that I imagined I could use to render clear relationships between talk and internal *unconscious* processes. The battle I have had in trying to continue with this analysis regardless of the discomfort I felt as the breakdown of my system became more and more obvious to me is an indication of my growing recognition of my own lack – the 'hole' in my understanding – and my resistance to acknowledge this. My desire to produce a competent and coherent account of the student teacher identities through passing *all* their talk through a clean neat tool to produce tables that could be interpreted was pushing me to continue along this path, regardless of my discomfort.

Theoretically I had accepted Lacan's insight that ignorance is not the simple lack/ opposite of knowledge – but rather an active refusal to know. As Felman (1987, p. 78) explains, for Lacan ignorance is a radical condition – an integral part of the very structure of knowledge. From this perspective, ignorance can be thought of as a kind of forgetting – while learning is obviously remembering and memorising, ignorance is linked to what is not remembered – what *will not be memorised*. This is tied to repression, that is, with the imperative to forget, to exclude from consciousness, not to admit to knowledge. From this perspective, ignorance is not a passive state of absence, it is not a simple lack of information rather it is an active refusal of information.

I now had to accept this insight at a deeply practical level in relation to my own research. Having reached the point of recognition that my instrument was producing data that I did not seem to be able to use for insightful interpretation, I was forced to ask why? Despite my attempts to 'stick it through' and produce a story that 'would do', I found myself continually reaching a point of breakdown where the fantasy of a whole coherent account crumbled and the distress at not being able to provide an intelligible explanation/ clear account for what was behind the texts paralysed me. Having come so far in my work on this thesis I was faced with the prospect of simply excluding the student stories and exploration of their identity construction, or with examining this breakdown to find an alternative way through.

Going back to the Lacanian insight, I needed to find ways in which my ignorance could be turned on its head to become self instructive. As Lacan tells us, "It is necessary, says Freud, to interpret the phenomenon of doubt as an integral part of the message" (Lacan S11.155, quoted in Felman, 1987, p. 79).

Now that I was in a position to see that my own lack to grasp, in sufficient depth, the theory that I was trying to 'use' left me two choices. First I could just give up this pursuit and cut this part of the exploration out of the thesis and do the pragmatic thing and complete the study and submit it, focusing only on the institutional practices revealed in the first part of phase three. On the other hand, I could try to understand why I had arrived at this point, what it did show and didn't show me about the pedagogic identities of the good subject of the institution, and through this try to find a way of reporting, in a more limited way some insights this aborted process had revealed. I came to realise that to try and do the 'in depth' *and* comprehensive type of analysis I had set out to do in the beginning – that is, to find sufficiently robust and

reliable ways of analysing the transcripts in a systematic and complete way to reveal the constitution of the teachers as pedagogic subjects and the forms of identification at work in this - would be an impossible task in the context of this thesis. Attempting this would in-itself constitute a PhD study, and yet for me this was only one aspect of the third phase of a study that was already complex and had numerous other parts.

In order to find a way through this impasse, I needed to return to the Lacanian theory to find a way to confirm and discuss the insights into the student teachers identity construction that were emerging from the work I had already done with the transcripts. I needed to go back to the theoretical field in order to (re)consider the theoretical referents of my internal language of description (Bernstein, 1996, p. 136) and from there to (re)produce the external language of description²⁰⁶, to enable me to more modestly recognise “what is to count as empirical relations and to translate those relations into conceptual relations”. That is to reconsider the model for producing and interpreting the data.

5.1 A return to the theoretical referents: reconsidering aspects of the internal language of description

In the earlier discussion of theoretical referents I use in this part of the study, I considered the notion that an identity is an argument produced by an individual subject to justify who they are or want to be. I wanted to try and link the argument for a specialised self (in terms of M, ME and MT) to the place from which arguments for a pedagogic self are justified, and hoped that this would enable me to see something of the constituted specialised identity. However I found that I was unable to unambiguously recognise the empirical evidence to produce the required data, that is, to link the content of utterances to the idea of psychic registers and their data. I now return to discuss Lacanian theoretical referents in more detail so as to theorise the problem of describing the internal pedagogic specialisation at the level of the subject (acquirer).

Firstly it is clear that basic information available from the empirical field, from which I hope to produce data to describe these subjects’ specialisation as ‘mathematics teacher’, is supplied by the subjects themselves. Therefore, what it has the potential to reveal is what they say about what they believe, think, feel, etc., in relation to the various forms of specialisation under consideration in the interviews. In the language I have been using previously, it is expected

²⁰⁶ The issue of internal and external languages of description were discussed in Chapter 6.

that they will *project* identities, fabricate images of their ideal self. There are two things to recognise: firstly, the subjects will construct arguments for how they *want to be seen* as persons who are about to become fully qualified mathematics teachers, rather than for how they actually are; and secondly, these arguments will be *justified* by drawing on various (probably complete) images of what is right/wrong, good/bad, appropriate/inappropriate, etc., produced in terms of aspects of their past/ present careers as novice mathematics teachers, or on discursive resources they have accessed in their studies. With respect to the latter comment, there may also be times when they are unable to articulate an image, that is, they will be unable to call up a specific discursive/ symbolic resource in order to justify their position. It is most likely that these points would be places where they are being forced to talk about something that they have no knowledge of at all and where there is no everyday language hook that they can use to produce an image²⁰⁷, or where they are forced to come face to face with an aspect that they thought they could explain but when pushed to examine their justification are confronted with a problem that reveals their lack of knowledge/ignorance.

Lacanian theoretical referents may help to conceptualise a different way of looking at what these individual pedagogic subjects say they want (desire) and through considering their arguments for justifying what they want, get some fix on the gaze that explains why they say they want this. If this can be done, then the ideological field in which the individual good subjects construct their arguments for identity may be illuminated, which may in turn reveal something of the ideological veil²⁰⁸ through which pedagogic discourses work, at the level of the teacher education classroom, to specialise their consciousness and conscience.

One key conceptual element that can assist us with this is the notion of Lacan's 'big Other', which is often presented as "the inexorable logic of an automatism that runs the show, so that when the subject speaks, he is, unbeknownst to himself, merely 'spoken', not master in his own house" (Žižek, 2006, p. 41), that is the anonymous mechanism of the symbolic order, which is related to the idea of interpellation²⁰⁹ mentioned by Brown et al. (2004) previously in

²⁰⁷ For example, if asked to explain what it means to do a mathematical *investigation* (as the NSCM requires on a number of occasions), the word investigation may conjure up images of detectives investigating, or researchers exploring a question, that can be used to fabricate an explanation of what it is. On the other hand, if one is asked to explain what an indefinite integral in Calculus signifies, there is very little in the everyday that could be used to produce what may seem to be a sensible explanation to the subject.

²⁰⁸ This was discussed in Chapter 3 in the discussion on pedagogic discourse and teacher education.

²⁰⁹ Althusser (1971) is usually associated with the notion of interpellation. For him it refers to the creation and shaping of the subject through ideology (not a distortion of a preexisting subject). For Lacan, while the subject is also constituted as an effect of the discourses in which she/he participates, that is through interpellation, interpellation always fails, since there is always a lack in the symbolic, that which the symbolic cannot symbolise.

this chapter. However as Žižek shows, Lacan also presents the big Other as another subject “in his or her radical alterity, a subject from whom I am forever separated by the ‘wall of language’ ” (Ibid.). Examples which illustrate this subjectification (or personification) of the symbolic include the case of “ ‘God’ addressing us as a person larger than life, a subject beyond subjects”, or “History asking something of us” or being called to make a necessary sacrifice for the “Cause” (Ibid.). Žižek explains that what we see here is not simply an ‘other’ (human being) that we interact with, but rather the subject that stands above our human interactions (the big Other) and *wants* something of us. The question is, ‘what is it that is wanted?’ Whatever that is, it is what we desire.

Lacan says “man’s desire is the Other’s desire” (quoted in Žižek, 2006, p. 41). There are two meanings in this, first, that what a person desires (wants) is structured by the symbolic space in which they live through identification (positive identification leading to commitment, or negative identification leading to rejection and transgression). The laws/ rules/ social norms that might structure what is recognised as ‘good behaviour’ within a context, also structure what would be considered ‘bad behaviour’. The law can just as easily give rise to passionate attachment to its letter as give rise to the desire to violate it. The second, meaning is that the subject (person) desires only in so far as he/she experiences the Other itself as desiring. What I as a subject want is what the Other desires. But this is unknowable and mysterious. Thus what it is that I want is unfathomable, I do not know what it really is, but whatever it is, it is something beyond my control.

How do we understand the idea of the pedagogic subject projecting an image of how he/she *wants* to be seen in these terms? Where does this desire originate? The Lacanian answer would be: from the place where, when we look at ourselves through the gaze of the Other, we appear likable to ourselves (symbolic identification), or, in an *image* through which the subject recognises him or herself as a unitary being and likes what they see (imaginary identification). To get to grips with this in a way that will enable progress, we now need to consider what is meant by identification.

For Lacan the first form of identification is with an *image* of the self: *imaginary identification*. It refers to self-recognition of the subject in an image (visual or metaphorical), and the imaginary relations set up between subjects acting as individual egos – the image of one in relation to the other (Davis et al., 2005). Lacan (2002) theorises this identification through the example of the formation of the “I” function in the “mirror stage”. When the infant sees

her/himself in a mirror, s/he sees an image reflected, a virtual complex (a specular image), a whole self, an image of completeness. The infant engaging in gestures watches the reflection move in jubilation as s/he gains a sense of mastery over the image. An identification or transformation takes place *in* the subject as s/he assumes the image. For Lacan, this

seems to manifest in an exemplary situation the symbolic matrix in which the *I* is precipitated in a primordial form, prior to being objectified in the dialectic of identification with the other, and before language restores to it, in the universal, its function as subject. (Lacan, 2002, p. 4)

This form of identification produces an image of a *unitary self*, what Lacan refers to as the “ideal-I” (or the ideal - ego), which

situates the agency known as the ego, prior to its social determination, in a fictional direction that will forever remain irreducible for any single individual or, rather, that will only asymptotically approach the subject’s becoming, no matter how successful the dialectical synthesis by which he must resolve, as *I*, his discordance with his own reality. (Ibid, p. 4)

The image of the total self produced is given as a gestalt, that is more constitutive than constituted, it “symbolizes the *I*’s mental permanence, at the same time as it prefigures its alienating destination” (Ibid, p.5). The identification is with an image outside itself which establishes the beginning of a relationship between the subject and its reality. As Žižek (1989, p. 104) puts it, “to achieve self-identity the subject must identify himself with the imaginary other, he must alienate himself – put his identity outside himself, so to speak, into the image of his double”.

From this perspective the *illusion* of the self as an autonomous agent is present from the very beginning in the mirror stage - located in the illusion of control over the self (established at first through the apparent *control* of the movements in the mirror). It presents the beginning of the subject’s misrecognition of the self, that is, it enables the subject with a way to misrecognise his/her radical dependence on the big Other, that is, on the symbolic order.

In Lacan’s account, when the mirror stage comes to an end, dialectic that will thereafter “link the *I* to socially elaborated situations” (Lacan, 2002, p. 7) is inaugurated. The specular *I* turns into the social *I*, and it is at this point that the ego-ideal is constituted. It is at this moment when the mirror stage ends that human knowledge is tipped into being “mediated through the other’s desire” (Ibid) and human knowledge objects are thus constituted

... in an abstract equivalence due to competition from other people, and turns the *I* into an apparatus to which every instinctual pressure constitutes a danger, even if it corresponds to natural maturation processes. The very normalization of this maturation is henceforth dependent in man on cultural intervention ... (Ibid)

The ideal-ego established through imaginary identification is transformed through cultural intervention and processes of symbolic identification into the ego-ideal. Language is the medium through which symbolic identification is possible and in which the subject becomes constituted.

Žižek (1989, p. 105) suggests that the difference between imaginary and symbolic identification is best explained by considering the relations between the two forms. His explanation of these relations is to be described as a difference between *image* and *gaze*:

imaginary identification is identification with the image in which we appear likable to ourselves, with the image representing ‘what we would like to be’, and symbolic identification, identification with the very place *from where* we are being observed, *from where* we look at ourselves so that we appear to ourselves likeable, worthy of love. (Italics in original)

For Žižek a dangerous but predominant and spontaneous idea of identification is that of imitating models, ideals, image makers (that is, seeing oneself in an image of an ‘other’). The danger is twofold. First, the basis of the identification (that is, the trait, characteristic, or essential feature) is usually hidden - and this hidden trait is not necessarily attractive. Žižek gives the example of Hitler, where in his public appearances people spontaneously and specifically identified themselves with “what were hysterical outbursts of impotent rage” (Ibid., p. 106). They recognised themselves in his hysterical *acting out* and spontaneously identified with him. The second danger, is that imaginary identification is “always identification *on behalf of a certain gaze in the Other*” (Ibid., emphasis in original). So Žižek emphasises that the questions to ask of every imitation (model image, role play) evoked, are: When the subject identifies with this image which *gaze* is considered? *For whom* is the role being enacted? The gap between the image (the way I see myself) and the gaze (the point from which I am observed) is, for Žižek central for understanding the difference between imaginary and symbolic identification.

Žižek uses examples to illuminate this difference between imaginary and symbolic identification. In his first example he shows how in Chaplin’s films children are teased, mocked, generally humiliated in failure and fed with scattered scraps as if they were chickens; they are not treated as vulnerable and in need of protection. This image of children, while appearing abhorrent (or hysterically aberrant) from an educated adults gaze, can only be produced if we ask the question, from which point must we look at children so that they appear as objects to be mocked and humiliated? The answer is from *the gaze of children themselves*. It is only children who treat their fellows in this way, thus, sadistic distance towards children implies the symbolic identification with the gaze of children themselves. In

his second example he uses the image produced in Dickens' novels of the 'good common people' – "the imaginary identification with their poor but happy, close, unspoilt world, free of the cruel struggle for power and money". Again the only way to grasp this image (and to recognise its falsity) is to ask: from where is this Dickensian gaze peering? The answer must be from the corrupted world of power and money. Through further examples the distinction is made: the ideal-ego, the point of imaginary identification, is always already under the aspect of symbolic identification, that is subordinated to the ego-ideal. It is the symbolic identification (the point from which we are observed) which determines the image, the imaginary form in which we appear likable to ourselves. However, when the identification is imaginary, the subject is simply reacting to the whole image, rather than having access to the discursive order that structures the image.

In Davis' (2005) terms, this is explained by recognising that imaginary identification is always-already structured by symbolic identification and is the image subjects forms of *themselves* as unitary beings. Thus a particular form of the symbolic is always at work in imaginary identification. Symbolic identification is produced through symbolic relations entailing a subjection to social "institutions", which include discursive fields. With symbolic identification a distinction between individual subjects and the symbolic mandates that they assume is asserted and maintained. So for example, when we are confronted by a policeman stopping us we have to put aside particular characteristics of the person who confronts us – the personal relation – and ask what the law is asking – the symbolic relation. Here the policeman identified by his uniform (a symbolic mandate) represents the law (social institution) rather than himself. The symbolic title (in this case policeman) and the mandate that is attached to the title (in this case, to enforce the law) is granted through a process of symbolic investiture in which a particular authorising function is transferred to individual subjects so that social institutions might act, through them, on social relations and individual subjects. In other words, symbolic relations and symbolic identification are predicated on the social existence of a legitimating field external to the individual subject, including s/he who holds any particular mandate.

When someone is named a 'mathematician' a symbolic title is conferred on the person that carries with it symbolic relations and symbolic identification that make him/her what they are proclaimed to be and constitute his/her symbolic identity. Whether or not they *are* what they are proclaimed to be is tied up with the relations between symbolic and imaginary identification at the level of the subject. (They may fraudulently take on the mandate – like the

subject who is not a policeman donning the uniform and pretending to be a policeman – acting as policeman without being a policeman. In the present context in SA we become aware of the danger of this form of imitation – when the criminal ‘looks like’ the policeman and instead of holding up the symbolic mandate invested in the position high-jacks us.) This can be related back to Bernstein’s notion of pedagogic identity – is the pedagogic subject’s consciousness specialised so that he/she becomes what the symbolic title proclaims? *How* this specialisation takes place is crucial in determining the nature of the identification – whether or not the subject *is* what they are proclaimed to be.

Furthermore the existence of a mathematician (someone who practices mathematics) or a mathematics teacher (someone who practices mathematics teaching) of necessity proclaims the existence of mathematics (knowledge), and, as Davis (2004, p. 49) so clearly explains,

the supposition of the existence of knowledge is necessary in the constitution of any discursive field: we cannot speak of mathematics, for example, without the supposition that the discursive field we refer to as mathematics, even though it is produced through the activity of individuals, follows any elaboration which is independent of any given individual. When we speak of the ‘nature’ of mathematics we appear to be referring to the peculiarities and specificities of its internal logic rather than to the individuals implicated in its production.

The pedagogic subject’s specialisation into becoming a ‘mathematician’ of necessity requires his/her consciously internalising a mathematical gaze, working within the internal logic of mathematics itself. If this symbolic identification is not established with the external discursive field, then the title mathematician would be fraudulent. This does not mean that what counts as mathematical knowledge is ever exhausted or complete. In a sense, one of the issues this thesis has been attempting to grapple with is to what extent a specialisation into ‘mathematics teacher’ also requires a specialisation into ‘mathematician’, and how to recognise the legitimating field (fields) – theorised as M, ME and MT - for the symbolic mandate of mathematics teacher is (are) constituted within the pedagogic context of teacher education, within specific institutions and across the field.

Let us now return to the issue of the identities of the student teachers within the mathematics teacher education contexts in focus here. These pedagogic subjects are about to be conferred with the title ‘mathematics teacher’ – presumably since they have been inducted into the legitimating fields as constituted within their individual contexts. The extent to which their identification with these field(s) is constitutive (i.e. through ‘whole’ images/ models/ metaphors) or constituted (through a symbolic gaze), that is, imaginary or symbolic, is of

significance to the quality of teacher produced. If the imaginary identification is the dominant form, then the implication is that the teacher will be in the dangerous position of attempting to imitate a practice for which they do not have access to the Symbolic or discursive field through which it is legitimated. This fits with the descriptions of “strategic mimicry” (Mattson & Harley, 2003) and “facile ventriloquism” (Shalem & Slonimsky, 1999) discussed in Chapter 3 in relation to the practices of teachers attempting to implement policy images for which they do not possess recognition and realisation rules.

We can now relate forms of identification with our earlier discussion about the psychic registers, the Imaginary, the Symbolic and the Real. The Imaginary register emerges from the relations (imaginary identification) that produce a subjects’ identity as an individual (one), a unitary being as an individual ego. The term imaginary here is concerned with the role of images in constituting the ego – these images are not hallucinations, they are the “sedimentation of ideal images” (Davis, 2004, p. 76) produced through social relations. As Davis explains, the Imaginary register is the order in which social relations are personal, focused on relations between individual egos, where the subject is self absorbed and narcissistically relates to the other as an individual ego. On the other hand the Symbolic register is constituted by symbolic relations, relations in which the subject relates to the Symbolic order of social institutions, and so here the relation is between the subject and the Other as of the Symbolic order, that is, the subject relates to the other as the law, as knowledge, as morality and so on. Both the Imaginary and the Symbolic registers work together in all human interactions, including pedagogic relations. However, human existence is such that while images provide a focus for identification of the self, and the field of language and symbolisation produce knowledge of reality, there is always a hard impenetrable kernel of reality that resists symbolisation. This is the Real register constituted by that which exists outside the order of symbolic relations. In a sense the Real exists at the limits of knowledge, it announces itself as the *lack* in the Other, without which the Other would be a closed system, that is, we could have complete knowledge, bring everything in the world under the control of the symbolic. The existence of the Real is why interpellation fails – as (Žižek, 1989, p. 122) puts it where the subject recognises (consciously) that

the Other itself ‘hasn’t got it’, hasn’t got the final answer, is in itself blocked (...) This lack in the Other gives the subject – so to speak – a breathing space, it enables him to avoid the total alienation in the signifier not by filling out his lack but by allowing him to identify himself, his own lack, with the lack in the Other.

In Davis’ (2005) reading of Lacan, one way we can get a glimpse of the Real, from within the Symbolic, is when there is some or other disturbance, or breakdown. Thus any attempt to

overcome unsettling disturbances in the Symbolic, drives the desire to further symbolise the Real. He suggests that Bernstein's description of the discursive gap, the space of the yet-to-be-thought, is where the Real is to be found, and thus knowledge production can be seen as "a continuous attempt to symbolise the Real as it incessantly reappears as the limit of knowledge" (Ibid., p. 75). Within the pedagogic context the Real is potentially encountered at the limits of knowledge selected for reproduction, and at the points of failure in the pedagogic subject. I will not attempt to produce a discussion of the interaction of the Imaginary, the Symbolic and the Real in pedagogic discourse²¹⁰ here, the point that is of importance to my project for now, is that it is at times of breakdown, where the lack in the Symbolic can be glimpsed. That is it is in times of breakdown that the limits of a pedagogised subjects' access to a field of knowledge and its legitimate practices may be glimpsed.

Looking back to the discussion related to the information provided by the good subjects of the institutions in this study at the beginning of this section, we can consider the utterances of the student teachers who are about to be conferred with the symbolic mandate of mathematics teacher, as having the potential to provide data relating to relations in the Imaginary (through unitary images of who they want to be), Symbolic (discursive use of knowledge to explain a position or action), and the Real (where they are unable to use the Symbolic to articulate themselves). How this data can be read, how we can use it to get a glimpse on the discourses that structure pedagogic identity within the empirical sites, is our next focus.

Žižek's (1989) reading of Lacan is helpful here. He asks the central question that can help, and then answers it for us:

What creates and sustains the *identity* of a given ideological field beyond all possible variations of its positive content? *Hegemony and Socialist Strategy* delineates what is probably the definitive answer to this crucial question of the theory of ideology: the multitude of 'floating signifiers' of proto-ideological elements, is structured into a unified field through the intervention of a certain 'nodal point' (the Lacanian *point de capiton*) which 'quilts' them, stops their sliding and fixes their meaning. (Ibid. p. 87)

If we recognise that at the institutional level, the pedagogic context represents an ideological field in which the subjects' identities as mathematics teachers become specialised, then it is possible to consider their projected images and their justification as expressions of imaginary/symbolic identification which form part of the ideological field itself. Within these expressions of how the pedagogic wants to be seen, will be traces of the gaze in the Other, or the Symbolic order, that structures the field. Within the talk we can expect to find a proliferation of floating signifiers.

²¹⁰ For such a discussion see Davis (2005, pp. 73 - 80).

So for example the floating signifier or descriptor, *mathematical problem-solving*, might be used frequently in different narrative accounts to describe *what* is of most importance to the pedagogic subject in their mathematics learning. The use of this descriptor may be an attempt by the subject to communicate the recognition rule for the legitimate text of what constitutes mathematics within this context. However, the “very identity” of these signifiers is “‘open’ - over determined by their articulation in a chain with other elements – that is, their literal signification depends on their metaphorical surplus-signification” (Žižek, 1989, p. 87). What does *problem solving* signify within this particular ideological context? There are numerous possible meanings, and the use of the words (the signifier) in the utterances does not give a fix on the content of their meaning (signified). For example, does mathematical problem solving mean, finding solutions for predetermined ‘problems’ using reasonably well established ‘methods’ or ‘problem solving skills’ in order to acquire hierarchic structured mathematical texts through practice? Or perhaps, it means, develop strategies for using a variety of mathematical tools to solve ‘real life’ problem’s in order to make sense of the world? Or, even, solve various types of ‘problems’ using mathematical reasoning processes in order to construct personal understanding of mathematical concepts? These are all very different interpretations of ‘mathematical problem solving’ and the mere presence of the signifier does not necessarily give a purchase on the structured meaning of the identity that underlies its use. The answer is it depends. It depends on the Other through which the ideological field is quilted. For example, if we quilt the field through performance-based pedagogy, the meaning associated with the first description would fit.

Now if we consider, at each institution, the student utterances as narrative arguments for a self as they *want* to be seen, we should be able to analyse their talk to illuminate convergences and divergences in their use of floating signifiers across the different narratives to describe their specialisation as mathematics teacher. It will be through considering the relations between these in their explanations of self with respect to M, ME and MT that we will be able to get a glimpse of the gaze (Symbolic order) that structures the pedagogic context in which their identities as mathematics teachers are specialised; the gaze that must be applied in order for these subjects to appear likable to themselves – whether they are consciously aware (i.e. identify with this symbolically) or not. This gaze if we can name it, will give us a purchase on the ideological veils through which pedagogic discourse at the institutional level is filtered. It may only be at points of breakdown in the narratives that we will be able to glimpse the limits of the subject’s symbolic identification.

In this section I have provided an account of Lacanian theoretical referents that I will use in addition to the original Bernsteinian referents, as a basis for producing the external language of description, or model, through which the data for this part of the thesis will be produced and interpreted. In the next section I will describe the way in which this will be done.

5.2 The way forward: restructuring the external language of description

Working through the evidence in my attempts to produce data using the framework, described in Section 4, of this chapter enabled me to recognise that a more modest approach was necessary. I was not, in the space available in this thesis, going to be able to produce an in depth comprehensive analysis of the construction of pedagogic identities of each subject in my study as I had originally envisioned. This task was too big for my current project. I needed to adjust my focus off the individual students in the sample to the group of students at each institution. To recognise that the identity relationships I hoped to reveal were those that were connected into the ideological field constituting and constituted in the empirical site of teacher education practice.

Having parsed through the transcripts a number of times in my attempts to work with the original framework I was able to identify a number of relationships within the student stories that sparked my interests and curiosity and I felt provided insights into the way in which identification was working within the institutional context. I needed to take seriously the principle that learning does not proceed “through linear progression but through breakthroughs, leaps, discontinuities, regression and deferred action” (Felman, 1987, p. 76) and work with these stories and relationships in less rigid ways. I decided to take a leap and *select* elements from the cross section of pre-interpreted narratives produced by the student teachers at each institution, selections that could help me illuminate aspects of pedagogic identity formation within the institutional contexts of the case studies. In other words “... not to seek truth or to find a final resolution in line with some supposed ideal, but rather to ask how the discursive formulations have taken the shape that they have” (Brown et al., 2006, p. 35).

In the following two chapters I will begin by presenting the first layer of interpretation as described in Section 4.1, that is, a biographical description of each of the institution’s good subject’s career. These narratives will be reconstructions from selected aspects of the

biographical accounts, i.e., from the arguments the good subjects construct to justify their projected pedagogic identities. The selections on which the reconstructed narratives will be based will be taken from various aspects of their written biographical histories and supplemented with talk (transcripts) from the interviews. The rule for selecting the limited stories that will be used is based on the images that I found to be illuminating as I parsed through the transcripts in my previous attempts to produce a comprehensive data set for interpretation. These reconstructed accounts will form the basic data for a more in depth discursive analysis that follows. This analysis will not include a systematic and full analytic coding and sifting of the data through a particular instrument (for example, as originally suggested in Figure 42). Instead I will take a Lacanian ‘look’ across the narratives. The purpose will be to identify patterns in the reconstructed narratives so as to illuminate discourses circulating in the ideological field generated at the site of pedagogic practice, within which the institutions’ good subjects’ pedagogic identities are negotiated. This will be done in three stages.

Firstly the narratives will be examined for convergences and divergences in the arguments for pedagogic identity produced by the good subjects. This examination will be used to identify common threads in discourses used to justify these accounts (of what the subject *wants* to be and does *not want* to be) that snake their way through the ideological field. The next step is to examine these threads in order to illuminate the ‘nodal point’ (c.f. Laclau & Mouffe, 1985) - the Lacanian *pointe de caption* - that sustains identity in the field, that fixes or quilts the numerous and contingent ‘floating signifiers’ in the subjects’ writing and talk. The purpose of this step in the process is to consider the various common floating signifiers or descriptors of pedagogic identity recognised in the threads, in relation to one another (whether they are used positively or negatively by the subject to argue their identity), in order to identify (if possible) an overarching narrative/discourse (the Lacanian One) that quilts and unifies meaning within the specific context. This process may illuminate the place from which *all* the institution’s good pedagogic subjects construct arguments for images of themselves as mathematics learners and mathematics teachers (i.e., the place from which subjects sees themselves in the *gaze* of the Lacanian Other, or the images they produce of themselves in relation to others) and hence elements of the content of the distributive rule operating at the institutional level. In some sense this will illuminate aspects of the specialisation of consciousness acquired within the pedagogic context at the level of the individual subject, at least the discursive fields (Symbolic) that structure the images of what they want to be.

Secondly, points of breakdown in the narratives will be identified. These are points in the interview process at which the pedagogic subjects were unable to articulate an argument for their position and at which they became agitated/ emotional/ frustrated as they realised they lacked resources to enable them to engage, whether sensibly through the production of images and metaphors, or intelligibly through calling up symbolic resources from a particular discursive field. At both institutions, these points of breakdown were mostly related to points in the interviews where the subjects were pushed to discuss/ explain mathematical concepts underpinning specific assessment standards in the NCSM. On the brink of becoming fully qualified teachers these good subjects were confronted with the possibility that they were ignorant of important aspects of school mathematics. While this analysis *cannot* be use to produce a reliable interpretation of the acquisition of mathematics/ mathematics education/ mathematics teaching knowledge, that is, the content of the recognition and realisation rules acquired by the subjects within the pedagogic context, it can be used to illuminate aspects of the pedagogic conscience, self regulatory aspects of the identities. How the pedagogised subjects reacted at these points of breakdown and issues that these reactions raise in relation to the specialisation of consciousness and conscience will considered and illuminated.

Thirdly, the focus moves to identification with official discourses (or images from official discourses) circulating within the ORF represented within the narratives. These official discourses, for example, discourses connected to the various ‘roles’ of a teacher within the NSE, to the orientations to mathematics as identified in the NCSM, and to some of the general features underpinning post-apartheid curriculum reform, were discussed in some detail in Chapter 4.

Fourthly, the discourses illuminated in the previous steps will be considered in the light of some general features of the contemporary content of the distributive rule of the pedagogic device operating at a wider social level, as identified by Davis (2005). In particular the following features are considered: the negation of boundaries (in social relations and in knowledge relations), the consequent degradation of traditional authority relations, the rise of contemporary utilitarianism and the dominance of competence pedagogies. In addition, the institution’s pedagogic subjects will be considered in the light of Davis’ discussion of the effects of the contemporary demands of global capital: the production of a narcissistic subject and the consequent development of competence curricula and pedagogic modalities that arise in order to pedagogize this subject.

6 Concluding remarks

The process described will produce an account of the pedagogic identities projected by each case study institutions' good subjects, and illuminate discourses that quilt the local ideological field (within the PRF) in which these subjects have become specialised as novice mathematics teachers. Furthermore it will have rubbed this account up against official discourses and pedagogic identities projected from the ORF, and reflected on them through an account of the content of the distributive rule in contemporary society under the effects of global capital. The final step will be to synthesise these accounts, reflecting back on the analysis of the three message systems of the pedagogic device (curriculum, pedagogy and assessment) operating at the institutional level, produced in Chapters 7 and 8. The accounts so produced, will form the focus of the next two chapters in this thesis, the first focusing on the 'good' subjects of CU and the second of RU. This will be followed by the penultimate chapter of this thesis in which a cross-case analysis will be undertaken in order to highlight findings that raise important issues for the field of mathematics teacher education in South Africa.

Chapter 10

The ‘Good’ Subjects of City University

Mr/s X had a totally different teaching style to what I had previously experienced. The processes she took us through seemed to register with me at a very base level, and my creative side came to life. I began to see that my creativity and my maths learning and experience were not such polar opposite entities. When I stopped being so afraid of being “successful”, I let go a bit and stretch my mind and my thought processes as far as possible. When brainstorming before starting a painting/ sculpture, I always tried to flip my thinking upside-down and try and express ideas in many different but meaningful ways. I started to learn how to apply this to problem solving in maths. (Karyn Biographical Questionnaire)

The first day of mathematics at university was scary! We were given a task to do in any way that we found possible and to write up a report. For the first time in my life I actually had to think about mathematics. This was really difficult for me because it was not in my comfort zone. However as I started to work, I really enjoyed what I was doing, and mathematics became my favourite subject at varsity. [...] we all started to fully understand mathematics. We were exposed to a variety of teaching methods and ways of learning mathematics and all benefited from it. Mr/s X proved that anybody could do mathematics! (Nicole Biographical Questionnaire)

1 Introduction

In Chapter 9 I described the difficulties I encountered in my attempts to produce an analysis of the identities of the ‘good’ subjects who are in focus in this part of the study. I related the theoretical journey that I took to get to the point where I am now, able to produce an account of these student identities. I produced a detailed description of the processes and languages of description that would be used to produce the data to analyse the novice teacher identities. In this chapter and the next I use the methodological approach described in the previous chapter to produce accounts of the identities the ‘good’ subjects of each institution²¹¹ project through writing and speaking themselves. The focus in the current chapter is on the ‘good’ subjects of CU. The following chapter deals with RU’s ‘good’ subjects.

In line with the methodology outlined, CU’s ‘good’ subjects are introduced using reconstructed narratives based on biographical information supplied through their written responses to the biographical questionnaires and supplemented by interview material. Their stories are structured through a lens which highlights their locational, knowledge and moral careers. In each case the narratives are structured in order to highlight the student teacher’s orientation to knowledge (consciousness) and being (conscience) in relation to the specialised discourses of mathematics, mathematics education and mathematics teaching theorised earlier

²¹¹ Recall that these ‘good’ pedagogic subjects were recognised and selected by their lecturers to take part in the study.

in this thesis. These are by no means complete stories and while social-historical aspects of their stories are presented they remain mostly at ‘thick’ first level interpretations (i.e. doxa). However, this provides a base on which a deeper level of analysis and interpretation is presented.

Patterns across the narratives are then examined and points of convergence in discourses circulating within the institutional context, with which the teachers seem to identify, are highlighted. In addition points of divergence and breakdown within the narratives are revealed. The narratives are then considered in terms of identification with official images/discourses circulating in SA more widely. Finally the convergences and divergences recognised within the CU identity field described are reflected against the general content of the distributive rule in contemporary society.

2 The ‘good’ subjects of CU

Four students, two female and two male, were identified by the head of mathematics, Mr/s X, as exhibiting characteristics of ‘successful student teacher’ at CU. As explained in the discussion of the institutional context, CU had introduced its B.Ed at the latest possible time in terms of the policy and in 2004 the first cohort of students was only in their 2nd year of study, while the 4th years were still registered for the HDE. However, the HDE group was being used as a vehicle for developing and trying out the new B.Ed curriculum. For this reason in the CU case two students from the 4th year and two from the 2nd year were selected to be part of the study. It is expected that the second year students would not be as mature in their outlook and may not have the same level of socialisation into the CU context, although they would have experienced the change from the HDE to the B.Ed in a way that no other group would. On the other hand the fourth years would have been socialised into the CU culture more deeply, but would only have begun to experience elements of the new curriculum after their first year of study and would not have fully experienced new directions being taken within the institution. The selection of students from the two groups recognises that at CU there was an institutional history of initial MTE and that the new B.Ed curriculum was in a sense a refiguring of what had gone before.

Each student was asked to provide a pseudonym that would be used in this research. The CU students choose to be referred to by their given names, Karyn, Sonny, Nicole and Emmanuel. Sonny and Karyn were in their fourth and final year of study and were expected to complete their HDE at the end of 2004 with good results across their various mathematics modules.

Nicole and Emmanuel were in their second year of study, but had been identified as students who were committed to mathematics and were exhibiting the qualities that Mr/s X believed would only be strengthened and that would make them good products of the institution in the long term²¹².

2.1 Karyn's story: breaking boundaries, being creative and uncovering the mathematics

Karyn was in her 4th year HDE in 2004 when the data was collected. She is a 24 year old white female. She has lived in the City all her life. Her mother is a teacher and her father a bank manager. She matriculated at an Art School in the city. In the context of South Africa her background is advantaged; economically and educationally.

Karyn's discussion of her locational career spans a number of institutions: the School of the Arts; the general campus of CU where she began her studies in Architecture; the education campus of CU where she has studied to be a teacher and the schools in which she has practiced teaching during this time. In addition to this, a fourth institutional space is figured into her development: while studying at CU, she concurrently completed a Bachelor of Arts through a distance university. She began the BA because she was not sure that teaching would turn out to be right for her, she wanted to extend herself, and, she did not expect the HDE to be very academically challenging. Other locations that figured in the development of her mathematics career include her home environment and primary school. All these locations were institutions that were advantaged in terms of resources (material/physical and epistemic/knowledge).

While at school her interest was in art and mathematics was simply one of the subjects she took. She had no specific interest in becoming a teacher, in fact she recalls that "my mom was a teacher and the idea of teaching had never been appealing to me" (KBQ1). After school she enrolled at the CU and began a degree in Architecture. She explains that she did not complete her first year due to a personal family crisis, and after dropping out was forced to make changes in her life. She had no particular plans but heard that she could get a bursary to become a teacher and this offered her a way out. She recalls that "it was not a very bold decision" and that "deciding to become a maths teacher was [...] something I just allowed myself to become part of, without initially reflecting in any depth" (KBQ1).

²¹² In early 2007 Mr/s X confirmed to me in conversation that all four students had met his expectations. All four students had flourished and become committed mathematics teachers. In addition Emmanuel had since enrolled to study an honours degree in mathematics education.

In her account of her mathematics knowledge career across the various locations Karyn reveals positive early experiences with mathematics, recollecting that “since I was very young, my dad did a lot of maths with me, all the time. I loved playing number games with him” and “primary school maths was very rewarding for me” (KBQ1). However in high school she lost interest in maths, and

most of my time and energy went into doing art. At the art school, there also wasn't a focus on maths, so no one minded that I was getting 50's. Matric was difficult for me, and half way through I dropped to standard grade. This meant that I could spend even less time on maths and still pass. (KBQ1)

During these years she did not see mathematics as important and was not encouraged to work at it, nevertheless in her account of herself she describes a mathematical gaze that assisted her in art:

What I did find useful is that I was able to solve problems that came up in sculpture class, using maths as a tool, whereas most of the other people in my class didn't take maths and at times could not find solutions to problems. (KBQ1)

In her recounting of her school experiences Karyn describes her teachers as “extremely traditional in their approach to teaching” and expresses sympathy for them, saying, “(t)hey must also have found my class very frustrating because it was clear that we weren't that interested in uncovering the maths” (KBO). This retelling of her past from her present vantage point reveals what she now believes: what is important in school mathematics is that learners are interested in “uncovering the maths”, that is in *understanding* it. This is confirmed when she recalls

I do remember sitting in the maths class in matric for days at a time where I couldn't understand any of the concepts that the teacher was dealing with. I didn't really understand what I was doing. (KBO)

In relating this story Karyn makes a link between teachers being ‘traditional’ in their approach and learners losing interest in uncovering the maths – and she reveals her rejection of a traditional approach which does not focus on understanding the content. This is clearly a retelling of her school mathematics experience from her present vantage point as a new teacher, and reveals something about her current perspective on mathematics teaching.

Karyn's interest in Art and her spatial/ geometric eye lead her into Architecture. However while she “enjoyed the mixture of maths and art”, she didn't see Architecture “as socially relevant, and I knew I wouldn't be happy doing it”. Karyn retells her story constructing a self that is both artistically and mathematically able, but that cannot be happy doing just anything that utilises these talents – she needs to have a *meaningful* career, one that will be *socially relevant*. She tells us that falling into mathematics teaching enabled this. She admits that her

matric mathematics results (SG C) were not that good, but she signed up for maths when she got to the college because she felt she was able, and by the end of her first year,

... I realised that I really enjoyed working with the maths and after the second year, I began to see that I felt strongly about maths teaching and maths education. This is mostly because of the issues that were being raised throughout my course, but also because I was becoming more aware of people around me and especially my classmates, who are mostly from very different cultures to mine. So now I know that I would enjoy working with maths education, as a career. I also feel more positive about becoming a maths teacher because I see that in different contexts, I will be able to remain an active learner forever. Mostly I am glad that I have found something to do that doesn't allow me to get comfortable – I always need to be thinking and creating and I love doing it. (KBQ1)

From this account she argues that she became motivated through working with the mathematics and interacting with other students from diverse cultures that were in her class. She recognised that in a mathematics teaching career she would be challenged to continually learn and be creative. In her account of becoming a teacher at CU she provides details of her knowledge career including the various mathematics specialist courses mathematics (M), mathematics education (ME) and mathematics teaching (MT), and their influence on her.

In her account of her mathematical development she recalls that her first year (2001) was “very difficult ... in terms of doing maths”. She explains that she “had a “block” against learning maths” and lacked self-confidence which meant she did not engage with the maths to any depth. It was in her second year that things started changing and she became committed to becoming a mathematics teacher. The impetus for this change was a new lecturer (Mr/s X) who

had a totally different teaching style to what I had previously experienced. The processes she took us through seemed to register with me at a very base level, and my creative side came to life. I began to see that my creativity and my maths learning and experience were not such polar opposite entities. When I stopped being so afraid of being “successful”, I let go a bit and stretch my mind and my thought processes as far as possible. When brainstorming before starting a painting/ sculpture, I always tried to flip my thinking upside-down and try and express ideas in many different but meaningful ways. I started to learn how to apply this to problem solving in maths. (KBQ1)

A number of things are striking in this account. First was that the lecturer's influence was significant – the way this lecturer taught allowed her to apply her creative side to doing mathematics and this enabled her to become engaged and to flourish. Secondly what grabs her here is not the *content* of the mathematics, but rather the way the lecturer taught and the *processes* this enabled. Thirdly, for the first time she was able to see mathematics as a *meaningful* and *creative* practice. Finally she was able to develop the confidence she needed to be successful – she stopped being *afraid*. The new pedagogic mode instituted by this lecturer developed her confidence and interest in doing mathematics. During the interviews Karyn made numerous references to Mr/s X and the influence she had on changing the way

she thought about mathematics. For her there was a clear change in her consciousness with respect to mathematics and what doing mathematics was about.

The account Karyn gives of her third and fourth years of study in mathematics underscores the importance of this one lecturer's approach to her personal development and identity construction. In her third year she had a different lecturer (Mr/s Z) who had a "more rigid style", and while she was able to cope because her confidence had improved so much during the previous year, "I really hated this year, in terms of the maths we did. Compared to the previous year, I hardly grew at all."

For Karyn the lecturer has a major influence on her level of engagement and enjoyment – the reason for this is not located in the maths content itself but rather in the relay – how it was transmitted. For Karyn what makes something worthwhile is personal growth and understanding which is connected to the pedagogic mode of transmission (how) and how this affects the way she relates to the content (what) being transmitted.

In her description of her final year, she indicates "2004 has been better for me in terms of my personal maths learning". This learning is related to enjoyment and stimulation "I have enjoyed the applied maths and stats course, and the new method programme has been stimulating". Again the influence of the lecturers is important and she perceives that "the maths department seems to be more in touch with itself, and clearly the different lecturers are working hard at planning and course design, which I really appreciate". Here we see a recognition of a change in direction of the whole mathematics department at CU as the new curriculum is instituted. The movement in the maths department appears to include co-teaching (team teaching) which makes "the classroom atmosphere very discussion orientated and the interaction between the two lecturers invites active participation." Karyn explains that

during lectures, we all find ourselves addressing the class and proposing ideas about the maths we are working on. During these times, I find myself talking through the maths and the issues raised by the maths, and the class is always willing to listen to one another's thinking. I have found this very useful as well. (KBQ1)

In Karyn's story we find a focus on how she *relates* to the mathematics rather than on any specific aspect of mathematics itself. This is emphasised in the final interview where she was specifically asked about her mathematics courses and what inspired her:

- Di ...If I were to ask you is there something that you've done that absolutely inspired you that you thought this is incredible, this is ...?
- Karyn: Mmm, I, well perhaps I just become very stimulated from the classes that I've had, enjoyed them all the time, but like a particular section of work?

- Di: Ja, whatever, (...) something that you did and you thought, you know, gosh this is incredible, this is (...) I can really be a mathematician (laughing)?
- Karyn: (Laughing) I remember having those experiences (...) all the time definitely (...) definitely at least once a week (...) but I can't think of anything specific.
- Di: That's nice, that's very nice. Did they make you feel quite excited?
- Karyn: Ja definitely! I feel very excited about it, but sometimes I (also) feel very, despondent and like you don't know anything, like you are not never gonna be able to do this and then other times something clicks in and I'm flying (.....) (laughing). (IAT-K3)

Here Karyn presents an image of herself as being invested in doing the mathematics. She has a desire to succeed, but acknowledges that it takes work and does not always come easily. However during the second interview she had indicated that she felt that she had developed more as a mathematics teacher than as a mathematician. She felt that while she had developed some skills in mathematics and knew what was important in teaching mathematics, she did not have a clear grasp on the discipline itself.

- Di: Why would you say that?
- Karyn: I don't know I just (...) I just feel very unsure. When I was with Mr/s X I was fine but I am not really confident in doing all the maths stuff (...) not to blame anyone, but I had nothing to draw on from there [school], half of it I can't remember and I'm not sure whether the other half was done. So unless I teach myself or deal with it extensively, like the stuff that I've done with Mr/s X, I am at a loss. So its like big chunks are missing in my knowledge. So I suppose like next year its gonna be quite a growing curve because I will have to fill this all the time as I teach (...) I don't see myself as someone who is skilled in the discipline. I'm not skilled in that but I do think I have other skills that can help me get to the place and help me take other people there. I definitely think I'm strong in those skills but not the actual discipline.
- Di: Could you describe those things or do you have any way of.....?
- Karyn: You mean the skills that helped me then?
- Di: Yes
- Karyn: Well I can summarise easily and pick up the main points and kind of make connections. I'm learning more now on how to make connections and for me that's basically what a child needs ...
- (IAT-K2)

The above piece of transcript comes from a section in the interview where we had been discussing specific ideas in the NCSM, and she had been feeling stressed at not always being able to respond intelligibly on aspects of the curriculum, that she clearly thought she should be able to recognise and know well at this stage of her career. Earlier in writing of her past experiences at school she did not voluntarily focus on any aspects that were lacking – her parents, her teachers and the spaces are spoken about without any reference to lack or deficiency. It is only when she is pushed to explain ideas underlying specific assessment standards in the NCSM that she becomes anxious, faced with her realisation that she cannot do this effectively, she attempts to reconcile this apparent lack of disciplinary knowledge by stressing other more important skills. However, these are skills that are directly linked to her orientation to mathematics; her specialisation into the discipline clearly favours processes rather than specific topics. This was also clear in her response in interview # 1 where she

provides a description of the four mathematical ideas/ concepts she thought were most important for a FET school mathematics learner to learn about. She suggested,

... **formulating a problem frame**, like if they are given an everyday problem, setting up a method that is going to be able to solve that problem. So constructing a frame for the problem. **Interpretation**, being able to understand what the maths means. So if they get a result what does it actually mean because if it's meaningless, it's not worth anything. So hopefully that will help them to make the link to the maths that they've doing, and, I said, ja, **concentrating on processes that create links and connections**. Cos if they have all these bits of mathematical knowledge then like big tasks (.....) often they make those links for more integrated understanding and hopefully I said make things more meaningful and reduce the amount of information that has to be stored in their memory. And then, **show them that maths is logical**, it can be worked out in a logical way to increase, the feelings, foster feelings towards maths, positive feelings towards maths. (IAT-K1)

We see here an orientation to mathematics which appears to focus on two of the orientations identified in the NCSM in Chapter 4, that is orientations (2) mathematics as relevant and applicable within different contexts, and (3) mathematics for inducting learners into mathematical practices. This links into her previous conviction that uncovering the mathematics is important. It also speaks to the idea of developing productive disposition²¹³ (Kilpatrick et al., 2001), and provides a platform for leading onto a discussion of her career in terms of her specialisation into mathematics education and mathematics teaching. She reveals that mathematics education was not a substantial focus of course work while at CU. What had been done over the years was through the 'methods' part of the course. It took place one hour per week over the four years of study and in the first few years she "found the method course (one hour, once a week) very frustrating and not that relevant" (KBQ1). It never seemed to have a coherent focus and always felt like a waste of time. It was only in her fourth year of study when the department seemed to begin to work together to develop this as a proper aspect of the course that it started to have some meaning. Her reconstruction of her induction into mathematics education is as something that is superficial and has little depth. She recalls for example that one of the few theories they were introduced to in the methods was the van Hiele²¹⁴ levels. Yet this was done at

... such a surface level that wasn't really meaningful. Like here we got the stages and we got descriptions of what each stage is about and how they transcend in the stages but you know there's only two pages (...) not enough for me to understand what was happening in each level. And we've just done a project on it (...) we had to interview learners (...) write down their responses and then see what level they were operating at (...) with the one descriptive sentence of the level. I could try and relate it but it wasn't really meaningful for me (...) (IAT-K3)

²¹³ Karyn had been introduced to this article by her practice teaching tutor earlier in the year and had found it interesting. However she clearly indicated that this had never been discussed in her courses.

²¹⁴ Earlier in Chapter 7, Mr/s Y had indicated that the van Hiele theory was one of the 'maps' that she used to structure her teaching. The van Hiele 'levels' refers to this theory of the development of geometric thinking – a major work in the field that has been influential in teacher education, and is recognizable as a resource for the structuring of the school geometry curriculum in SA.

For Karyn the short (two page) summary of the theory gave no substance and so for her there was no way for ‘uncovering’ meaning though practical examples, it was more like a comprehension exercise of the two pages of notes. This was unlike in mathematics where uncovering of meaning was the key to their practice and so she could really get her teeth into it. She appears to be describing her desire for symbolic identification with respect to discursive resources –a two page summary that provides an image of the theory but does not allow for deep understanding and is therefore meaningless for her. In her account mathematics education is not a field that she has become invested in, for her it is mathematics itself that is meaningful, even though when confronted earlier with her realisation that she did not have an extensive conceptual knowledge of all the mathematics underpinning all the outcomes/ assessment criteria of the NCSM, she denied this.

Karyn indicates the van Hiele levels as the only theoretical perspective they were explicitly introduced to in mathematics methods. However she recognises that Mr/s X and Mr/s Y (but not Mr/s Z) work within a theoretical perspective themselves, and she has picked up a lot from them in relation to mathematics education. She sees this as the source of her inspiration for mathematics teaching.

I don’t know about Mr/s Z, but I know Mr/s X and Mr/s Y are very constructivist based. Like you know, construct your own knowledge, you know like build up the, fill in the gaps, and Mr/s Y is particularly interested in cognitive, the cognitive behind what’s happening. You know the actual physical things that happen in your brain, and she talked to us about, how the networks are strengthened when you practice things and how they expand when you explore things. (...) I think Mr/s Z is very traditional in a sense, like is very one sided in a lecture and (...) there’s not much of a (...) construction happening in that classroom. (IAT-K3)

Karyn says she recognises what has been happening in her maths classroom as ‘constructivist’ from work she has done in her Education courses rather than in mathematics methods. She describes her orientation to this as

each individual constructs their own knowledge differently to the next and in a classroom situation getting the learners to be active and take part in their own construction makes the learning more meaningful. That’s the way I understand it, and for me it has a very social orientation (...) for me [the “cognitive stuff”] is not as meaningful as understanding the context of the learning and how people create their own meaning. (IAT-K3)

Karyn wants (desires) understanding, and for her this is a key to learning. The mathematics education she has been explicitly introduced to has been at such a surface level as to be meaningless, but she has attempted to make it more meaningful by relating it to other aspects of education and to her specialisation into other discursive resources she has been able to get more in-depth access to, in particular through her concurrent studies in the BA where she

majored in Sociology and Psychology and took Philosophy to 2nd year level. She tells us that while “I found the Psychology quite a drag” she

... loved the Sociology and the Philosophy ... I have found that doing this degree had helped me to keep the “big picture” in mind all the time. It has given what I do at [CU] a richer context, and has definitely alerted me to many social and political issues that I would have otherwise not thought about. (KBQ2).

This reflexive consciousness has enabled her to be more explicit about the ideas and practices that she has tacitly learnt within the mathematics teacher education classroom. It also takes us back to Karyn’s need to be socially relevant and how important it is for her to be *interested* in what she does, to *love* the ideas and the work. Her developing subject (knowledge/disciplinary) identities are *not* only connected to M, or ME or MT – but go much wider into these other fields which provide a basis for deeper thinking about what she is doing in relation to the socio-political context she finds herself in.

The final aspect of her knowledge career is related to mathematics teaching. We have already seen that her concept of mathematics teaching has been deeply influenced by the practices of Mr/s X and her view of what mathematics teaching ought to be is directly related to her experiences of being taught by her. In relating her own experiences of teachings and practice in schools she reflects on the various practice teaching experiences over the years while at CU. She has found them to be very instructive not only for developing her confidence but also for providing a space to experiment with things she has learnt in her courses and for grounding her with respect to her own limits and to the reality of the classroom context.

In her first year her lack of confidence in her own maths and lack of motivation from her maths courses (particularly the ‘methods’) made her uncertain about her position as a maths teacher. But during the school experience she became motivated and so she worked hard to pass the maths. In her second year she gained confidence and found her voice and her creative side became engaged in the mathematics she was doing and in her mathematics teaching. Mr/s X’s approach had enabled her take risks while out on practice and she tried to break the boundaries of traditional school practices and to let go in experimenting creatively in the classroom. Her focus was on developing understanding (uncovering, conceptualising, deeper meaning) but she found that she was a little ‘out there’ for the learners, and in the next two practicals she consciously reigned herself in so that she could be more focused on learners and what was appropriate for them.

She recalls, by the third practice

I found that I could approach explorations on a level that was more appropriate to the learners and I saw better results. I guess I was trying to focus myself more, whereas the year before I was concerned with letting go and moving beyond what I perceived as boundaries. (KBQ1)

Practice teaching experience features as a key aspect of her development and it is the thing that brings her back down to earth. While she wants to be creative and to deal with conceptual issues she has realised that she needs to be more focused on the learners and develop appropriate tasks

I am trying very hard to try and focus my task writing so that it is not so “out there” and more useful in helping the **learners to uncover the deeper issues in the maths**. (KBQ1)

Karyn’s response to the interview question when asked what the four most important aspects of being a good mathematics teacher, confirms her commitment to the social and creative aspects of teaching:

I said well **being inclusive**; making sure all learners are fitting in (.....) develop all the learners. **Being creative**; looking beyond the maths, lateral thinking processes. **Being flexible**, adapting to each classroom’s social context, and reworking and rethinking all the time. And **being responsive**, listening to what’s happening in the classroom and the greater society and responding rapidly to create a deeper and more informative experience. (IAT-K1)

Her description of her imagined ‘ideal’ classroom practice during the interviews provides further detail of this commitment:

Karyn: Ok (...) a large part of my image (...) I have been working on is **respect** but I think it creates less of a barrier between yourself as a teacher and the knowledge you are supposed to have, (...) and the learners and their discussion of the concept. So I strive to make **my whole environment very conversational** and, (.....) I like to make the learner particularly **aware of the social issues** around learning mathematics. Again **I am not into the concepts**, and I’m not defining all of those but just the general environment of the maths class and **my emphasis would be on challenging everyday knowledge** that you know, that wouldn’t be in line with mathematical thinking, and not giving learners an easy way out of a problem, creating cognitive dissonance (...) all the time getting them to think about questions. Ja. That’s all.

When she is probed we recognise that when Karyn evokes the everyday, this is not a typical expression of the discourses circulating more generally in education around the need to integrate the everyday into learning to make it meaningful and relevant. She is wanting to develop a mathematical gaze in the learners – one that will give them access to mathematics that will challenge their everyday sense making. This is confirmed at the end of the final interview when Karyn was asked if she wanted to add anything to the discussion that we had not explicitly touched on. She revealed that she has a real concern about how people see the ‘everyday’,

Karyn: Well there’s one thing I think about it a lot (...) people starting talking about making maths meaningful and in our methodology classes we always start, everyone starts saying it must be [meaningful] in real life, you know applied to real life, and for me that’s not it! There a difference between like John buys 4 apples at the grocery store, and like taking the mathematical context out of where it is into everyday understanding (...) I think we have very

- limited understanding of everyday (...) I mean just everyone says it all the time and for me it doesn't always make sense so (...), do you understand what I'm saying?
- Di: I think I get a picture of what you're saying. So that's a question of (...) what is the relationship between the everyday and mathematics?
- Karyn: Yes, yes, but beyond that. Like that's like the one side of it. (...) What I mean by everyday understanding and use of [maths] it could be like looking at it as a language like if saying if we want to describe this angle [drawing on the page] it's, it's above the bottom parallel line to the right of the transversal, so like kind of taking the maths concept out of where it is to an everyday use of it, in terms of language.
- Di: Sorry I kind of get what you're saying. There's a mathematical language and but there's also everyday language and you might be able to make translations between those?
- Karyn: Yea, and maybe that's more useful than trying to make it apply to everyday life.
- Di: You think there's sort of like obsession with applying it to everyday life?
- Karyn: It's not really useful.
- Di: Why do you say that, I mean you have a feel about that?
- Karyn: I don't think that's new to the syllabus I mean if you look at the Classroom Maths at the end of the chapter there's always like word sums I think that's an old idea I don't think it's that particularly useful (...) for uncovering the concepts embedded in those issues. (...) I think but the messages we get are conflicting because I mean on the one hand at every opportunity we are getting told make it relevant, make it meaningful and on the other hand how do we actually get them to be able to complete you know, equations, sums or the exponent expressions, you know this conflict, the whole conflict.
- (...)
- Di: Do you think mathematics will always be useful?
- P: Well, I don't know. My personality is not that obsessive so I don't know if it's useful or not I just enjoy it. Anyway for me I don't think it has to be useful (...) we are obsessed about mathematics in our everyday but actually what about justifying it? (...) there's so much to talk about within the mathematics itself that it doesn't have to, we don't have to go out of the mathematics to understand, to uncover the meaning and the relevance of it, you know (...).
- (IAT-K3)

The story told so far spans a number of locations and provides insights into Karyn's development as a mathematics teacher. We note that her knowledge careers (in terms of her entry into M, ME and MT discourses) are not easily separated from one another or from the regulative or moral discourses in which they are embedded. We see a deep relationship that has developed with mathematics as a way of thinking and uncovering meaning, and connected to this a deep conviction around best practice in mathematics teaching. Mathematics Teaching, however, is mostly constituted as an experiential field, although what she has tacitly acquired in her mathematics classes in relation to the pedagogic mode operating within Mr/s X's classes grounds this identity. We also see that she has not developed much of a connection to any aspect of the field of mathematics education research, and notions around mathematics education that she has access to have mostly been tacitly acquired through her interactions with her lecturers or through reflexive thinking from other discursive resources acquired in her Education courses or through her concurrent BA studies.

To summarise, Karyn presents herself as a creative mathematical thinker who is interested in understanding and uncovering deeper meaning in relation to mathematics. She wants to help learners develop this interest and ability as well, and so while she has a desire to break

traditional boundaries with respect to teaching mathematics and to experiment creatively in the classroom, she recognises that she needs to focus on what the learners need and is willing to reign herself in to maintain a balance. She is fairly passionate about what she is learning and she invests herself in her learning: she “*loved sociology and philosophy*”; she found “*psychology quite a drag*”; she found the maths method course in first year “*frustrating*”; her experience of learning maths with Mr/s X in her second year “*changed the way [she] looked at maths and education in a very profound way*” and built her confidence; in her third year when her lecturer (Mr/s Z) had a “*rigid style of teaching*” she “*hated*” it; in her fourth year she “*enjoyed*” the courses and found them “*stimulating*”; in her final practice teaching she worked with a grade 11 SG class and at first found it very “*frustrating*” but she adjusted her thinking in response to the learners and then found the “*experience so rewarding*”.

Karyn explicitly rejects traditional forms of teaching. She wants to break the boundaries of the traditional. For her the appropriate pedagogy for today is ‘discussion based’ – it appreciates the knowledge of the learners, it uses their ideas, it encourages them to listen to one another, it focuses on constructing meaning and personal understanding through ‘uncovering’ mathematical ideas. For her social relevance is of great importance and is related to moving beyond the mathematics to be inclusive of all cultures and to ensure meaningful communication. However, she does not see relevance in terms of mathematics necessarily being connected into the everyday lives of learners, but rather in transforming their lives by providing access to processes which will enable them to see mathematics as meaningful in-and-for-itself.

2.2 Sonny’s Story: Mathematics is not supposed to be narrated

Sonny is a 26 year old Black African male student in his 4th year of study at CU. He grew up in a rural district attending schools run by the ex-DET. He describes his mother as a ‘housewife’ and reports that his father is deceased. His background is relatively disadvantaged in the context of CU.

Sonny relates his story across a number of institutional locations including his high school where he matriculated in 1998 with a SG A in mathematics, a bridging school that he briefly attended in 1999 after competing school and his entry into CU in 2001 when he enrolled for the HDE. During his studies he has had practice teaching experience in a number of schools. A further institutional location is a local primary school that he works at in the afternoons assisting with aftercare, homework and giving extra mathematics lessons.

In providing an argument for his decision to become a mathematics teacher Sonny informs us that after he left school he wanted to continue with his studies but did not do well enough in maths and science to get a bursary to go to university. He moved to the city to improve his prospects and managed to get into the ISCOR bridging school where he hoped to improve his chances by getting better matriculation symbols. Unfortunately he was unable to find work to support himself and in the end had to drop out and so did not improve his matric marks. He spent the next two years attempting to find work but was unsuccessful and suffered hardships. He then heard about education bursaries being offered at CU and he successfully applied. While the bursary was clearly the main impetus for his decision to become a teacher, he reconstructs his story to explain that he chose mathematics since:

I did not have difficulty with maths during my schooldays but it was challenging. There were more people greatly struggling so I used to help them while I am also a learner. This was fruitful. Besides this I really like working with young people that is why I decided to do after care at (a) primary school just to work with these young people. What really became a motivation even more was good results that I was getting in maths as well as the love of the subject. There are other things that added onto this such as the scarcity of maths and science teachers in the country. (SBQ)

Here we see Sonny constructing an argument for becoming a mathematics teacher that contains the following elements: he is able in mathematics; he is able to help others learn mathematics; he likes working with young people; he can contribute to the skills shortage in the country. His success in mathematics has lead to a love ²¹⁵ of the subject.

In his discussion of his knowledge career across his early institutional contexts, Sonny constructs a picture of himself as able and successful in mathematics while at the same time reconstructing a picture of his teachers as out of step with how things ought to be. He relates:

School mathematics was a novel narrated to us and we sat there and listened. We never questioned anything. It was too abstract and there was nothing we could look forward to. It was about following a recipe because we were following what the teacher had done without understanding for as long as we we're going to pass at the end of the year. We coped with this because we were scared of four lashes on the hand so we were working so hard to avoid this and this was helping us on the other hand. (SBQ)

He reconstructs his experiences of learning mathematics at school in a form where he negates the practice that lead to his success. His story is constructed from his present vantage point and presents a view of what he now believes mathematics teaching ought to be. This quote can be re-read in the following way: “we sat there and listened” [*we were not active*]; “We never questioned anything” [*we were passive, we did not discuss*]; “It was too abstract” [*It did not link to the everyday*]; “It was about following a recipe” [*we should have been able to*

²¹⁵ Note that this mention of ‘love’ in relation to mathematics was spoken in the context of remembering his school experiences and constructing an argument for becoming a teacher. Sonny does not peak of loving mathematics in relating his university mathematics learning career.

use own methods]; “we were following what the teacher had done without understanding” [*doing without understanding is bad*]

At the same time as he presents this negative view of his school experiences he also tells us that within this context he was successful, although he couches this success in terms of the hard work they put into mathematics – not for mathematics sake, not to please anyone, not for his future success, etc., but in order to avoid punishment in the form of “four lashes on the hand”. That is, they did everything that was needed to pass and were successful in managing the subject – but they did this to avoid punishment.

Sonny goes on to tell us that,

My grade twelve teacher has always been my role model in terms of the way he was teaching and I always said I will one day teach like him. He was narrating the content but we could understand what was going on. I don't want to be like him anymore because mathematics it's not supposed to be narrated. (SBQ)

From this piece it appears that while he was successful at school and is proud of that success, through his work at CU he has developed an ideal of what teaching mathematics *ought to be*, and in most senses this is a negation of his own school experience. Yet he acknowledges that his experience resulted in him loving mathematics and being a successful school mathematics learner. Here we see that his view of MT has been changed by his university experience – whereas his ideal role model was his grade 12 maths teacher and his image of teaching was built on that ideal he has now discarded that for a new role model (in particular one of his lecturers Mr/s X), but his articulated basis for rejection is ‘because mathematics it's not supposed to be narrated’. A new image (cf. Lacan) has replaced the old – the traditional is discarded on the grounds that it is *not supposed to be* like that.

The new ideal that emerges here can be re-described as: The mathematics teacher ought to teach in a way that enables learners to be active participants in the classroom – learners should not sit and listen and follow the teacher’s instructions, they should question and use (construct) a variety of their own methods and not follow given methods (recipes). Learners should understand the maths that they are doing. Mathematics should not be presented as abstract it should be relevant and linked to the everyday. This image of mathematics teaching is re-described by Sonny during the interviews on a number of occasions.

Later, Sonny describes his best and worst memories of learning mathematics at school:

The best memory about learning mathematics is when we went to E (a local town) to compete with other schools and we came first. What makes it the best is because we were never told in advance we were

going to do this yet we performed exceptionally well. I was used to passing maths but when I failed, getting 10% in the test it's the worst memory. I cried right in front of everyone. (SBQ)

Here Sonny reveals that what motivates him is his desire for recognition by others – when he is recognised for his good performances he is very happy and when he does badly he cries. This is reinforced again in his account of his university mathematics learning.

In writing about his university mathematics experiences he tells us,

I thought we were going to be doing secondary school maths but that is advanced. I was so surprised when we did something completely new such as combinations, groups, rings²¹⁶, statistics to etc. I had a problem with statistics because it was for the first time I did it and the way it was taught was even more complicated because we used to be spoon fed and now we were given hand outs to do at home and told to bring answers to class. This was helping me on the other hand, because I got to think more about what needed to be done. At the end of the year it was always a success to get an A symbol in maths and it has been motivating. I really feel that mathematics is the subject that needs a lot of time and practice because if one does not practice he becomes out of form. The way it has been presented, even though it has not always has been outstanding, so lecturers have influence as well. (SBQ)

Again he mentions how success and recognition of his ability motivates him to work hard and to practice. He also indicates the importance of lecturers to this process. He presents himself as someone who had to change from someone who was 'spoon fed' into someone who could work independently and who thinks hard to see what has to be done.

Sonny's view that mathematics takes hard work, diligence, patience and perseverance is repeated throughout the interviews. He also continually expressed the view that mathematics requires someone who can work systematically, thinks about what they are doing and argues convincingly. While Sonny presents this view of what it means to do mathematics which clearly emphasises the individual student's discipline towards work, he also expresses the importance of group interaction in learning mathematics. He alluded to this many times over the interviews, and in the final interview, when asked to reflect on the most important thing he learned about mathematics while at CU he suggested:

I think that, that thing will be working together (...) sharing ideas, reminding ourselves of what we learned in mathematics and really coming with different solutions, challenging each other, saying why do you say this is the case. But why do you say this is, what's wrong with my way of thinking, what is wrong with my way of thinking, what's wrong with my, my approach to this problem? ... (IAT-S3)

Added to this is the idea that mathematics needs somebody who can think critically, not just follow a recipe, an idea of mathematics that he rejects, even though he is all for lots of practice. This is emphasised in his selection of the most important ideas/ concepts an FET learner needed to know about mathematics:

²¹⁶ We note that these aspects of the old HDE curriculum have been dropped from the new B.Ed curriculum. The new curriculum is more concerned to cover in depth topics directly connected to the school curriculum.

I'll focus on, I don't know but this is broad, space, shape and measurement. But that is broad. That involves geometry. I'll focus on geometry first, ok, cause then it lets learners think, think critically about the pro, about solving the problem not like solving for x , bla, blab la, this is how we solve for x , additive inverse and all those things, without knowing why do we do that. But geometry will let them think critically and about what they are doing and solve it mathematically. (IAT-S1)

While he presents this image of the active critical mathematics learners, this is underscored by his commitment to practice and his need to be recognised by his teachers and to be taught mathematics well. The need to be taught became more obvious during the second interview when the NCSM was under discussion. During the interview Sonny became more and more agitated and frustrated as he found that he was unable to intelligibly discuss some of the questions related to the school mathematics behind the specific outcomes and assessment standards. The field notes taken during and after the interview record: "At the end, AFTER the tape is switched off, I ask him how he felt about the interview. Sonny responds by telling me that it "makes him 'hate' his school teachers". He directly blames his school teachers for the fact that he really does not know the significance of all the mathematical ideas discussed in the interview. He says they never explained why certain things worked or where they came from and that this has left large gaps in his school mathematical knowledge. He is angry about this as he feels it is getting too late for him to catch up on all this stuff and that he should already know it all, especially since he is completing his studies and will be going out to teach the following year. He feels that he must ask his lecturers at the college to help him fill these gaps in his school mathematics knowledge and understanding. He does not bring up the idea that as a teacher he is a scholar/ lifelong learner²¹⁷ and that he will have to work at getting to know this mathematics more deeply. Rather he focuses on his school teachers who he is angry with and blames for not teaching him effectively, and on his lecturers who could help him fill these gaps if only he had more time. (Field Notes, after Sonny Interview #2: 27/09/04; 09:00)

Sonny's writing and talk seems to focus mainly on two orientations to mathematics identified in the NCSM, namely, orientations (2): mathematics as relevant and applicable to everyday life, and (4) mathematics as a body of knowledge containing facts, conventions, skills etc to be mastered through diligence and practice.

Moving to examine Sonny's specialisation into the field of mathematics education while at CU, we find that his understanding of mathematics teaching and learning is mostly connected

²¹⁷ Recall from the discussion in Chapter 9 that Sonny had indicated that being a scholar, a researcher and a lifelong learner were important aspects of being a good mathematics teacher.

into his experiences of (re)learning mathematics in the mathematics teacher education classroom. When asked directly about being introduced to any theories in mathematics education that has enabled him to better understand the teaching and learning of mathematics, he reveals;

Sonny: We only started this year when we looked at van Hiele. And van Hiele levels has to do with geometry. But, I think but, but not at all. No theories are touched. Only, ok, this is mathematics and (...) the lecturer would say (...) I think this is the best way to present this section. And this is the best way to introduce this section and all those things. But no theories were really involved until this year when we looked at geometry and how to teach geometry and how to judge geometric thinking for learners.

Di: (...) Did you ever see any other examples of research to help you think about teaching and learning maybe not a big theory but ...?

Sonny: No, no I haven't.

Di: Do you think that maybe, even though you did not study any specific theory, that there is a theoretical perspective that underlies what you have been doing in your maths education courses?

Sonny: I really don't know.

(IAT-S3)

Sonny is only able to mention the theory he has done that is explicitly labelled. He does not explicitly recognise any theory underpinning his favoured approach to learning mathematics articulated throughout his writing and talk. When he is pushed, he insists that in their mathematics teacher education classes, mathematics education theory has been more or less absent, although he is clear that throughout his maths/ maths methods courses he has been given ideas on how to teach specific topics.

Sonny's specialisation into mathematics education appears to be mostly tacitly acquired and he does not recognise the elements in his ideal of mathematics and mathematics learning as being embedded in a particular theoretical perspective. His identification of the discourses he has articulated as underpinning his approach is possibly based on images that are not for the most part interrogated through discursive resources.

This is confirmed to some extent when considering his specialisation into mathematics teaching. In his reconstruction of his mathematics teaching career he begins by writing:

Maths needs a teacher who loves the subject and who ensures that he is well prepared because learners come up with so many methods of solving one thing and some of them do not exist, but as a teacher you need to comment and make the learner understand what is wrong with his thinking. If one does not like it everything becomes hard like a rock. (SBQ)

There is a distinct change in language here – whereas before when writing about his mathematics career he used an active voice together with personal pronouns, here he uses the passive voice and moves from *I* and *we*, to *you* and *one*. This appears to be a description that is rooted in learning within his University courses. It is interesting because it adds to the image projected previously. In particular, to be a good maths teacher you must: love the

subject; always prepare yourself well for teaching; learners will use many different methods for solving maths problems, some of which are not mathematically correct (*some of them do not exist*); so you must be prepared because you have to evaluate the learners (*you need to comment and make the learner understand what is wrong with his thinking*); if you do not comment/ are not prepared/ do not love the subject the learners will not learn and maths will become incomprehensible (*everything becomes hard like a rock*).

He appears to be arguing for an image of mathematics teaching that is underpinned by particular constructivist propositions. Although he does not explicitly recognise this, he is articulating the idea that: Learners construct meaning and come up with their own ways of solving problems; some of their methods may not be conventional but they may be mathematically correct and you must be able to recognise that. It is also the case that learners have misconceptions and they may use methods that are not correct (*they don't even exist*) and these are also important for teaching; as a teacher you must be well prepared to recognise the different methods that learners use, to recognise those that are correct, partially correct and incorrect – so you must evaluate their individual productions. You must be able to work with what learners produce to help them understand where they went wrong (*understand what is wrong in their thinking*). If not, the learners will not like maths because they will not learn with understanding, and maths will become incomprehensible (*hard like a rock*).

Sonny articulates a view that mathematics teachers ought to

... be able to relate mathematics to learners everyday lives so that they captured their attention and there needs to be visual aid that the learner can touch and can play around so that they discover e.g. properties, proofs etc. (SBQ)

The 'everyday' relevance of maths that was visible before, but only as a negation of his school experiences, is more explicitly expressed. Relevance of the everyday is related here to capturing learners' attention. Furthermore learners must be active (use visual aids and touch and play). This also points to the importance of using visual and tactile metaphors in developing mathematical ideas, since it is in that way that they can make meaning and 'discover' the mathematics.

Earlier we saw that Sonny negated his experience of learning mathematics in schools. He reinforces his changed perspective when he writes and talks about his experiences while in schools on practice teaching. Here he reveals his recontextualisation of what this 'new' practice should be in terms of the pedagogic pattern he would follow in the classroom.

From my school experience I discovered that learners get the easily bored especially if one is narrating/ preaching mathematics so I speak for 5 -10 minutes and let learners work on their own and get feedback later from them. This is useful especially if a teacher has a double period with learners. (SBQ)

This view was also expressed during the interviews when he discussed his imagined practices, although in that discussion he emphasised the need for “groups, groups, groups” and discussion rather than “letting learners work on their own”. I will not go into any detailed description of his imagined practice here as this has already been discussed in Chapter 9, however it appears that the ideal (groups, groups, groups) is tempered by his experience (managing groups is not easy).

This is confirmed in the final interview where Sonny reveals that while he has an ideal practice in mind, he finds that in practice it is not always possible to realise this. He argues that his inability to realise his ideal in practice is because he is obstructed by his mentor teachers when out in practice. His university learning has convinced him of the new ways, but when he goes out to practice he is obstructed, he is not trusted and teachers do not let him do what he is trained to do. They exploit him instead.

I feel that even though this is the case some teachers do not allow learners [student teachers] to do as they please as far as presenting a subject is concerned. They don't even allow learners [student teachers] to rearrange desks to try different group work methods. This is ridiculous yet when it comes to marking they are put first. This is exploitation and I don't think it's acceptable. (SBQ)

In addition to being obstructed and exploited by the teachers, he finds that the learners do not behave in ways that make it possible to put his ideal into practice. He reveals that for him mathematics classroom management becomes very difficult and he often has to tell learners that a piece of work is for marks to get them to do some work. He hasn't found that they intrinsically want to do the mathematics, unlike here at the university where everyone is involved. He reveals,

It's been difficult and I'm still trying to find ways.(...) Because we put them in groups thinking they are gonna share ideas and thinking they are gonna work around whatever work you've given them, only to find that they well, they are talking about something else not what you gave them to talk about. (IAT-S3)

When asked if he had observed any examples of teachers doing this successfully, Sonny responded “No I haven't, no I haven't”, and when pushed he suggested the only place he had seen it work effectively was in his teacher education class:

Sonny: I mean Mr/s X she, she uses it a lot, because we actually discuss and all those things. What she often does is she'll pick one or, one of you. She doesn't, she doesn't specifically say who's gonna report in that group so you kind of like listen attentively when your, your members of, member of the group are discussing, so that you are able to report back, otherwise she will find if you were not listening and you were not doing anything. But if, if it happens that she finds that you were not, you were not listening when they were, they were discussing she'll ask another to help you and if that one was not doing the work as well he'll be exposed so those are the kind of things that she commonly (uses).

Di: ... you told me Mr/s X is like, you enjoy the way she teaches, she's modelling this in your classroom?

Sonny: Yes (...but...) we are adults, so (...) I think it's different.

Di: Do you think this modelling here helps you at all for your own teaching?

Sonny: Well it does (...) especially in terms of like giving learners more work to do so that they are occupied and they don't have, they don't have time to talk about something else. They focus on mathematics so you give them more work to do but they don't like it. (IAT-S3)

Here Sonny reveals that while he can recognise and describe what he believes is the best practice for teaching mathematics, in practice he has not developed the skills to manage this kind of learning. He knows it can work through the way Mr/s X has modelled it in the teacher education classroom, but he has no way of putting into practice, or realising it in a school classroom with learners who do not behave as ideal learners, who obstruct the process because they are not intrinsically interested. He recognises that they are not adults and that what works in the mathematics teacher education classroom does not work as well in a school. His only way of trying to control things is to tell them that every piece of work is 'for marks',

Well what I often do is I say it's for submission and, and, and it's for marks even though I know it's not it's not for marks (...) because I know they are scared of (...) losing marks so if they, they hear submission they just do it (...) And I try to (...) take it in at the end of the lesson, just have a look at it and, ja, just give it back to them, so that's what I often do. (...) because they often ask you is it for marks. So if it's not for marks, ooh it's a holiday, ja, it's a holiday. (IAT-S3)

There is an echo here of Sonny's own experience as a school learner. The way to control the learners and get them to do the mathematics is through fear, however, when he was at school it was through corporal punishment that fear was instilled, here it is through the threat of not getting 'marks'.

It appears that Sonny does not have access to the resources that could enable him to put his ideal practice into practice. This may be related to a lack of access to explicit discursive resources that would enable him to reflexively work with this new practice, and in the end reduced him to a form of mimicry that tends to breakdown in practice. It may also be related to his educational and cultural background – from a rural context in which authority is generally respected and he never experienced learners as obstacles to learning, where he has to engage learners in order to keep them interested and involved. He recognises that he cannot narrate/ preach mathematics to these learners - they will get bored if he does (see quote above) and knows he must get them to work on tasks. However, he does not appear to problematise *what* he gets them to work on, and his notion of "feedback" does not appear to be substantially unpacked so as to be meaningful.

The discussion with Sonny around his career in schools through his practice teaching experiences while at CU is revealing and confirms some of the cultural dissonance that affects him. He has found these experiences to be painful on the whole. He reveals that over the eight practice teaching experiences he has always been placed in ex-model C schools, and his experiences have most often left him feeling inadequate. He sees part of the problem in the position he is given as a student teacher when out in practice,

Who am I? I am just a student teacher, I mean, that is how we are treated during the school experience in these schools²¹⁸ (...) Even our learners tell us that you are student teachers you don't know how to teach you are here to learn how to teach. Which is not the case, but that is how we're treated. And the way we are introduced as well to learners, (...), give learners the impression that we are student teachers and we have no power. They are like, 'who are you to tell me?' you are a student teacher you are here for three weeks and after that you are gone. (IAT-S3)

Sonny's need for recognition as a teacher is affronted by being treated as a 'learner' teacher, which of course he is. However it appears that it is the lack of support and recognition that he gets from school mentor teachers that underlies his frustration. He uses an example of how he is assessed on one of his practice experiences to explain,

And one of the things was like when the teacher that I was working with during school experience assessed me. You know. And I thought I was doing well. And she even told me that, that I was doing well. But what she wrote on the assessment form was really discouraging. Because she wrote something like, um, (long pause) she wrote something like, um, I am not managing homework well, but that it comes with experience and she still learning that too. Again she mentioned that I have to go and learn my, what, common sense things. Things like that. And I was so devastated. I said, but this! She's never been honest to me. Only in the last day that she writes that, she writes this. Why? Why didn't she tell during the process so that I could improve? (IAT-S3)

Sonny says that out of his eight practice teaching experiences he has had only one good experience. The bad experiences all appear to be linked to his mentor teachers not trusting him and not being open with him and undermining his ability to take control of his classes. He explains using an example,

... in one of the schools around (the City) I was working with this teacher who kept on interfering with my lessons. And as a result I ended up making silly mistakes that I should not have made. But it was because of her interfering with my lessons, giving learners the impression that I am not teaching them what they are supposed to know, or the way she is supposed be teaching them, and all those things (IAT-S3)

The good experience he has was at a relatively affluent school in the city which had high levels of discipline. He had a good experience there because the teachers were open to him and he was supported. Even though Sonny feels so badly treated during his practice teaching experiences, he still believes that going out in practice is an important part of the CU

²¹⁸ This is a very interesting comment, and will be picked up later after considering the RU case. In the schools that the RU students go to they are treated in the opposite way – they are experienced teachers and left to their own devices!

curriculum. His reasons for saying this however are not focussed on his own learning to teach but rather on dealing with the realities ‘out there’:

... it is informative in a way, because it is what we are going to come across when you out there teaching. You will come across people that are not open with you. They are not friendly at all with you, and you have to learn to deal with them, with those people. And you come across schools with different, um, disciplinary problems, and you have to deal with those things, and all these things. These are the things you are going to come across when we go out, so it has been worthwhile doing it, it has been worthwhile. Just so that you know what exactly lies ahead of you (...) And only when you are working in this school that you will be able to change those things and challenge those things. Challenge even forms of discipline used in the school, you're able to challenge those things. But as a student teacher you are powerless, you can't challenge those things. They will tell you that it's been done this way, and has been effective. Only to see that well these things are really not effective here, but they say it has been effective. (IAT-S3)

This reveals that Sonny's problems with practice teaching are located in the poor relationships he develops in the schools. His view of how things ought to be does not match with the reality he experiences. His need for recognition and respect is not met within these contexts and so while he learns about how to deal with this his growth as a mathematics teacher appears to be neglected. In probing further there is further confirmation that part of the problem for Sonny within these contexts is cultural. He reveals that his only experiences have been in suburban schools, and while he has been to all boys and co-ed schools where the learners are from mixed cultures, the teachers have been predominantly white. He has never had an experience in a so called ‘township school’,

I've never been to township schools. They are afraid to put us and township schools because they are also afraid to go there themselves, when they have to go there to crit you. Most of the time they just put us in model C schools. In the last year we can do electives and we can go just where you feel like going, even home, you just go home where you come from. I was not able to go. (IAT-S3)

To conclude, Sonny projects himself as someone who is motivated by the good results he gets in mathematics and as someone who loves maths, can do maths and can help other learners learn it. He describes himself as a changed person, someone who used to want to ‘narrate maths’ in a way that learners could understand it but has now seen the light and knows that this is wrong. An interesting aspect of this change is that it is related through the negative – who he previously thought he was and what he through was an ideal - he now sees as wrong – it is *not* the way it is supposed to be. He now wants to be a teacher who allows learners to actively participate in the classroom, who listens to learners’ explanations and who is able to evaluate their thinking, understand the way they think and use this to guide his teaching. He wants to be someone who makes maths relevant to the everyday lives of the learners he teaches. He does not narrate or preach mathematics (and so does not bore learners), but allows learners to work on their own and in groups, gets feedback from learners and uses this feedback to advance their learning. However, he acknowledges that while he has these ideals he has not been able to realise them in practice.

It appears that while Sonny has acquired a recognition rule for the legitimate practice projected from his institution, he has not managed to acquire the realisation rule – he has not been able to effectively put what he recognises as good practice into practice in the context of a school. It appears that he thrives on recognition from others to feel happy in himself with respect to both his mathematics learning and in his mathematics teaching. He has achieved recognition at CU in terms of mathematics itself and has developed a fairly strong consciousness with respect to his pedagogic identity as a person who can do mathematics and learn mathematics, rooted in his conviction of individual hard work, systematic thinking and sharing ideas to evaluate his thinking and solutions. His consciousness with respect to ME is however underdeveloped and he has little access to discourses in the field that could help him interrogate his ideals and ideas with respect to teaching and learning school mathematics. He is committed to a career in mathematics teaching, however, he feels the pain of lack of recognition with respect to his teaching, as experienced while out in schools on practice. He appears to have acquired imaginary identification with the new MT practices he now advocates, but does not have access to the substantial discursive resources that would enable him to work with these in productive ways. He is unable to read the underlying practices that enable successful discussion-based teaching. He is hampered by this lack and is left with the frustration of imitating what he recognises as his ideal practice.

2.3 Emmanuel's Story: to learn mathematics you need to dig deep from within

Emmanuel is a 24 year old Black African B.Ed student in his 2nd year of study at CU. His mother is employed as packer in a factory and his father is a pensioner. His background is relatively disadvantaged in the context of CU.

Emmanuel recounts a number of institutional contexts through which his mathematics career has developed. He attended high school at a disadvantaged township school where he matriculated but did not achieve high enough marks in mathematics (SG E) to enable him to continue with technical studies, which is what interested him. The year after he matriculated he found himself unemployed and unable to find funds to study further and so hung around at home feeling the pain of living in poverty with no prospects. The following year he decided to upgrade his matric mathematics and science marks, and attended a 'school' run by an NGO successfully rewriting these subjects. Thereafter he enrolled in a Technical College beginning studies towards a national diploma. He attended three different technical colleges between

1999 and 2001, completing his N6. He was offered a position to teach electronics at the last (private) college he attended and he spent four months teaching there, however, he “quit because they were failing to pay me because of finance” (EBQ).

Following this stint of teaching he did a short course at a catering school and trained as a waiter. He found work as a full time waiter, a skill he still utilizes (he works in the evenings to support himself through his studies at CU). However after a few months of waiting, he was offered another post at the private technical school and so he took the opportunity. He recalls

They introduced high school and they wanted me to come and teach grade 12 maths. I ... teach grade 12 maths for the rest of 2002 and produce 37% pass rate. At the end of the year I then decided to go to university to study to be a teacher in 2003. (EBQ)

It is notable that in Emmanuel’s story he does not mention the availability of the bursary as a motivation for becoming a mathematics teacher. Rather he is motivated by his realisation that teaching was a career he wanted to do after his experiences as an unqualified teacher.

Emmanuel’s tells us his relationship with mathematics began early. He

grew up loving maths because my brother was very good at it. Everybody used to praise him and somehow I also wanted to be praised. This really motivated me and it made me to love maths so that I can be praised like my big brother. (EBQ)

We see that for him, his early *love* for maths is something that is also connected to receiving praise and recognition by others, rather than any specific quality of mathematics in-itself. This desire for recognition is connected into his motivation for becoming a mathematics teacher. He writes:

Another thing that motivated me was the fact that I got an A after rewriting and I appeared on the newspaper. This made me to gain fame and recognition and students too used to come to me for help and I used to enjoy helping them. (EBQ)

Recognition by others seems to be a key to his identification with mathematics.

Emanuel describes his school mathematics career from his present vantage point as a student teacher. He tells us,

Maths was taught in a teacher centred method and that all that we had to do as students was just to listen and practice and then to get to be assessed. Since we were not given a conceptual understanding of mathematics, we had to memorize most of the things. (EBQ)

This description characterizes his school maths experience as ‘bad’ and reveals what he sees as ‘good’ from his current position as a student teacher at CU. Maths was teacher-centred [*it should be learner-centred*]. The learner’s role was to listen, to practice and to be assessed [*learners should be active and creative*]. Conceptual understanding of mathematics was not

given and so we had to memorize most of the things [*conceptual understanding should be the focus of mathematics learning – if conceptual understanding is a focus then memorization is not so important.*]

He explains this position from the perspective of learning geometry.

The theorems in geometry, I used to memorize them as they are and make sure I know the properties of congruency and that way I was going to pass. I never knew that there was a link between Grade 9 and Grade 10 geometry because all I do was to memorise and when you go to the next grade you start afresh and if the teacher has changed you just learn his method of assessment and then continue memorising accordingly. This means that teachers were not laying good foundations for each other and this was burden to teachers because they had to fix the foundation first and then continue and this was not fair to learners. (EBQ)

Here he reveals something of his stance on how teaching geometry ought to be. That is: if you memorize theorems then you will not understand the links between different aspects of geometry (*maths should not be learnt through memorization; understanding involves making links*); teaching in a disjointed way and encouraging memorization will lead students to learn what is necessary for their tests and adapt themselves for you as a teacher, (*this is not a good thing because they will not develop mathematically, instead, each time they get a new teacher they will start again and not try and build on what they did before*); teaching in this way means that good foundations for learning further concepts are not built up (*it is important to build foundations for the concepts to develop that can be carried through to the next grade*); you need to be fair to learners, being fair involves helping them to see the way things are connected (*in other language, enabling them to get access to the recognition rules – and from this the realization rules for the real practice. It is unfair to expect them to mimic the practice on the basis of examples that are given and learnt by heart*).

Geometry was clearly a difficulty for Emmanuel at school but he rewrites himself in a way which shows how he coped. Later in his writing (as well as interviews) he refers to the geometry course at CU as being very important to him.

For Emmanuel his learning of mathematics has been hampered by language difficulties, as he reveals in his description of his worst experience of mathematics learning:

My worst memory of the studying maths was when I was doing my grade 10. I was still fresh from Venda and the languages I was a familiar with was Venda and English. I went to (V) High School where they have two vernaculars and it was Venda and Tsonga. So it was an obvious thing that everyone in the school understands both languages. The teacher who used to teach maths used to teach maths and translate it into Tsonga and sometimes teach it in Tsonga. That made maths to be more difficult for me and it took me a while before I could adjust to it. (EBQ)

Emanuel provides little insight into his mathematics career through the technical school. However he mentions that he had a teacher there who was particularly inspiring and motivating,

I went to the Technical College I met Mrs. S who knew the content and also how to apply it. I have always admired this lady on the way she used to teach maths. She used to know how to reach even the less competent students who quit maths at Grade 9. She used to offer all that she was as a teacher and I saw the joy she used to have through obtaining the highest pass rate. (EBQ)

In recounting aspects of his university career thus far he tells us that the first course was,

not an easy course for me because I had to go with the method of teaching. I was not used to discussing and reasoning in a maths class. This took time to adjust but at the end we were all well able to cope with this style and the end we were enjoying it. (EBQ)

In reflecting on this in an interview on the changes they had to undergo in order to get to the point that they enjoyed their mathematics course at CU Emanuel recalls,

... when we just arrived from high school (...), (Mr/s X) introduced her method of studying and teaching (...). And for that very first month we really hated her. But because she knew what she wanted to achieve at the end, we ended up in line with her method and we got linked into what she was doing. We were not used to discussing maths. First thing. So its like we go in class and then one of the questions that we never liked in maths is 'discuss', or ... 'explore', 'why?' 'what do you think?' And then, those are the main sort of questions that she always asked. (...) for example, if you have the inequalities, if I were to divide both sides by negative, I have to change the inequality sign. And then she asks why? And then we say, no we were taught that way! And then she is going to say, I want you to write the whole page, full page, try to prove why do we change the inequality sign. And at the end we just say to ourselves, you know Mr/s X, she thinks everything is logical, we were just taught this way and we were never taught how to do this. And so now, the way it was happening, we then asked ourselves OK, what then? Because, no matter how much we complained, it was not stopping. Everything was increasing. And at the end we realised, you know, Mr/s X is here to stay, and as we need to think, you've got to think! And so I think with time you then learn to know the method, (...) and we had to grow to discuss within, among ourselves. When they said discuss now, we know what to do. (...) as time goes, it really helps. (IAT-E3)

Here we see have a description of how he had to change to cope with the new practice at CU. We see that this change is based on the way Mr/s X modelled maths teaching and the pedagogy that is connected to it. He was forced to think deeply about any particular piece of mathematics to uncover its meaning. His learning curve here is related to the change in the pedagogic modality: discussion based learning; and, a change in his conception of what mathematics is all about: a focus on reasoning and hence developing conceptual understanding. Emmanuel's reconstruction of this change in his pedagogic identity with respect to mathematics learning and mathematics teaching identifies Mr/s X's perseverance in socialising them into her method as the key. They *hated* it at first, but later *loved* it.

Emmanuel gives us some detail related to each of the mathematics courses he has completed thus far in his university career. He enjoyed the geometry course in first year most since "it taught me how to deal with geometry and also how to teach it in such a way that learners will

understand it better” (EBQ). He mentions some of the details, in particular that he learnt about “the way in which we can lay foundation in geometry” through practical work (“cutting papers”) and theory (“van Hiele levels... how to develop each level in a learner together with identifying the levels learners are at”). He does not mention the ideas of Geometry nor the notion of proof or higher reasoning here – his focus is on the foundations and practical aspects of laying these. What he is identifying with here appears to be the practical aspects through which analysis of specific properties of shapes and relationships can be explored, that is, with using visual/ practical/ concrete metaphors to develop basic geometric facts and knowledge rather than geometric reasoning as such.

However, mathematical reasoning is the central focus of the second year Calculus course. Emmanuel writes about the calculus course as “the most challenging” – again this is not because of the content (he was already very familiar with that having studied at the technical college) but rather

the method of approach was different. I had to learn to reason with the definition and also to learn to explain definitions in my own words. As a second language speaker of English, this was very hard. (EBQ)

Emanuel emphasised the importance of conceptual understanding (“it brought a new understanding of calculus”) and on how understanding is linked to the development of confidence for teaching calculus. For Emmanuel, Mr/s X is a major influence on his development and is instrumental in the development of his changed view of maths learning, through her modelling pedagogy for teaching and learning mathematics in her lecturers.

That this is an important aspect of mathematics and learning mathematics is reinforced by Emmanuel’s description of the four most important mathematics concepts/ ideas/ processes that an FET mathematics learner needs to know. His immediate answer is “Ah! The mathematical strands.” This is significant because he is referring to a specific mathematics education resource (Kilpatrick et al., 2001) which he recognises and identifies with mathematics in-itself. When he is probed on this he responds by saying,

Em: Like the conceptual understanding, the productive disposition, adaptive reasoning, I think those are the main important things. Because once you know them you’ll be able to move on with what you are doing. For example if learners learn to appreciate the maths then they will be able to move on with it. Um, be able to have a positive attitude towards maths, which I think right now is the major problem that we are having as maths teachers, in the learners. And they need to be taught to understand maths and not to memorise maths. Problems like those you normally see them, that deals with geometry. For example, myself, when I was still in high school I memorised geometry, only to find out that in the long run you are going to have a problem. Because you memorise, and now you need to really really dig from within, which is one of those things. And be able to apply. I think being able to apply maths, it really helps. Then you be able to know the use of maths (...) I

think the conceptual understanding (is the most important). Though we need to start with the productive disposition, whereby we groom learners into loving maths, as it is.

Di: These are not really ideas, are they? I mean how would you teach them those as mathematical ideas?

Em: Ok. With conceptual understanding, (...) how I can introduce that is through a form of a story. For example, if I want learners to appreciate maths, one of the things that can happen, is this story that I am normally told – about this lady, whom every time when he cook a lamb, he cut a half and then throw it away and then he cook the right hand side. And then one day his son asks him why and he didn't know why and he said, my mother used to do it this way. And then they went to their mother and the mother said my grandmother did it this way. And when they went to the grandmother the grandmother says no its because we didn't have a fridge so it was going to be wasted. Had they knew they were not going to throw it away. Then they are going to have to understand the concept of why are we doing it. And the only way it managed to work now is because somebody questioned it.²¹⁹ (IAT-E1)

We see here that Emmanuel's conception of conceptual understanding in mathematics is related to asking questions. Why do we do this? What are the reasons? Is this something that is following a tradition that has no meaning? What is the meaning behind this? In pointing to the 'mathematics strands' Emmanuel is not identifying any specific aspects of the discipline of mathematics, rather he is identifying with a perspective in ME that is focused on what have been referred to as *mathematical practices* (for example see, RAND, 2002), which are more focused on the specific regulative elements of learning mathematics than on its contents. His specialisation into mathematics at CU appears to be one that has developed his relationship with the processes involved in doing mathematics rather than with the content of mathematics itself. What is important is to "really really dig from within" to reach conceptual understanding. Learning to dig from within is what learning mathematics is all about. It is what develops interest in and love for the subject. Although, he adds, knowing how to apply it also helps.

In his biographical writing of his mathematics career while at CU, Emmanuel also mentions the "most boring course" he has ever done - the compulsory course, 'maths in teaching concepts'. He explains,

they teach us the history of mathematics and how to introduce some of the topics. The boring thing is when you find them teaching at the level of the learners. Using some posters and charts to show us how to add fractions. I think one of the reasons I am at this university is because I had done that well and there was no need for me to do it again. (EBQ)

This complaint of being taught at the 'level of the learners' appears to cause Emmanuel some frustration. While the FET specialist mathematics courses are not like this, the compulsory mathematics courses have this feature as do many other courses taught across the curriculum as a whole. He expresses his frustration at having to waste so much time in these classes

²¹⁹ This is a story circulating in ME circles, although he has it a little confused. The reason for cutting the side of meat and wasting part of it is usually connected to the size of the pot or the size of the oven the grandmother uses. Emmanuel's retelling is not logical! Why not cook it all if there is no fridge?

because they are compulsory and his DP depends on attendance. Their time table is so full and they find it difficult to find the time out of lectures to do all the necessary work and assignments.

While Emmanuel generally represents himself as an able and committed mathematics learner through his writing and talk, he found that during the discussions on the ideas underlying aspects of the NCSM statements that he was unable to provide coherent conceptual explanations or examples. While he became a little agitated at this, he felt mostly at ease, recognising he was only in 2nd year and expressing confidence that by the time he completed the B.Ed he would have deep conceptual knowledge of all sections of the mathematics curriculum.

Emmanuel's descriptions of his specialisation into mathematics through his career at CU as an orientation to mathematics that mainly favours orientation (3) identified earlier in the analysis of the NCSM, but also orientation (2). While other orientations may be present this is the overwhelming focus: mathematics for induction into mathematical practices; and mathematics as useful and applied to problems in a variety of contexts.

In writing about learning ME at CU, Emmanuel tells us that this is dealt with in the best course he is doing, the curriculum course that focuses on teaching maths:

It is helping us to become better maths teachers. We use different kinds of theories and learn maths and how to teach, assess and cope with it. (EBQ)

We see here an account of highly integrated learning, a focus on ME (use theories), M (learn maths) and MT (learn how to teach, assess and cope). In the final interview, when he was asked specifically what he had learnt through mathematics education theory, he emphasises that,

what I've learned is teaching is not just teaching. It's an art that needs to be portrayed and when you stand in front of the learners you need to be knowing what you are doing, not only in terms of the content, but knowing how to teach and those are the theories, but the theories that I'm getting here is the theory that teaches me to be a better teacher. (IAT-E3)

It appears that the theory that he has acquired is focused on how to teach. When probed to reveal what he means by this he explains,

Like teaching how to assess. Before, well, I used to think assessing is only about you give them a paper and I just mark what's right and then what's wrong. And now I've learned that it's not only about marking it's all about learning the learners. I learnt more than learners during my assessing. I learnt to know what is it that learners are struggling with, not only one learner individually, but the class as a whole that become common errors that learners make I learn that before I even start teaching the section then I'll be able to deal with it before I even go there. (IAT-E3)

Here Emmanuel is specifically pointing to the importance of him knowing what common learner errors and misconceptions in school mathematics are and how to use these in his teaching. When probed further on the basis of this learning, particularly what resources from the field of mathematics education research he has been introduced to, he suggests that his learning in the curriculum course has not really focussed on reading research, but is more practical and grounded in experience:

Em: You know what they do they bring something that the learners have done from the schools and then we assess it ourselves and then we discuss about it, what went wrong what would be done in this paper, what the problem the learner has. (...)

Di: So you are not actually looking at other research that other people have done and say well this is ...

Em: No, not really. (...) I think even our lecturers experience it even helps but most of the things we learn it from (...) looking at (...examples...) and when you go on school experience again you go with an assignment based on that. (IAT-E3)

When pushed Emanuel agrees that they have studied ‘the van Hiele levels’, ‘the strands of mathematics’, and the idea of ‘relational and instrumental understanding’. He suggests that when they observe teachers they look for their methods of teaching to try and see how they teach reasoning, because as student teachers they are going to have to work out “how do we teach as if we are not just gonna stand in class and distribute the knowledge”. (IAT-E3)

While Emmanuel can identify a number of perspectives he has encountered during courses he finds it hard to recognise the theoretical grounds on which his own mathematics learning in the teacher education class is constructed. He recognises however that

we are being encouraged to use relational understanding (...) even when we go for school prac when teachers, when lecturers come they expect to see (...) in action. (...) being able to make learners discuss maths, yes. (IAT-E3)

In focusing on his MT career through teaching practice experiences, he writes:

Teaching maths has been an enjoyable experience. I have learned to cope with the learners and also to understand them. (EBQ)

While Emmanuel is only in his second year of study, he writes as if he is now experienced.

Going to school experience helped me realize that learners are not as empty vessels as we portray them but they have enough information that can carry one lesson to the other. All they need is to be given a chance and they will be able to show it. Through assessing them, I have realized that for every wrong answer they give, they have clear explanation for it and it is not all about marking them wrong but understanding where they are. (EBQ)

Notice how retelling of his practice experience reveals his university learning for which, he argues, he finds evidence in practice. *Learners are not as empty vessels*, is a typical statement related to a constructivist/ competence based discourses. What follows that phrase reinforces this. These sentiments could be located in discussions about constructivism in ME or

recontextualised from the competence discourses associated with the new curriculum and circulating more generally in the education context. BUT the last sentence here tends to support the first possibility – as it picks up on the idea of using misconceptions, a feature of pedagogic constructivism, that appear to be a common ME practice at CU.

Emmanuel, reflecting further on his teaching practice experiences, writes

I learned that, knowing the content is not enough to make you the best teacher. There are many things that need to be understood before you can become a teacher. You must know your learners, why they get wrong answers and what makes them confused. How to match their level as you teach and not just teach because you know how to get the right answer. (...) One of the major problems is dealing with the issues of discipline but you always make it if you know your learners. You should be able to detect why they do what they do, if they are loud, what is causing that and how do you deal with it. Teaching is an art and not just a profession. For you to make it you must be talented and be eager to learn at a daily basis. (EBQ)

Notice how Emmanuel does not refer to his experience in the same way that Karyn and Sonny did, he is far more removed. He seems to be referring to his view of what his experience should teach him rather than his actual experience out in a school, which may be connected to the fact that he is less experienced (only in 2nd year), or to his specialisation into mathematics teaching through a focused learning in the curriculum course. This view of what practice ought to be can be characterised as: as a teacher you must know the maths, you must know your learners, you must listen to your learners so that you can find out what they know and can follow their thinking so that if they go off track you can help them by working with their misconceptions. He also did not express the feelings of alienation that Sonny had in relation to practicing in Model C schools²²⁰.

On looking back at Emmanuel's description of his ideal mathematics teaching practice, it becomes apparent that he is modelling himself specifically on Mr/s X, and that his ideas related to the ME theory he explicitly refers to from his courses are underpinned by a competence-based discourse that he does not consciously recognise:

Normally I always see myself standing in front of the learners who are there, who need to be guided in order to reflect on their own knowledge. (...) how I see myself in the classroom is, these learners know something and I'm there to make it to the point that they are aware that they know it. And the only way to do that, if I stir up the passion in them to be able to reveal it. Yes. Though sometimes you find that what they don't know, I'll be able to add on it, but most of the thing, I think its all about using the information

²²⁰ In the final group interview all the participants had presented aspects of their careers that had been significant to them in their development as mathematics teachers, and Sonny had expressed his feelings about practice teaching as described earlier. After the meeting I gave Emmanuel a lift to work and he indicated that he didn't think it was appropriate for Sonny to bring all of that up – he felt that these issues had been dealt with. However he did say there was a problem because not many of the lecturers would go into township schools, although Mr/s X was one who would. He himself had never been to a township school for practice teaching (done 4 school based practices so far), but that was not a problem because he had been in school in (the township) so he knew what happened there. Also Mr/s X was careful with the schools he selected for experience – Mr/s X knew his problem with English so sent him to schools where he would be accepted.

that they have to bring what they are supposed to be – that I want them to know, or be aware that they know it. And, how do I do that? How I have noticed it? (...) Over the years, I have been looking at Mr/s X. With Mr/s X she always comes in class and something that we never thought like we can discuss it, ask questions so we can discuss it, there were so many things that I said to myself, god, this thing its being done by grade 9's but I can't do it right now. And somehow, I know it but how come I can't do it now. And more and more if I engaged into that thinking and dig myself into it, I always find out that I can do it. So I think it is all about being able to facilitate them, lead them to the right direction. (IAT-E1)

Elements of the logic of competence as discussed in Chapter 4 come out strongly in this piece of transcript. We also see how for Emmanuel what is most important is developing a relationship with mathematics – to become *passionately* involved, to dig deeply within oneself to find what you already know and to bring it out, make it more explicit. The teacher's job is to facilitate this revelation. This is different from the constructivist ideas recognised in Karyn and Sonnys' narratives of constructing meaning. The learner already *knows* most of what is to be learnt. The teacher may have to add some content to this sometimes, but mostly it is about making the knowledge explicit through specific forms of reasoning, in a sense teaching how to reason.

In conclusion, Emmanuel presents himself as someone who in his earlier life was motivated by praise and recognition of his abilities by others which motivated to love maths early on. However, during his university career this love has deepened, and now he projects himself as a passionate mathematics learner who digs deeply to work with mathematical ideas and develop conceptual understanding. Thus his motivation is now mostly intrinsic. His mathematical identity is strongly invested in mathematical practices developed within the 2nd year B.Ed mathematics classes at CU. He wants to be a teacher who is *not* teacher centred. He presents himself as someone who: allows learners to actively participate in classroom discussions; listens to learners' explanations and assesses their productions, is able to understand the way learners think, evaluate their thinking and use it for improving teaching and learning. In addition, he wants to be someone who makes maths relevant to the everyday lives of the learners he teaches through applying mathematics to problems and using practical/concrete aids to help develop concepts; who generally works at the level of conceptual understanding in the classroom and therefore builds strong foundations for further learning; and who will be fair to learners.

Emanuel identifies strongly with his lecturer Mr/s X and models both his mathematical practices and teaching practices on what he has learnt through interactions in her classes. He is explicitly aware of some ME theory/ research underpinning his view of mathematics learning and teaching, however he is not yet committed to ME as a field in itself. His

identification with ME is mostly through its use value for learning how to teach, and much of what he has had access to through this learning is based on experience and practice. He expresses a clear commitment to a competency-based pedagogy, which at this stage is mostly grounded in reflections on his own learning experiences in Mr/s X's classroom: he recognises himself as reflected in the model of mathematics teaching that Mr/s X uses.

2.4 Nicole's story: teachers must make mathematics interesting and stimulating

Nicole is a 21 year old 2nd year white female B.Ed student. She matriculated at an ex-model C school in a neighbouring city. Her mother works in the IT sector and her father is in sales. Her background can be described as relatively advantaged within the South African context.

Nicole's discussion of her locational career includes a number of institutional settings: her high school where she completed her matric in 2001 with a HG C+ in mathematics, another university in at which she studied sport science the year after she completed matric, and finally CU where she enrolled to become a teacher in 2003. While at CU she has also had experiences at some schools while out at practice teaching.

In presenting her motivation for becoming a teacher, Nicole tells us that

Since I was young, it was always my dream to become a teacher. Mathematics was always my favorite subject at school and I was disappointed when I didn't do very well at it. The reason for this was because I was lazy at school and always felt that the teachers did not make maths very interesting and stimulating. So I decided that I would become a maths teacher and change my view for the learners of the future. I would like to contribute to the enjoyable mathematics experiences. I also feel that maths is an interesting and challenging subject to teach, so it would mean that my job is never boring and stagnant. (NBQ)

We see in this a retelling which positions Nicole as someone who has chosen teaching – she did not 'fall' into the profession by default – she always wanted to be a teacher. We also see that choosing to do mathematics had to do with the fact that it was her favourite subject at school – so her attitude towards it was positive – even though she did not do as well as she had hoped she would in matric. Objectively, in the context of school mathematics achievement in South Africa as a whole, Nicole did very well in mathematics, and in the context of this study had by far the highest school mathematics achievement of any of the students in the sample across both institutions. However she positions herself as having failed, or not having achieved to her potential. She justifies this sense of failure by apportioning blame to herself (*I was lazy*) and to her teachers (*they did not make maths interesting and stimulating*). We see in this two foci for what *ought to be* with respect to

school mathematics: learners need to work hard to succeed in mathematics, and teachers need to present mathematics in an interesting and stimulating way to catch learners attention and keep them involved.

In her discussion of her high school mathematics learning career, she reveals that in the lower grades “I never got less than 80 % ... and I never had to open a book before a test”. She simply ‘saw’ what had to be done, found it easy and really enjoyed it. She suggests this enjoyment was rooted in the nature of the subject itself, “because it was a subject that had definite right and wrong answers. I hate any subjects that are opinionated and have more than one correct answer” (NBQ). For Nicole, more than any of the other good subjects of CU, mathematics is a discipline with clear boundaries and a strong grammar.

While this view of mathematics sustained her through the first few years of high school, Nicole tells us that from Grade 10 it could no longer be sustained. She relates,

... when I reached Grade 10 my views about mathematics started to change. Beside the fact that the work became considerably harder, the teacher that I had also made it more difficult. She would constantly start teaching something, and then be unhappy about the way she taught it and re-teach it. This confused all of us, as we never knew what the correct way was. Due to the fact that I had never opened a book in grade 8 and 9, I had become a lazy maths learner and had got into the routine of never putting effort into mathematics. My marks still remained above 80% but I never really understood or grasped the work properly. I started to find mathematics a bit boring. I managed to survive grade 10, and the same habits of mine persisted in grade 11. However, I couldn't maintain those distinctions anymore always getting in the 70's now. In grade 10 I had actually missed out on a lot of important skills or concepts and now I was battling a bit in grade 11 because they were necessary for the grade 11 work. I started to lose interest in mathematics and put even less effort into it. Once again, I place some blame on the teacher because her class was so boring. The entire class could sense her boredom of teaching and each and every lesson followed the same pattern. There was never any excitement or enthusiasm in her classes. Grade 12 arrived and we were blessed with an amazing mathematics teacher – Mr. Phillips! This guy really knew his stuff and his lessons were fun. We started to enjoy going to mathematics. There was only one problem – for two years I had not really understood mathematics and it was a bit late to try now. Although I did follow what he was teaching, when it came to applying stuff from grade 10 and 11, I was lost. (NBQ)

Once again we see that she shares the blame for her perceived lack of achievement in mathematics with her teachers. In this story we also can read her current position with respect to mathematics teaching and learning. Teachers ought to be clear about what they are teaching and make sure they teach the ‘correct’ methods so as not to confuse learners. They should make sure mathematics learning is not boring and they need to keep learners’ interest, by being enthusiastic about their subject, trying out different ways of doing things and creating excitement in the classroom. At the same time learners must put effort into their work and develop habits in their mathematics learning that enable them to stick out the difficult times and work hard enough to develop understanding of concepts. She also reveals her view of mathematics as a subject that has very clear methods and ways of doing things to

get specific solutions, and that is built conceptually and requires the development of skills and progressive learning of concepts.

Nicole's discussion of her mathematics career at CU reveals that it has changed her consciousness in a significant way; in particular, it made her aware of mathematics as something that she needed to engage with through deep thinking. She recounts,

The first day of mathematics at university was scary! We were given a task to do in any way that we found possible and to write up a report. For the first time in my life I actually had to think about mathematics. This was really difficult for me because it was not in my comfort zone. However as I started to work, I really enjoyed what I was doing, and mathematics became my favourite subject at varsity. This was the Mathematics for Teaching A course with Mr/s X, and we all thought she was amazing. The course was fairly simple but still very interesting and we all started to fully understand mathematics. We were exposed to a variety of teaching methods and ways of learning mathematics and all benefited from it. Mr/s X proved that anybody could do mathematics! (NBQ)

Her identification with Mr/s X is reinforced throughout her biographical writing and the interviews and connects directly into her relationship with mathematics and mathematics teaching. In her story of her CU mathematics career she takes us through all the courses she has completed thus far giving details of what she *enjoyed* and what she *hated*. The geometry course they did in the second semester in first year was "still very enjoyable but not as stimulating as interesting as" the first course with Mr/s X. She suggests this was

Partly was because it was geometry and nobody really likes geometry, but also because we had some different lecturers to Mr/s X. We had got used to her style and efficiency and all of us demanded to understand the "why's" about everything - and when some of the lecturers couldn't provide them, we were not impressed. (NBQ)

However while she saw the content learnt in the geometry course as useful, this was not the case with the compulsory first year Mathematics for Life course. Nicole found this to be very easy, not stimulating, covering basic school mathematics that a student with reasonable matic mathematics already knew well, and very drawn out. She emphasised,

Personally, this course could have been sped up and done in a two or three month course. This is a feeling I have about every course at the college of education because they really spoon feed us and treat us like schoolchildren! (NBQ)

During the various interviews Nicole made this point a number a number of times. Her experience at a 'proper university' (in the year she did the BSc in sports science) gave her a view of what university learning ought to be, where students were given responsibility for their learning, whole chapters were covered in a week or so, and where there was time outside of the lecture theatre to work independently and with others to digest the material. She expressed frustration with the way things were run at CU, with the slow pace of learning, the lack of time outside of lectures to work independently, and with being treated as if they were school children themselves by many of the lecturers. However she made it clear that this was

not the case with Mr/s X, who, while he may not have covered the material at a high pace, made it worthwhile because of the depth of their exploration and his insistence that they had to understand and think deeply about what they were doing at all times.

She continually refers to the influence of Mr/s X in the development of her mathematics career. Her relationship to mathematics and her enjoyment of courses is directly attributed to his way of teaching.

The first semester of second year was Mathematics for Teaching 103. I thoroughly enjoyed this calculus course and did not find any of the work or lectures boring. The course answered so many of my questions about mathematics and the skills I learnt about learning and teaching mathematics was endless. I was sad when this course was over - I could have carried on with it! Mr/s X was once again our lecturer and this played an enormous part in my enjoying of this course. If it were not for him, many of us would probably have found the work difficult. Mr/s X just proves that a good teacher can make all the difference. (NBQ)

That it is Mr/s X that makes the difference is reinforced by her description of the other two mathematics courses done in her second year. One was taught by Mr/s Z (Linear Algebra), and while the work was relatively easy,

the lecturer we have does not focus on the conceptual understanding of things and we find this really difficult to cope with. Many of us demand to know why we are doing something, we are not satisfied just knowing the method. (...) I am not enthusiastic about it. (NBQ)

The other is the compulsory Mathematics Concepts in Teaching course, which she reveals she hates. The reason for this is also connected to the lecturer, Mr/s W. As Nicole relates it,

I am not sure which is worse - the course or the lecturer. We have been stuck with Mr/s W who although might know her stuff, is incapable of explaining, she cannot answer questions that students ask, and when this happens she just ignores the question and moves on. Many of the maths major students actually show her up in the lecture, and we should actually be learning from her (...) it has been a total waste of time. It is no wonder that so many of the students hate mathematics. (NBQ)

Nicole's retelling of her mathematics learning while at CU reveals how her relationship to mathematics is very connected to her relationship with her lecturers and the pedagogic mode that is implemented in the teacher education classroom. Being stimulated to learn mathematics and to be personally invested in it is connected to the way it is presented and taught, and particular to an approach developed by Mr/s X that focuses on conceptual understanding.

While Nicole's story above reveals that personally for her it is the relationship with mathematics that counts, when she was asked what she saw as the four most important mathematical ideas/ concepts/ processes that a FET learner should know, she focused on the content of mathematics:

- Nicole: I think lots of emphasis should be based on geometry because most even grade 8 and 9 don't understand geometry I think we have to adjust the way we teach geometry because it's actually, geometry you can use a lot, so I think more emphasis need to be placed on geometry. And I would say more on Calculus because people going to B.Sc a lot of the time have done Calculus at school but don't really understand it. And then there are certain things like I don't see its worth, like linear programming. I don't know why they do it (...) And also probably maybe more word problems because that's if you (...) maths at school it's not gonna be a sum, it's gonna be a word problem that you are gonna solve and most kids can't.
- Di: I want you to just maybe rephrase that again because what you've talked about here are topics. (...) what is it about geometry what are the fundamental ideas (...)
- Nicole: I think, geometry for me it can be approached from so many different angles and you need to teach learners to think for themselves and given that, in their own heads, see what's being asked. Cos it requires them to think a bit more. So I think we want to get learners who are more like creative, (...) if they can in their minds visualise what's (...) so if they say an angle is obtuse, visually they need to be able to see (...and ...) say, ok, well look what I can see because of these sort of reasons, so like getting to those concepts (...) and like a logical process and putting them together.
- Di: And for Calculus what would it be for Calculus?
- Nicole: I would just think more of an understanding of Calculus because we've done a lot of Calculus now and when I was at school I actually didn't really know what it was about, it's Calculus actually if you know what it 's like there's so much that you can do with it. (IAT-N1)

Nicole is justifying her selection of topics from her view of herself as a school mathematics learner from her current perspective as learner teacher: geometry is important because it is not well understood at school (and we saw earlier that “nobody likes it”) and what needs to be focused on is geometry that can “you can use a lot”, which for her is connected into visualisation as a basis for developing reasoning; Calculus needs more of a focus because learners at school don't understand it and it is important for further study; and her learning at CU has shown her how useful it is to understand it; linear algebra is a waste because she has no understanding of it or its use; and word problems are important because that is part of what you are going to have to do in the new curriculum.

In this reconstruction Nicole reveals her past pragmatism, maths that has use value is important to focus on, and her new view that reasoning and understanding is important in learning mathematics. This focus on understanding came up again and again in Nicole's account. When questioned about what she saw as most significant in her CU mathematics career, Nicole once again reinforced this:

- Nicole: I wouldn't say there's one thing. But like our Maths Course in Education C, I thoroughly enjoyed that. But there wasn't one thing that grabbed my attention but that course (...) our Calculus course, I loved it. I could still be doing that now, because we did so many interesting things and we all got into the idea of discovering it and working and trying to make sense of it ourselves. I really loved that course.
- Di: So making sense of the Calculus was something that was very inspiring for you?
- Nicole: Ja!
- Di: And that sense making, was that sense making mathematical or related to the real world or what?
- Nicole: No mathematically. Because like Mr/s X would like say, okay look at this theory and try and make sense of it. And we'd draw diagrams and (...) and eventually when we had made sense of it without him even telling us and we would present what we think. As a class we'd come to make see (...) that actually in our minds it's so easy, and I really enjoyed doing (...) For my

Calculus course well I don't even think I opened a book for the exam, but the way we had done things, I understood it like if you woke me up in the middle of the night and ask me to explain that, I can. And that is why I really enjoyed that course. (IAT-N3)

Considering Nicole's orientations to mathematics in terms of the earlier analysis of the NCSM, we recognise within the narrative thus far a commitment to orientations (2), (3) and (4), that is, to the use and application of mathematics, to mathematical thinking and practices, but also to skill within the specific contents of mathematics.

In her explanations of her commitment to mathematics we see Nicole identifying strongly with Mr/s X's pedagogic practice – one that insists that learning mathematics requires the learner to work mathematically at a conceptual level and to be able to explain it to others to reach an understanding. This identification with Mr/s X is carried over to her career in mathematics education and mathematics teaching. Many of her ideas and ideals about ME and MT are connected into her experiences within Mr/s X teacher education classroom. His method of teaching is the preferred method; she presents him as a role model for what she would like to be as a mathematics teacher. In the Curriculum 103 course these ideals are reinforced. Nicole writes that,

One of my favorite courses at varsity (...) is the curriculum studies that is aimed at mathematics teaching. We learn so many interesting and helpful things about mathematics teaching and learning, and I can actually see the difference that this course is making to my teaching. The lecturer once again plays the huge part here because she is so passionate about producing super mathematics teachers. (NBQ)

While Nicole sees this course as being of great importance she does not recognise what she is learning here as connected to ME. She sees it as helpful for developing her MT consciousness. In attempting to probe her specialisation into discourses from the field of ME research in the third interview, she was asked explicitly,

Di: ... do you think there's a particular theory or theories that you are using to think about mathematics education?

Nicole: Not really, but (...) they are definitely trying to get us away from, to stay away from the routine that we've been used to because all of us come out from the like old system (...) all of them are trying to move away from that sort of approach and they are trying to move to a different approach.

Di: ... how would you describe that approach? Could you give a name to that approach?

Nicole: More like outcomes based, you know, you are discovering things, not as rigid as, and like (...) the lecturer kind of lets learners take part of where the lesson is going, so she's not like saying it has to go like that so that's the only way (...) Not that you kind of distract (...) the lecturer from what she's trying to, but our ideas and stuff are not brushed aside.

(...)

Di: Have there been things that you looked at specifically, that other people have researched say, to help you think about your own teaching?

Nicole: Not so much, well not a lot of it (...) but I did a geometry course last year that placed a lot of emphasis on the van Hiele levels (...) and I think that was quite helpful but not really theory (...) educational theories that we mainly deal with are in our education courses not in maths and stuff.

Di: Have you talked about the application of those educational theories in your maths teaching?

Nicole: No, no, I have like, you know, when I'm doing something, thought 'Oh! That's, that psychologist did say that something', but the lecturers haven't like applied it. (IAT-N3)

When pushed further Nicole recalled a few readings that she had done, but none of them seemed to have had a lasting impression. She explicitly describes the basis for her mathematics teaching practice as being located in her experiences as an aerobics teacher,

(...) I always try and get a concept across (...) in a context they can understand. So take something really, really simple and then try to build onto it. Like when I was teaching factorisation to learners I try start off by asking, I gave them two binomials to do (...) because that's something that they could do, and then I asked them what is the difference between what they've got. And then that's how I would try to teach, they were stepping stones even if I thought it would probably take me half of the time to just quickly show them how to factorise a binomial they understand it better in that way. (...) I teach aerobics (...) it's like teaching a dance, you just never show them the difficult steps. You start off with two steps that they know how to do and you slowly adjust, so that is what I would with the teaching (maths), but I think I got it from (...) teaching gym for a long time. (IAT-N3)

The focus on getting the concepts across is a reinforcement of Nicole's commitment to 'conceptual understanding'. However the approach to introducing the steps appears to be focused on something more, at the same time developing procedures and skills for carrying out specific operations. This fits with her description of the most important aspects of being a good mathematics teacher that she described in the first interview:

I think, well judging from what I've learned here, definitely a teacher that doesn't just teach the procedures and must teach the understanding. I think more emphasis should be placed on understanding you know than procedures. I also think, like because kids get bored very easily, you need to have like a variety of teaching strategies that they never get used to (...) like a dance that keeps them on their toes and it like keeps them interested. (...) definitely some of the stuff that we do in maths is like just a session of just like problems. I think that they should (...) say if well we are gonna work with this problem of, let's say they are building this house, so we'll work with trigonometry with the angles and a bit of you know maths calculations, getting away from the whole idea of ok today we are just doing (...) 25 sums. And I think a teacher that is going to be understanding because (...) especially now there's a lot of different cultures and levels of learning because some of the kids have been to, you know, decent schools their whole lives and some are just coming to the system later. (IAT-N1)

Nicole is also very positive about her learning experiences while out on practice teaching. In her mathematics teaching career she has been to practice in schools four times, two of these experiences have been focused on mathematics teaching. She tells us that these experiences have been the most important part of her education as a teacher so far. She writes,

My teaching experiences of mathematics have constantly improved at each practical. Each time I think I am doing really well until the next practical when I see how much I have improved. However, I do not feel that we improve because of what we learn at college but rather because we become more comfortable and confident with our teaching. As we are exposed to new ideas, we try to implement them into our teaching. The school experiences are the best way to learn because you are not just given all this theory - you physically have to do the teaching. Dealing with the questions that the learners ask is not always easy because sometimes you have not prepared for such a question or it is a section that you are not so familiar with, but this forces you to brush up on their school mathematics. Also, it is not always as easy as it looks to convey even the simplest concept to a class of learners. It requires so much thought and practice and therefore the more teaching experience we get the better. I feel that we learn much more on teaching experience than at college and more time should be given to this. (...) Not all of our school experiences are positive because it largely depends on the school and the teachers you are working with. However, there is always something new to learn and some times you actually learn more from the bad experiences than the good! (NBQ)

Here we see some rather contradictory statements. Clearly Nicole puts practice up front and suggests that it is the key to learning to teach – but we also see that the new ideas she wants to try out are based on ideas that have been presented to her at CU. Her consciousness as a teacher constructed specifically through her experiences in the mathematics teacher education classes is the basis of the ‘thought’ on which the practice is to be built, and yet she explicitly downplays this.

In her description of her ideal mathematics teaching practice in the very first interview, Nicole told us:

Nicole: I imagine the kids saying I am a very good teacher, they obviously respect me (...) a relaxed sort of setting but obviously the learners are willing to learn and put the effort in, and like, the relationship that I’d like to have with like my learners, is obviously a professional relationship but also quite a friendly relationship. I want them to feel that they can come and approach me and I also think that if you’ve got that sort of relationship with the kids it makes your teaching, because as much as they know that they must listen they are gonna try their best to test you all the time (...) and you know you will listen and respond to them. I don’t wanna be like pressurised most of the time. (...) so make it like more an open sort of maths class. Obviously there are other things, all the work and time, but also show the integration between things, and don’t be like, ok, we’ll do this for a week and move onto that. You know it should be something that will take lots of practice to get it to work like that. (...) I’m influencing the kids. I wanna influence them positively, but I also cos there’s so many kids that I know that are actually just hate maths and I’d like to change that. You know that obviously all depends on your skills and the manner in which you have with the learners. I want, I’d like them to actually enjoy maths (...) because maths is quite nice.

Di: (...) If I’m a fly on the wall what would I see?

Nicole: Ok, (...) I would say (...) groups of four, like desks and stuff. I’d have the blackboard and overhead projector but a lot of the teaching probably wouldn’t be done by me just writing on the board. I’d have worksheets, you know little workstations that they are gonna work on in more of like a friendly sort of way in their group, (...). Like, there’ll be lots of posters and interesting things to look at in the wall (...) stuff like that. (IAT-N1)

Nicole appears to be convinced that open relationships are a key to effective mathematics teaching. She believes that by creating the right classroom atmosphere she will be able to get the learners to work together on task, which she sees as a key to their learning. She sees understanding in mathematics as being built up over time through integrating different ideas. However, she is not so naïve as to think this is an easy process. It will take time, as she emphasises, when asked about the most important thing she has learnt about mathematics teaching at this stage in her career,

There’s a lot more that goes behind (teaching) than what it looks like. You kind of think a teacher just takes a textbook and that’s it. But there’s so much underlying all of that maths and the smallest things can confuse, because there’s (...) those ground level things that you need to get right (...) and I think to an effective teacher there’s a lot of prep and thinking behind it. (...) you can’t just decide ten minutes before a lesson that I’ll teach that. You really have to think about it if you want it to work nicely. (IAT-N3)

To summarise, in this account Nicole presents herself as someone who is able in mathematics. She sees mathematics as a subject that needs to be built progressively through a

focus on conceptual understanding. She recognises that learning mathematics requires effort and commitment. While her main orientation is to conceptual understanding in mathematics, she also sees its relevance as being connected to its use value through applications. While she is very positive towards mathematics, she presents a self who needs to enjoy her classes in order to be truly invested in and do well in a mathematics course. Her enjoyment is connected to the interest and excitement that her teachers are able to generate towards the mathematics at hand and is sustained through a practice that focuses on conceptual understanding. If her teachers provide the right kind of environment and focus she excels in and loves mathematics, however, when the environment is more traditional and the focus more procedural she gets bored and tends to lose focus and not do as well. Her mathematics identity is strongly connected to the environment within which she learns and practices mathematics, and this is generated through identification with experiences in Mr/s X's classroom.

Nicole's ideal of what mathematics teaching and learning should be about is directly connected to Mr/s X's practices, in particular the use of discussion to assist in the development of conceptual understanding. Nicole has little investment in ME as a field of research and a basis for understanding teaching and learning and is largely unaware of the discursive resources that underpin the practices that she identifies with in Mr/s X's classes. Her MT identity while clearly invested in a focus on developing conceptual understanding in mathematics and influenced by the pedagogic model instituted in Mr/s X's teacher education classroom, is also rooted in her prior identity as a gym teacher, where she has developed particular practical skills that are transferred into her mathematics teaching.

3 Identity formation and Identification within the ideological field generated at CU

As indicated in Chapter 9 I do not have the space here to do a complete and comprehensive analysis of all the information collected, rather I choose to focus on some points that enable me to provide insight into pedagogic identity formation within the institutional context. This section therefore examines patterns in the narratives produced in the previous section in order to identify discourses circulating in the ideological field generated at the CU within which the pedagogic identities of the good subjects of the institution converge/ diverge.

Firstly, it is clear that for all student teachers at CU their lecturer/ teacher *matters*. *How* they are taught in the teacher education classroom is directly related to their levels of engagement and enjoyment of mathematics. In particular we recognise that Mr/s X features strongly in all

the ‘good’ subject’s stories: they all identify strongly with her and recognise themselves as mathematics learners and as mathematics teachers within images modelled by her. In as far as Mr/s X has been a common factor in their development other specialist teachers have also contributed to this. Mr/s Y, while she is not seen in exactly the same light as Mr/s X, is also identified with positively. However, Mr/s Z’s pedagogic and mathematical practices, are rejected. This section therefore begins with an examination of the students identification with Mr/s X’s practice and the discourses that appear to underpin it. This is followed by a similar discussion focusing on Mr/s Z’s practices and the discourses they seem to reject.

It is obvious that the individual teachers have different socio- historical backgrounds through which their careers as novice mathematics teachers have been constructed. In particular we notice differences related to economic and class positions, to race, to previous advantage/ disadvantage in the context of differentiated schooling in SA, to gender; to language, and to individual experiences. At this stage no attempt will be made to make specific connections between these societal/economic positions and the identities projected, rather, an attempt will be made to map out a field of differences with respect to the individual teacher’s identification with the various discourses that come together through the mention of ‘Mr/s X’ and ‘Mr/s Z’ in their speech and writing. Through discussion some insights into forms of identification with M, ME and MT discourses within this site of teacher education practice will be illuminated.

The discussion so far focuses on those aspects with which the student teachers identify (either positively or negatively). The next move is to consider those points of breakdown in their narratives at which they were unable to articulate their positions and at which they became agitated/ emotional/ frustrated as they realised they lacked resources to enable them to engage intelligibly. These points of breakdown were mostly related to points in the interviews where the students were being pushed to discuss/ explain mathematical concepts underpinning specific assessment standards in the NCSM. Students were confronted with the possibility that they were ignorant of aspects of school mathematics. How the students reacted at these points of breakdown and issues that these reactions raise in relation to the mathematics teacher education context will considered and illuminated.

Thirdly, the focus moves to identification with official discourses circulating within the ORF represented within these student narratives. For example, discourses connected to the various

‘roles’ of a teacher within the NSE, to the orientations to mathematics as identified in the NCSM, and to some of the general features underpinning post-apartheid curriculum reform.

Finally the discourses illuminated in the previous sections will be considered in the light of some general features of the contemporary content of the distributive rule of the pedagogic device operating at a wider social level, as identified by Davis (2005). In particular three features are considered: the negation of boundaries (in social relations and in knowledge relations) and the consequent degradation of traditional authority relations; the hegemony of contemporary utilitarianism; the dominance of competence pedagogies.

3.1 Quilting points in the local identify field

3.1.1 Identification with discourses converging around ‘Mr/s X’

In all the narratives we find common threads converging around identification with Mr/s X.²²¹

The student teachers all enjoy the discussion-based pedagogic practice operating in Mr/s X’s teacher education classroom, although, at first they were challenged because it was outside of their prior experiences and they had to *change* to adjust themselves to it. However once they had become used to it, they project themselves as *fundamentally changed* – that is their *internal* classification has been reoriented so that new rules of recognition for what they consider to be legitimate mathematics and ways of teaching mathematics have become entrenched. The extent to which new realisation rules are internalised is not possible to identify from narratives, although some evidence exists that these are differentially distributed. Nevertheless, it is clear that their views of mathematics and mathematics teaching, developed over twelve years of being school mathematics learners, have been negated and new images and conceptions of what mathematics is and how it should be taught are now embedded in their consciousness.

In all the narratives we see a convergence around *understanding* as the major aim of engagement with mathematics. While there are some differences in which each of the students appears to understand what ‘understanding’ means in relation to mathematics, we recognise the dominant focus to be related to *conceptual understanding*. Connected to this is the pedagogic practice that is seen to enable access to ‘understanding’ in mathematics, which for all the students is modelled on Mr/s X’s teacher education classes. The common thread

²²¹ I am well aware that the student teachers in the sample were selected by Mr/s X and so in some way represent his/her ‘disciples’. From this point of view it is not surprising that they identify strongly with these practices. However I note that Mr/s X is the head of department and leads the whole department in its thinking and in this sense it is also not surprising that s/he represents key aspects of the ideological field within which the student identities are constructed.

within their narratives appears to be focused on the development of an environment which enables *mathematical discussions* which creates the conditions in which they are able to develop/construct conceptual understanding, i.e., a *discussion-based* pedagogic modality.

Identification with Mr/s X's practices therefore appear to converge around two key descriptors, *conceptual understanding* of mathematics and *discussion-based* pedagogic practice, although these exact words may not always be used in the narratives. While 'conceptual understanding' and 'discussion-based' pedagogy are descriptors around which the narratives converge, the individual student teacher's identification with the discourses circulating around these is not entirely uniform, and, within the field there are some similarities and differences.

Theoretically these descriptors could be described as representing 'quilting points' (c.f. Lacan) in the ideological fabric of the identity field in which all the good pedagogic subjects of CU construct arguments for themselves as mathematics learners and mathematics teachers. The place from which the arguments for conceptual understanding and discussion based pedagogy are structured form the symbolic basis of the individual student teacher identities, whether the identification with these is dominantly imaginary or symbolic. In what follows I will elaborate briefly on the field of differences generated around each of these key descriptors and hence provide an argument for the structuring of the identity field generated in the institutional context of CU and forms of identification visible within it illuminating aspects that may be of significance to the field of MTE practice more broadly.

3.1.2 Conceptual understanding as the focus of mathematics learning

What does *understanding* mean in these narratives?

For Karyn understanding involves 'uncovering the maths' – revealing the logic and structure of mathematics through working with the concepts of mathematics to solve problems; thinking 'creatively'/ using your creative side to solve mathematical problems and uncover meaning. Thus learning maths is a meaningful creative process that enables 'making connections' between different mathematical ideas. Relevance here does not necessarily mean focusing on everyday/ applied contexts. The everyday should be considered simply in terms of language – mathematics challenges everyday language. Understanding in mathematics enables a mathematical gaze with which to look at the everyday differently. Maths is relevant in and for-itself and there is enough within mathematics itself to focus on without bringing in the everyday.

For Sonny understanding in mathematics involves critical thinking rather than learning recipes. Learning mathematics is a challenge that involves hard work, systematic thinking, perseverance, time and diligence. Understanding is made possible if mathematics is made relevant to everyday life and making meaning is possible through engagement with problems and arguing for your method and solution. Concrete and visual metaphors assist in providing access to meaning.

For Emanuel, understanding in mathematics is related to making meaning of concepts (being able to answer, mathematically, why this is as it is) and seeing the links and connections between them (how they are related to one another). Learning mathematics is linked to developing *mathematical reasoning processes* that enable a learner to ‘dig deep’ within to reveal (make explicit) the knowledge that they, to a large degree, have already acquired.

For Nicole, understanding in mathematics is built through working progressively with concepts and focusing on the links and connections between them. It is developed through a focus on why (why we do what we do in mathematics and why it works) and making sense of the mathematical concepts for yourself. Although she privileges understanding, she also recognises that to do mathematics you have to know how to work with it procedurally.

What is similar between these positions is a focus on ways of *thinking/ processes* and *meaning making*. However within this similarity we can also recognise some differences. Karyn focuses on creative processes that enable concepts to be brought ‘out’ into the open so that connections and links between them can be made (‘uncovering’ mathematics). These creative processes are brought into play by solving mathematical problems/ tasks and always referencing them back to the context of the problem and the mathematical concepts to ensure that the solutions are meaningful. Emmanuel produces a similar view although for him it’s about ‘digging deep’ to bring out the meaning. And Nicole has a focus on ‘building’ conceptual understanding through making links and connections. Sonny is the only one in the group that appears to have a slightly different view: he wants to develop critical thinking by which he also means make connections between ideas, but for him it appears that this is more related to specific contexts (for example, geometry is important because it enables critical thinking, unlike algebra which is more bla, bla, bla – and the way to make connections and develop thinking and understanding is through the use of visual and concrete metaphors rather than the mathematics itself, for example the methods of proof.)

In all the accounts, mathematics is spoken about in terms of the students' individual relationship to the ideas and concepts. In terms of the literature reviewed earlier in this thesis we can recognise this in terms of Boaler's (2002a) and Boaler and Greeno's (2000) discussions of the different mathematical identities produced by two different pedagogic modes, didactic teaching and discussion-based teaching, and related orientations to meaning as received knowing and connected knowing.²²² These students do not focus on mathematics as a structured discipline to be directly learnt, rather they focus on unpacking the meaning within any specific piece of mathematics, developing their understanding of it and connecting it to other aspects that they already have access to. They are able to construct meaning and personal understanding by appealing to practices that have been instilled by Mr/s X in the classroom.

In these descriptions we see a focus on 'proper' mathematics – an uncovering of the concepts and theory of mathematics through working with definitions and problems. Connections between the concepts are uncovered through the discussions and mathematical arguments that are constructed by the students. While we see some conflict over the use of the everyday in learning mathematics (c.f. Karyn's concerns and Sonny's utilitarian perspective), there is some commitment to using and connecting mathematics to real world contexts. There is also within this practice a clear orientation to teaching – mathematics is being learnt for the purpose of teaching not necessarily as a practice in-and-for itself.

While all the students recognise mathematics in terms of developing conceptual understanding (unpacking/ building meaning), they recognise that this orientation comes with the development of specific ways of working and habits of mind, both social and mathematical, and that these are embedded within the processes that thread through their pedagogic context: there is a pedagogic modality which enables these relationships with mathematics to be produced.

3.1.3 Discussion-based pedagogic practice

One of the overriding similarities in the student teachers' narratives is the importance of the way in which Mr/s X has changed their conception of what mathematics learning is all about and the pedagogic practice that was necessary to make this possible. Emmanuel's description

²²² We note here that Boaler's work referred to school pupils' learning mathematics in-and-for itself, where as here the focus is on learning mathematics for a different purpose – for teaching - *MfT*. Nevertheless there are strong similarities between the practices described.

of being forced by Mr/s X to think deeply and construct mathematical arguments to support any specific position/ solution in the mathematics classroom illustrates the culture that has been instilled *within* the teacher education classroom at CU and the *type of communication* and *rules of engagement* between students and the lecturer who interact within this context. Karyn's description of the mixing of diverse cultures and the possibilities opened up to think creatively and discuss ideas within the classroom context is also illuminating.

It is clear that Mr/s X insists that the students engage with mathematical ideas, use reasoning processes to come to their own personal understanding of what is being discussed, and publicly discuss these understandings to test them and verify their thinking and arguments. The classroom climate enables a safe space for the student teachers to present their mathematical arguments and interrogate each others thinking, enabling access to understanding. The hierarchical relations between the lecturer and the students are flattened – students have the right to speak and to input their own ideas and methods which are all seriously considered. The pace of learning is determined by the students' engagement under the gaze of the lecturer. Everyone listens to each others arguments, but the criteria on which they are judged are always related back to, or grounded in, mathematics. Everyone is on first name terms (although in this thesis I refer to the lecturer as Mr/s X, the students all use his/her first name throughout the interviews and in the classes) and the rules of respectful engagement, listening and turn taking are part of the practice in the class.

These teacher education classes model an ideal teaching practice for all four pedagogic subjects in this study, and indelibly influence their understanding of learning mathematics, mathematics education and mathematics teaching. However in their teaching practices there are some variations, with Nicole advocating a step-by step building of ideas that is influenced by her experience as a gym teacher and Sonny recognising the difficulty of putting the ideal into practice. For Sonny there is a dislocation between this ideal discussion-based pedagogy and the realities of his experiences of school classes populated by students who are not all that self motivated and present obstacles to this way of teaching and learning. There is also a dislocation connected to his position in the school as a learner teacher on practice teaching (and with this a lack of respect/ recognition of him as a teachers by other teachers and learners) which exacerbates his difficulty. He is unable to realise the ideal practice and adapts it. His adaptation leads to a process that is recognisable as structured around his presentation of ideas (maybe ten minutes) followed by students working on problems in groups, discussing amongst themselves, followed by feedback – a common image/interpretation associated with

‘good’ practices projected from the ORF. Karyn recognises that there is a clear connection between the tasks/ activities used in the classroom and the levels of productive engagement by learners, which Sonny does not seem to have fully grasped. Sonny also strongly advocates bringing in the everyday as critical to meaning making in mathematics.

One of the key aspects of this ideal pedagogic practice as modelled by Mr/s X is that it enables productive dispositions towards mathematics to develop, that is, mathematics comes to be seen as worthwhile, interesting and meaningful and this enables the students to work productively. It also develops self confidence in their ability to think creatively/ critically using mathematical reasoning. A further common thread is an orientation to considering misconceptions and errors in students work as a basis for the development of mathematics discussions and structuring further learning.

Access to the favoured model of practice is mostly tacit, through the experiences of being in Mr/s X classroom and of comparing this to what they were used to at school, which is now rejected as *boring* and inappropriate for learning with understanding. ‘Traditional’ school practices are rejected outright and characterised as ‘bad’.

3.1.4 Rejection of discourses converging around ‘Mr/s Z’

A second point of convergence in the talk and writing identifies ‘Mr/s Z’ as representing what they do not want to be: *traditional*. This provides a further quilting point, around discourses converging on traditional teaching, where doing mathematics involves being expected to follow given methods without understanding why, and memorisation rather than understanding. All CU’s pedagogic subjects reject these images. We can recognise this rejection as a rejection of what Mr/s X does not stand for.

Mr/s Z represents traditional mathematics teaching – this is not learner-centred (although the students recognise that s/he is trying to involve them) it requires them to learn methods without understanding and therefore to use memorisation and it leads to unconnected learning. It has a rigid style that does not enable the student teachers to engage freely and to be creative and inventive. Hierarchical relations are maintained. The students *always* refer to Mr/s Z by title and never use his/her first name. The pedagogic subjects have to bend themselves to the methods presented and for most of them they *hate* mathematics learnt in this way, it is *boring* and becomes *meaningless*.

We see in this rejection of Mr/s Z's pedagogy (explanations/ examples followed by practice) and orientation to mathematics (pure mathematics as a set of concepts and skills to be mastered), a commitment to mathematics learning as enjoyable and interesting – and this comes to be so, not necessarily because of the mathematics itself but because of the relationship that is developed with it through the pedagogic context. Enjoyment is critical for keeping the student teachers' (and by extension school learners') attention and this is generated within a specific course by the way it is delivered, its relevance to future mathematics teaching practice and present learning needs in terms of developing understanding and reasoning through mathematical arguments, as exemplified in Mr/s X's classes.

In terms of Boaler's categories, we can see that this rejection is a denunciation of the tendency to treat mathematics as received knowing and associates doing mathematics with practice in the methods associated with specific topics. We could possibly say for Karyn, Nicole and Emmanuel, this orientation to mathematics is *condemned*, not simply rejected – being taught like this is so dislocated from their reconstructed pedagogic identities that they find it completely demoralising. Nicole and Emmanuel suggest that they insist in these classes on explanations for why something is done and not only how it is done, causing some disruption and discomfort. Sonny is not as negative about these classes, since while he rejects the idea that mathematics should be narrated, he still ascribes to systematic diligent practice as an important part of learning mathematics.

It becomes clear that within all the student teacher's narratives, the Other which quilts the pedagogic identity field at CU presents an image of learners (student teachers) as self realising subjects who are knowledgeable, whose prior knowledge needs to be revealed and used within social contexts to construct further meaning and understanding of mathematics, a pedagogic constructivist discourse supported by a competence-based pedagogic mode. Mathematics must be enjoyed for it to be meaningful, and enjoyment comes from the opportunities to engage in creative inventive thinking and problem solving and in the social practices that are instituted in the classroom to support discussions and construction of mathematical understanding. And levels of enjoyment are directly associated with *how* the subject is taught.

3.2 Points of breakdown in the narratives

At the beginning of the research process CU's selected good subjects were fairly confident of themselves and their mathematics education as novice teachers. They were clear about where they stood in their relationship to mathematics and were able to describe their ideal images of practicing mathematics and of practicing mathematics teaching, expressing their love and commitment for the subject and their chosen vocation. There were clear differences in the specialisation of the fourth year students as compared to the second year students, which would be expected. The fourth years, when describing their mathematics learning experiences at first appeared to be fairly certain that they were well prepared for teaching school mathematics, expressing the opinion that they had access to the content of most aspects of school mathematics and fairly well developed conceptual understanding of its topics and beyond. The second years recognised that they had not yet covered all aspects of school mathematics, but were sure they had in-depth understanding of what they had learnt so far, especially related to the courses that Mr/s X had taught; algebra and functions, and calculus.

However, as we saw in their narratives, when discussing the NCSM, and in particular when the interviews probed the underlying conceptual basis of the contents of school mathematics embedded within the assessment standards, all the students found themselves, at some stage or another, unable to intelligibly explain significance and meaning of the mathematical notions under discussion. For example, this was the case in relation to the concept of 'function' and the recognition of different 'types' of functions (e.g. parabolas/ hyperbolas/ exponential and logarithmic functions) from their defining equations. There was a tendency to explain what a function was in terms of specific equations and their graphs, using the 'vertical line test' – a visual metaphor – to explain why something represented a function. In addition when asked to name and describe the general characteristics of the graphs representing specific types of functions listed in the statements, these were generally misrecognised (except for the parabola and straight line). However it is noted that all the CU subjects were able to fairly competently describe a general methodology for setting up an investigation to explore the effects of certain parameters on the graphs representing the various functions (this was seen in relation to responses to Question 12 in Interview 1 – see Appendix G.2).

The students became restless and uncertain as their understanding of the statements were probed, and they were forced to come to terms with the possibility that they *lacked* knowledge/ understanding in areas of the curriculum that they thought they knew well. They

reacted differently to this realisation of their ignorance, which for the fourth year students was far more devastating than the second years.

Karyn re-evaluated herself – from earlier presenting herself as confident in her mathematical knowledge, she now *denied* this aspect of her specialised pedagogic identity. She now suggested that she suffered from not having learnt mathematics well when she was at school as a result of the lack of focus on the subject at the Art school and as a result of the traditional methods that had been used by her teachers and Mr/s Z. She now presented herself as *not* really competent in the discipline itself, but rather as someone who possessed other skills that would enable her to teach well. She tended towards blaming her past career and reiterating her position as someone who cared more about the processes than the contents, and suggesting that this is what would be most important for learners as well. She also indicated that these discussions had made her aware of the steep learning curve she would have to follow in her first year of teaching.

Sonny, on the other, was extremely upset by the realisation that he did not recognise and could not explain aspects of the school curriculum. He expressed his *hatred* for his mathematics teachers and presented himself as a *victim* of a disadvantaged schooling and of teachers who did not cover what was necessary during his school years. While he did not appear to blame his teacher education programme or CU lecturers for this situation, he also expressed the clear sentiment that time was running out for him and that access to these ideas would not be easy without being taught them in his teacher education programme.

Nicole and Emmanuel were also shocked at being confronted with ideas that they could not discuss, given that these had already been the focus of study in their courses. However neither of them reacted badly, and remained confident that by the end of the four years they would have overcome any of these difficulties and would be well prepared for teaching.

The reaction of the subjects when confronted with a *lack* in their knowledge, and more importantly *understanding*, is instructive. In particular, while being faced with aspects of their ignorance, they tended to lay *blame* on others who had not taught them properly/ on lack of opportunities in their past careers. They did not position themselves as life long learners/ scholars/ researchers who would actively take responsibility for their own learning. I will return to this later when reflecting back on the context of CU and the spaces that appear to

have been opened/ closed for the specialisation of consciousness and conscience through the teacher education programme.

While the positive identification with Mr/s X and negative identification with Mr/s Z provide a useful way of bringing together points at which the identities of the institution's good subjects converge, other discourses in circulation in wider society, that go beyond the individual lecturer's influence and the institutional context, are also at play here, although these may not be immediately visible within the stories as narrated.

3.3 Identification with Official discourses

In Chapter 4 aspects of the official pedagogic identity projected from the ORF was discussed. Here I briefly reflect on aspects of these official discourses that appear to be present within the student teacher narratives, and that have structuring effects on their identities both in terms of orientations to knowledge discourses and practices (especially M and MT) and to their commitment to the teacher roles. I also consider aspects of the general regulative discourse underpinning the curriculum transformation and the commitments to the 'critical outcomes'.

Firstly in terms of mathematics there three of the four students were committed to an orientation towards mathematics that favours orientation (3) as identified in the NCSM, i.e., to mathematics for inducting learners into mathematical practices, what it means to be a mathematician, to think mathematically and view the world through a mathematical lens - a disciplined, rigorous and systematic way of thinking about, structuring and communicating in the world. This orientation focuses on ways of thinking and reasoning in mathematics, particularly on developing conceptual understanding, and on the ability to communicate mathematically - verbally and symbolically. Sonny did not have the same commitment to this view of mathematics as the others, although he was committed to a form of critical thinking in mathematics.

While orientation (3) is dominant in most of the narratives, there is also a focus on orientation (2), i.e., mathematics as relevant and applicable within different contexts including real life, local contexts and other disciplines; including applied mathematics, problem solving and mathematical modelling. However it is noted that the orientation to this official focus does vary amongst the subjects, with Karyn expressing her discomfort with the interpretation that

this should involve bringing the everyday into mathematics, and Sonny seeing this as important for creating access.

We also see in Nicole (slowly building up the steps) and Sonny's (diligence and practice) narratives some commitment to orientation (4), i.e., mathematical structures, conventions, skills and algorithms to master in order to gain access to further studies. The other students do not explicitly appear to value this orientation.

There is very little in the narratives to suggest a commitment to orientations (1) or (5); that is, mathematics for critical democratic citizenship or mathematics as historically produced, although there is a clear commitment to mathematics as 'constructed' in social contexts.

One aspect that strongly threads its way through all the narratives is a projection of themselves as *mediators of learning*, although only Sonny explicitly uses these words, equating this with 'facilitator'. However this is clearly recognised in all the student narratives: in terms of the NSE this is described as a move from the old chalk and talk methods to constructing "learning environments which are appropriately contextualised and inspirational" and communicating "effectively showing recognition of and respect for the differences of others" (DoE, 2000c, p. 12) – a move towards 'learner-centred' practices, forms of co-operative learning and discussion oriented classrooms. The specific orientation towards being a mediator of learning is as mediating the acquisition of mathematical reasoning and understanding.

Other roles which are visible are the 'specialist role' and the role of 'assessor', although the assessment role is more visible in the narratives as a means to mediate learning through the recognition of misconceptions and errors, than to assess products of learning. The role of 'scholar, researcher, and life long learner' is explicitly mentioned by Sonny, Nicole and Karyn, however this does not necessarily fit with their projection of themselves when faced with aspects of their ignorance. However Karyn and Nicole do seem to identify with an image of the profession as offering the opportunity to continually learn and grow.

We also see within these narratives a number of aspects that emphasise the general regulative discourse of the new curriculum, in particular, a commitment to social diversity and inclusion are common to Karyn and Nicole, although not mentioned as relevant by Sonny or Emmanuel. This is an interesting difference that appears to be connected to racial/ cultural

issues – Karyn and Nicole have found mixing with other cultures in their classroom an important part of their learning, whereas Sonny and Emmanuel appear to find this less important. There is also a general commitment to developing creative/ critical thinking and to an image of learners as self realising subjects

3.4 Reflecting on the content of the distributive rule in contemporary society

In considering the discussion of the narratives in the previous sub-sections, we see a dominant orientation to M as developing mathematical reasoning processes in order to construct understanding and meaning rather than on learning of specific texts²²³. This ideal is entirely recognizable in terms of ‘constructivist’ discourses that dominate the general content of the distributive principle operating in contemporary society (cf Davis, 2005). We recognise the form of constructivism as more connected to, what Davis terms *pedagogic constructivism*, than to utilitarian constructivism, although there is some variation as Sonny does tend towards the use value of mathematics more than the other subjects do. We also see that the constructivist discourse that appears to structure the ideological field within which CU pedagogic identity formation takes place is one that favours the development of *connected knowledge* through *social interaction*, and in this sense, the individual pedagogic subjects’ conceptual (cognitive) understanding is mediated through discussion. The specialisation into MT that is favoured within the ideological field is of a discussion-based pedagogic modality, which implies a pedagogic discourse where the instructional discourse is embedded in regulative discourse that favours the flattening of hierarchical social relations, encourages independent and creative thinking, an invisible pedagogy where the pedagogic subject appears to have control and that works to ensure that they remain interested, love the subject and enjoy their learning experiences.

The rejection of traditional authority structures in the classroom, and authority of mathematics as a strongly bounded body of knowledge to be mastered, fits well with Davis’ comments about the consequences of the adoption of constructivist discourses and flattening of boundaries and hierarchical relations. We see that at CU old role models in the form of traditional teaching are negated as boring and inappropriate, and replaced by a new role model (based on an image of Mr/s X) where learning is exciting and interesting, where learners construct meaning through a pedagogy that reveals what they know (uncovers it, brings it into the open) and constructs them as self realising competent subjects. This is

²²³ The exception to this is Sonny. There is some cultural dissonance for Sonny, who is the most traditional of all the students in the group.

particularly visible in Emmanuel's descriptions where the general features of the logic of competence as put forward by Bernstein (and discussed in Chapter 4) are clearly distinguishable.

In particular within this we recognise, to some extent, in the CU context the “production of a narcissistic subject who experiences the external imposition of boundaries, hierarchical relations and other's pleasure as displeasure”, (Davis, 2005, p. 79): three of the four ‘good’ subjects of CU's *hate* mathematics if it is taught through traditional modes as received knowledge; they are motivated by personal relationships with their mathematics lecturers and to mathematical practices in which they become engaged, identifying with images of mathematics teaching which support ‘similar to’ relations in the school classroom. The pedagogic subjects are apparently free to produce their own mathematical arguments and to justify these constructing their knowledge and understanding. In Davis' terms, these subjects fit the description of ‘ideal ego’ – part of the ‘me’ generation. Access to deep mathematical knowledge for these subjects has to be through the building of personal relationships with the symbolic forms and under the gaze of their teacher. They must enjoy it to learn it, and their enjoyment is dependent on how they connect with it through the pedagogic mode in operation in the classroom context.

Sonny is in some senses the odd one out. He is more traditional at heart. While he rejects his past and presents himself as changed, he speaks and writes about the new privileged forms of knowledge and practices in negative terms (e.g. rather than presenting positive images of doing mathematics and connecting this to personal enjoyment and deep thinking, he tells us mathematics is ‘not supposed to be narrated’). His view of himself as diligent and hard working, his need for recognition and affirmation (rather than enjoyment and fun), and his understanding of mathematics which includes a strong orientation towards seeing it as an external body of knowledge to be mastered all suggest that he is not as connected into contemporary culture as the others. It is possible that his discomfort and the cultural dissonance he feels in attempting to realise the new practices when out in schools is related to this.

4 Conclusion

In this chapter I reconstructed narratives of the four student teachers who were selected as ‘good’ subjects of the institution. These narratives provided insights into their specialised identities on their journey to ‘becoming’ mathematics teachers. In particular they focus in on their specialised identities in relation to the three discourses, M, ME and MT, theorised in Chapter’s 3 to 5. The narratives are understood, in line with the methodology and theoretical orientation used in their reconstruction, as arguments presented for who they would like to be (and not necessarily reflections of who they are or were). The narratives are presentations of each student’s doxa, their projections of themselves through their speaking and writing. Clearly these are limited by the very nature of the research environment, the limited time over which information was collected and the direction of the questions posed, as well as the languages of description used to select the evidence and structure the narratives. Nevertheless the narratives once produced, gave fairly thick descriptions of each of the good pedagogic subjects’ experiences and orientations towards M, ME and MT, as developed through their careers as mathematics teacher learners (novice teachers).

The ‘good’ subjects of CU identify strongly with a conception of mathematics that fits fairly closely with the description produced in Chapter 7 through the institutional analysis. They present themselves as changed by their experiences of learning mathematics *differently*. While it is not possible to say how they would realise these ideal images in practice, there is a commitment to mathematics as a thinking/reasoning practice and to mathematics teaching as a discussion-based activity that would not be in contradiction with the kind of teacher that is required by the official discourse of the NSE and the NCSM. However, there are areas of divergence, for example, that there was no explicit commitment to mathematics for critical democratic citizenship and the various extended roles of the teachers were not visibly stressed. However the general orientation to teaching and learning is completely in line with the official discourse: e.g., a commitment to critical thinking, to mediating learning through discussion; to providing opportunities for learning through well structured and selected tasks and lessons; etc.

The case of Sonny throws up some dissonance, particularly his experiences of practice teaching where there appears to be some cultural differences which make his experiences difficult. His identity is not as ‘in line’ with the institution’s ideal as the other ‘good’ subjects. His view of mathematics and his understanding of the MT teaching practices that are

privileged within this context are not as connected into the new discourses, and still retain many traditional values and commitments.

Nevertheless the overall conclusion is that the ‘good’ subjects of CU have been specialised into forms of mathematical knowledge and mathematics teaching practices that would fit comfortably with the official discourse of South African policy and the FET school curriculum. It would also fit with orientations recognisable within the field of ME and MTE, particularly with the professional judgement of many of the mathematics educators who do see mathematics studied from a disciplinary perspective as necessarily valuable for teachers (as discussed in Chapter 2).

In coming to this conclusion, we see that the institutional perspective is not incongruent with official discourses circulating in the ORF. Reflecting back on the selection of the case, we see that while the positioning of the institution at first appeared to be unofficial in terms of their formal documentation (see Chapter 5 on the selection of cases), having come to the end of the analysis we see that it turns out to be more positioned in line with official discourses. It is, with the state, influenced by the global economy and by the dominant distributive rule within contemporary culture. This was identified early in Chapter 2 in relation to the discussion of the UNESCO documents – and the need to produce teachers for the 21st century. Thus while on the basis of the analysis of the curriculum documents submitted to the DOE, CU was recognised as presenting its own ‘institutional and unofficial’ position, the case study has shown that the subjects (disciplines and persons) of the institution reflect, to a large degree, the dominant discourses circulating in the ORF, and confirm the content of the distributive rule of contemporary society as part of the ideological fabric in operation at the institutional level. In other words while the institution appears to consciously position itself as unofficial and independent, the patterns in discourses visible at the level of the institutions pedagogic practices and at the level of the acquirer fit with the official, and thus is in fact positioned as upholding official discourses in relation to the ORF.

In the next chapter I turn to consider the case of RU’s ‘good’ subjects. I follow a similar pattern to that used in this chapter to produce an account of the identities of these pedagogic subjects. Later in Chapter 12 the two cases will be considered along side each other and the study will be brought to a close.

Chapter 11

The ‘Good’ Subjects of Rural University

My feelings and attitude had really change completely because now I’m positive and I have decided that whatever I don’t know it is my burden to get help and know it because there are no excuses at school and I didn’t want to be the kind of teacher who doesn’t get his facts straight (The Minister Biographical Questionnaire)

1 Introduction

In the previous chapter I considered the ‘good’ subjects of CU and produced an account of the specialised identities they presented in their talk and writing. These images were shown, in the main, to be congruent with the projections of the institutions and with official discourses circulating in the ORF, with mathematics education discourses circulating in the field, and in general, to be in line with contemporary globalised and networked society.

In this chapter the focus is on the mathematics teacher identities projected by successful mathematics student teachers at RU. The pattern followed in this chapter is the same as in the previous chapter. It begins with reconstructed narratives which provide ‘thick’ descriptive interpretations of the student teachers’ careers as they focus on becoming mathematics teachers. This is followed by an analysis and interpretation of the narratives to highlight points of convergence, divergence, and breakdown. The narratives are then considered in terms of official discourses circulating and rubbed up against the general content of the distributive rule in contemporary society.

2 The careers of RU’s ‘good’ subjects

Four students were identified by Dr A as exhibiting characteristics of ‘successful student teacher’, i.e., ‘good’ subject, of RU. Each student teacher at RU chose to provide a pseudonym that would be used to refer to them throughout this research report: Phiri, The Minister²²⁴, Mazet and Makhozi. All four students are in their fourth and final year of study and were expected to complete their B.Ed at the end of 2004 with good results across their various mathematics modules.

²²⁴ “The Minister’ might evoke a religious connotation. This name however refers to a political role, as in a ‘Minister of Transport’ or ‘Finance’.

2.1 Phiri: ‘a great thinker’ and ‘a highly recognised person in mathematics’

Phiri was in his final year of the four year B.Ed degree when the data was collected. He is a 23 year-old black African male. His home is in a deep rural area. His mother is a community health worker and his father is deceased. He matriculated at a High School located in the rural district relatively near his home. In the context of South Africa he is disadvantaged, economically and educationally.

Phiri’s account of his locational career spans a number of institutions including: his primary school and high schools, deep rural ex- DEC schools located near his home, where he successfully completed his matric in 1999 and was later employed as private teacher; the university campus at RU where he enrolled for a four-year B.Ed degree in 2001, and the various schools in which he has taught while out on practice teaching. All these locations were disadvantaged institutions in terms of material and epistemic resources.

Phiri’s employment as a temporary²²⁵ teacher motivated him to become a teacher, in particular because he was recognised by others as being a good mathematics teacher:

When I was teaching at that particular school, learners said that **they understand me better than anyone in maths**. They also informed their parent about me. So in that case I become motivated that I can be the best teacher especial in mathematics. It’s where I see that my career is in teaching because I do it better and people or **learners were left with no questions** after my lesson. The inspector came to my school in one Saturday class and said he heard some rumours about a very excellent mathematics teacher who is so young, so he decided to come and motivate me that I must not leave the school instead I must do correspondence learning. To me that means **I was a highly recognised person in mathematics** so I decided to take mathematics, as a major subject in this university. (PBQ)

This reconstruction of what he was recognised for, i.e., why he was an *excellent mathematics teacher*, emphasises that the learners understood him (his explanations were clear) and therefore *they were left with no questions*. This provides some insight into Phiri’s current view of teaching - providing good explanations. It also suggests that this recognition and affirmation from others confirmed his conclusion – he is a *person in mathematics*. His identity as *someone* is recognised *in mathematics*.

Phiri tells us that he made the decision to go to university to become properly qualified as a teacher after he heard an advert on the radio that RU had bursaries for teachers. He applied,

²²⁵ Phiri’s story illustrates a practice that (anecdotally) appears to be fairly common in South African rural areas. Successful matric students are employed in the schools as unqualified teachers soon after completing their matric. Often they remain in these teaching posts for a long time before they have the opportunity to study to become qualified.

was accepted and so took this opportunity to become a residential student, choosing not to stay on at the school.

In Phiri's reconstruction of his mathematical knowledge career across the various institutional locations, he explains that in primary school

I saw mathematics as something that is not important, something that can not work. I used to do it for the sake of passing it to the next class. The reason was that educators were not relating it to the real life situation, they did not open a page where by I could see mathematics working practical. They were only teaching me about adding numbers only not adding things. (PBQ)

In this account Phiri retells his primary school experience from his present position as a student teacher, highlighting what he now sees as important: mathematics should be *practical*, it should be connected to *real life situations* (e.g. adding things) and not only seen as abstract (e.g. adding numbers).

Phiri describes how he found mathematics very difficult during his early high school career and that when it came to choosing his subjects at the end of Grade 9 he was being encouraged by his peers and parents to take History because he was failing mathematics. However, as he explains,

... when I reached grade 10, in that year I decided that no! I had to take the stream of mathematics. And some others used to come and say **if you are doing mathematics you get lots of money**, [laughs] and others used to say **if you do mathematics you become a great thinker**. So that's why I decided to take the mathematics stream. Although **it was something that was not easy to me**. (IAT-P1)

The idea of becoming a 'great thinker' was something that Phiri was particularly attracted to and this together with the promise that mathematics could lead to wealth motivated him to continue with the subject. He recalls that it was only when he was in Grade 8 and Grade 9 that he realised that mathematics was important and he began to see that mathematics was not meaningless but had practical applications: "I started to get very motivated in mathematics and see the practical part of it" (PBQ). Although mathematics was the only subject he failed in Grade 9 he chose to take it in Grade 10:

I did not surrender in it. I used to motivate myself and say 'the knocked down is not the knocked out'. I will pass maths once I get someone who will have time with me. In grade 10 on June everything was changed and I was always the highest in mathematics and people were asking some questions to me and asked me to help them in mathematics. (PBQ)

In this retelling of his mathematics career, Phiri presents an image of himself as someone who is a self motivated and able. He believes in himself and in his abilities. He persevered (*did not surrender*), and this lead to success. In this account he provides an argument for mathematics as meaningful (*not meaningless*) and he connects meaningfulness in mathematics to its practical or use value.

While he sees his success in mathematics as connected to his hard work, he also recognises

(t)he one who was teaching me used to motivate us before teaching us, so that if we learn we must know where are we going and why do we need to know and pass maths” (PBQ)

Here we see a view of mathematics as a body of knowledge that must be ‘known’ in order to pass. What motivates you to learn it is to know why it is necessary to know this stuff – and for Phiri it is connected to having a prosperous future. In his account of his knowledge career Phiri does not present the way he learnt school mathematics in a bad light – he needed to learn the mathematics that was presented to him and he learnt it! He had to bend himself to get to know the mathematics, and this is what he did. Mathematics did not knock him out, he mastered it.

Phiri passed matric mathematics with an E (46%) on Higher Grade and considered himself as very successful²²⁶. However, after successfully completing his matric, he found himself unemployed and spent 2000 looking for employment. To keep himself busy he did voluntary teaching helping Grade 12’s in the area with math and science. At the beginning of 2001 he was asked to take up a post as an unqualified teacher at his old high school where he taught mathematics to grades 10 to 12 from February until April, leaving to come to RU in May 2001²²⁷.

In his biographical account of his knowledge career at RU Phiri focuses on the courses he completed over the four years of study. He gives some information about the focus of each one but gives little information as to his feelings towards these courses nor does he produce images of his teachers or of himself as a learner. He explains that each year they did at least two modules in mathematics, one more focused on mathematics and the other on mathematics education. In first year he did Linear Programming and Geometry:

In first semester we did Linear Programming (...) which was the chapter that I saw as if it were difficult at school because I did not get time to do it at school. I thought I will be the only person to fail that module but only to find that we were two who passed the first test that motivated me a lot. (...)The other module we were doing error patterns and computation. In second semester we did a module in Geometry where we learnt a lot about how to use media in teaching Geometry. We used to make a lot of presentations. (PBQ)

²²⁶ It is important to recognise that given his context this was a great achievement. However, for students in more affluent schools this would have been seen as a very disappointing result and they would not have considered themselves as good at mathematics with this kind of result.

²²⁷ It appears that while RU had designed their new curriculum to begin in 2001, they only managed to get everything in order to start the degree quite late in the year. All the students say that there was a fair amount of confusion at the beginning but eventually things were sorted out. The first semester was very short, beginning in May and ending in June. However RU had a relatively large number of bursaries for maths and science teaching and this is what attracted most of the students into teaching.

There are two things we notice about this account – first that he was motivated by success, and second, that he is quite matter of fact about what he learnt. He does not criticise or praise. He does not enthuse over his *love* or bemoan his *frustrations*. He continues, writing,

In my second year we did a module in Instruction in Mathematics where by we were taught how to correct a learner who has done a mistake in solving a problem. In second semester we did a module in exponents and its laws including surds. In my third year we did a module in Calculus whereby it was very difficult to us as students, but at the end we achieved the understanding of it. It was problematic to us when we deal with integration, it was not easily understandable to us. In my fourth year first semester we did a module in Algebra and Statistics, featuring sequences and series then the real statistics including mode, median, and how to collect data. It's either qualitative or quantitative data. Then the second semester I'm doing assessment in mathematics. (PBQ)

Again we note the matter of fact way he writes about these courses. We see that the only course that he gives any indication of his engagement with is Calculus, which everyone found *very difficult* because it was not *easily understandable*. This could be read to imply that the other courses were not as challenging as this one, easily understandable. It is also notable that Phiri writes about *we/ us as students* rather than about himself as an individual. The information provided in the Biographical Questionnaire is very limited, and it is only in the interview situation that Phiri begins to reveal more details.

Through the interviews we find he identifies strongly with the Calculus course, even though it was the most challenging. Studying Calculus was instrumental in his development as a *mathematician* – it provided access to some of the same mathematics that other students at the university studied, not just to school mathematics. That this learning was significant is confirmed by the selection of work provided by Phiri as important to his development, which includes his *whole* calculus workbook, including all the exercises and problems he worked through, the rough work and the final solutions. His success in the Calculus courses helped him (us) gain recognition, not only among his peers in the B.Ed but also amongst mathematics students in the Science faculty as a whole. I will return to discuss this in the section that follows the individual student stories, as it is relevant to identity formation that goes beyond the individual.

What becomes very clear as his story unfolds is that Phiri is part of a *group*, and that his identity as a mathematics learner (mathematician) and mathematics teacher is directly connected into this group. When he talks of 'us students', 'we', etc. he is referring to the members of his 'group', with whom he strongly identifies. The group was first mentioned in the focus group interview at the beginning of the process. Three of the four student teachers selected as 'good' subjects of RU belonged to this group, although Dr A had not been aware of this. Over the series of interviews it became obvious that all the members of this group were

successful students, and that the group was *the* central part of their university life. The group identity and the individual members' identities are highly connected. I will not discuss the group in any detail here as it intersects with the stories of three other student teachers in the sample. Rather I mark it as an important location and institution in the development of Phiri's career as a beginning mathematics teacher. In the next section I will return to examine this aspect of RU university life and learning and discuss its role in the identify formation of the student teachers.

Through the interviews we do gain some insight into Phiri's specialisation into M, ME and MT. In terms of mathematics, we already have a notion that Phiri views mathematics as a body of knowledge that needs to be learnt and that an important aspect of being able to access that learning is to understand 'the practical part of it'. In his description of the four most important things that an FET mathematics learner should know, Phiri reinforces this, suggesting "... one of them it should be geometry, geometry, trigonometry, analytical geometry and algebra" (IAT-P1). His focus is on the four traditional school mathematics topics – the old outgoing curriculum. He is not choosing specifically, he is saying they should know all of it! He is also not suggesting anything in relation to the new curriculum, for example, statistics does not feature here. When probed on what fundamental ideas/ concepts/ processes he would choose for geometry, he suggests:

Yes in geometry, I can choose some theorems. Some sort of theorems, because the basic thing in geometry is theorems. Without theorems you cannot survive in geometry. There are some theorems. (...) In order to work with the theorems you need proving, proving some triangles or anything that you would need to prove, because it is about proving and finding some angles (...) It is very important to teach geometry because as we are sitting here, this house can be defined in terms of geometry. So as to what kind of a quad or what, the kind of shape, its about shapes, figures and also measurements. As you can look around there are some windows, there were some measurements that were taken there, so this is knowledge of geometry. This is the basic thing where learners can start to assimilate and say, oh, geometry is important because this is the practical part of it. When they are seeing the doors, the rectangles, then geometry is introduced there. (IAT-P1)

This account suggests something of Phiri's view of geometry as an area of mathematics: geometry is a theoretical body of knowledge (it consists of theorems), in order to work in geometry you need to be able to prove, that is the basic skill required. However the importance of geometry is that it can be used in the real world – it is about shape and measurement and that is practical and can be related to things such as buildings. How the theorems are related to the real world however is obscure – however, the fact that we can see shapes in buildings etc enables one to *motivate* the need for geometry. In his explanation of analytic geometry, trigonometry, and algebra, Phiri puts the theoretical part first, and then relates it to some

practical aspect. This emphasises that he sees mathematics primarily in terms of its contents. Mathematics is an external body of knowledge that must be learnt and used.

Earlier in Interview #1, after he had been discussing the various courses that he had studied during his university career, I asked him if there was anything he would like to add. He provided further insight into his view of mathematics and mathematic learning, saying,

What can I say is that **mathematics is challenging** (laughs), it's challenging. It needs somebody to think critically. Because one speaker simply say, when he failed mathematics, he simply say "hey Mr Martin, mathematics is not everybody's cup of tea" (laughs). He took it from this experience, that out of 100 questions you might even get 2. So it's amazing, it's amazing. So **it needs somebody to pay attention** to what he's doing. To **concentrate more in mathematics**, especially you don't have to sleep without doing a problem that is based in mathematics. You won't fall asleep, you won't fall asleep, if you are doing a problem. It's unlike any subject when you are making some reading to find yourself sleeping (laugh). But **if you are doing a problem that really troubles you, you won't sleep**. And what I've noticed is that, if you have a problem that takes a long time to trying to solve, **the day when you get the solution, you'll feel very happy**. You'll celebrate. You will celebrate after getting the solution to that problem. So that's what I've noticed about mathematics. Yes. (IAT-P1)

Here Phiri emphasises that working with mathematics is not easy - it is challenging and requires much concentration and thought, which he calls *critical thinking*. Problems based in mathematics are particularly challenging, but they get into your mind and will not let you go – you can't sleep until you have solved it. Here we see something of the regulatory principles that Phiri sees as important for learning mathematics: as a person you have to immerse yourself in the mathematics, you must pay the mathematics attention, i.e. the Other which is mathematics defines you and regulates your thinking, its not a selfish pursuit; you have to persevere in the face of your difficulties when a problem is not easy to solve (you won't sleep because it will take you over); but its all worth it because the joy that comes from having solved it makes you celebrate. This is interesting because we find here that Phiri connects solving challenging problems with happiness and pleasure.

Later he elaborates, putting forward the idea that doing mathematics is about working on problems, mathematical problems and applications, and this requires learning *problem solving*. Problem solving as a key skill in mathematics learning is mentioned a number of times during the interview and when specifically asked in the final interview what the most important things he has learnt in his studies, he replies,

Phiri: I also developed the **problem solving skills in mathematics**. There are some problems whom I thought that initially, I can't solve this problem, I am afraid of this, of this particular, to attempt this particular chapter. But now after I've learned it here, I've discovered that, no man! There is nothing which is difficult. But it's just that I have to **get time to stick on this particular problem**, (...) So I also think that those chapters that I did not touch on, from the skills ... the problem solving skills I've developed, now I can sit down and try to think more about it and get started in this particular problem. Irrespective of whether I've started to do it here in University or whereby **the skills that I've developed allow me to do things that I've never seen before**.

- Di: (...) when you say I got these skills now and I can tackle anything.(...) What is it that you do? How do you approach, what you do? What are those skills?
- Phiri: Like initially, when I was looking at a particular problem, it was giving me a fear that I can't solve this problem. But by **motivating myself** now, motivating myself and simply say, okay, irrespective of how difficult this is, **I'll be able to conquer this problem**. So telling myself that there is nothing which is difficult. I can solve it, this particular problem. Especially in, let's say in Calculus for example. So the **skills that I have developed** is the interpretation of maybe some certain graphs, how to interpret graphs and those derivative stuff. So anything pertains to derivatives, I can have some way, **some strategies** of attempting. It's unlike previously, that when I'm looking this particular problem I simply say no, I forget how to do this problem. So I'm encouraged now, that no! (...whatever ...) problems that are given, I've got some solutions so I have to attempt, irrespective of how wrong am I doing. But next time I will do it better. (...) I will succeed. (IAT-P4)

Here we see that he connects problem solving skills firstly to *self motivation* – the belief that he can do it, the belief that no matter how difficult a particular problem seems he can solve it. Without this *self belief*, he wouldn't be able to solve anything, because he would be trying to remember how to do the specific problem, and if he couldn't recognise it he would give up (forget how to do this problem). In addition being able to solve the problem also depends on *specific knowledge and skills* within the mathematical topic. These skills *provide entry points* for looking at any particular problem, for working with the problem, even if it takes *time*, and along the way you make mistakes and get it wrong, eventually you succeed. It is clear from this that problem solving for Phiri is not a means for learning the mathematical ideas, it is about working with the ideas, about using the mathematics learnt. For Phiri, problem solving is both dispositional, about self regulation, and dependent on access to mathematical knowledge and skills.

It is very illuminating that at the end of this discussion on problem solving Phiri refers back to his school mathematics learning contrasting it with his university experience, suggesting that learning this ability to problem solve in mathematics is connected to the attitudes of his lecturers towards him as a student,

Because people simply, my lecturers simply say, there is nothing that I can fail to do. While at school they say it's difficult for me to conquer this particular part. Now the negative thing has become a positive now. So this is the kind of thing that I discovered at University. (IAT-P4)

This account underlines the lecturers' construction of their students as able, as recognising within them their ability to learn and 'conquer' any mathematics they are confronted with, and this has enabled Phiri to see this within himself and to position himself as an active agent in his learning. This is directly linked to the image Phiri projects of himself as a scholar and researcher, a great thinker and an "intellectual somebody" (IAT -P1), an image we will see later is carried into his group and affirmed by his peers.

Earlier in Chapter 9 Phiri's description of the four most important aspects of being a good mathematics teacher were discussed. I will not repeat that discussion here, except to point out that in that discussion, the importance for a teacher to be a scholar, researcher and lifelong learner was emphasised. While we recognised aspects of official discourses in his account, we also recognised that this was related to Phiri's reading of the educational context in which he needed to argue for a self as an active agent in the context of change. Now we see it is also related to his view of himself as a mathematics learner as well as a learner teacher. His courses have not covered "all the chapters" (in the school curriculum), and he will have to take responsibility for this learning. I will return to discuss aspects of this later when dealing with the group as this was a common concern, and the actions taken by the group to deal with these gaps are very illuminating of the field in which the RU student teachers' identities are formed.

The recognition of gaps in his learning, while acknowledged openly in terms of 'chapters not covered', came as a surprise to Phiri when revealed during the interviews. While discussing the conceptual underpinnings and significance of specific aspects of the new curriculum, he became visibly stressed as he found he was unable to respond intelligibly. At first he coped with this by talking fast and trying to fabricate reasoned responses²²⁸, until eventually he had to say, he had no explanation. Phiri then began to question me in the interviews and to use these as opportunities for his own purposes.

To gain some insight into Phiri's knowledge career in ME, he was specifically asked in the third interview, whether there was any theory from his mathematics education courses that he uses to think about teaching and learning mathematics. Phiri explained that in maths

... the theories like getting to know about Pythagoras theorem, so in mathematics we simply dwell on numbers. Calculate this using Pythagoras without knowing it why do we say it's Pythagoras. So there is a story behind the numbers, a history behind numbers not numbers only. If you are doing this thing, why do you have to do this particular thing? So in mathematics educations you learn such kind of things. (IAT-P3)

That knowing something about the history of mathematics was important was underlined a number of times, and in particular, that knowing this history made things more interesting for learners and could be used to motivate mathematics learning. Dr A was an inspiration for getting them interested in this. When pushed on whether there was anything that enabled him to understand better how children learn mathematics he mentions

²²⁸ More than any of the others students in the study, I felt that Phiri wanted to show me that he was informed and somebody who knew his stuff. He wanted to present himself as knowledgeable, a deep thinker and somebody who is an active agent in his learning.

- Phiri: Yes, yes, yes, yes, yes there is a research, (...) like checking, lets say a problem is given, so there are some errors a learner can make. So the thing is to check as to how can one assess this particular learner in such a way that he must feel or she feel that she is not that much wrong, he must not feel, that much inferior that (he says) 'I'm not supposed to do mathematics'. So there should be a research behind those things as to how can you assess a learner in such a way that she must feel comfortable, yes.
- Di: And what did you use to think about that, did you do any particular readings from journal articles or did you have lectures or were there some examples that you got from?
- P: (...) Yes I consulted teachers who have got an experience in teaching as to if they've given a learner this particular problem then make some mistakes in it how can I make it sure that this learner must not feel inferior so these teachers were giving me good responses, they were giving me good responses as to they were helping me actually because they see that I'm a person who's without an experience (...).
- Di: So was this like a little research project that you did for your course or was it just for you?
- Phiri: No it was for me, it was for me I was doing it roughly. (IAT-P3)

This interchange seems to confirm Phiri's argument for his identity as a teacher interested in doing research to learn more for his teaching, and affirms his earlier conviction that it is important for teachers to know how to assess, but does not appear to give a purchase on his specialised consciousness in ME acquired through the pedagogic context at RU. Pushing Phiri harder to see if he would reveal anything of this, I asked him more specifically if he had read any articles or research papers, or studied any theories. He dredged up some memories,

- Phiri: Ah. If I can recall it back, yes I remember I remember it was in 2001 I read in some articles that there was a researcher Nick James (...) who was in, who was researching about the study in mathematics as to how people feel when they are doing mathematics, yes, yes.
- Di: Were there any others that you read that you thought were important in your thinking about teaching and learning mathematics?
- Phiri: Yes there are some other articles although I cannot remember where who was that person but he was thinking he was talking about how can one study mathematics effectively and he was explaining the things that you must have while you are think about mathematics if you are given maybe a problem so you must have something, that is in your hands in order to write down he explained some of the things like if you thinking a mathematically problem you must have a pencil in your hand together with the paper so you must relate the previous knowledge with the current one so, these are the things he was stating in that particular article. And then he also state that you must give yourself self time to relax you must not do problems too quickly, so you must reflect what you have done and look whether you are still on the track.
- Di: And you found that they are useful?
- P: Yes it was very useful because obviously, obviously if you are having a pencil is better than a ballpen, then in the ballpen, in a ballpen form you can find that you have written two pages while you are trying to do one problem but the pencil you can write after discovering an error, then you simply scratch things, you rub and then you start afresh it was very useful it was very useful. (IAT-P3)

It appears from this exchange that Phiri has had little specialisation into the field of mathematics education research, and while he sees himself as a researcher, his induction in ME appears to be more practical than theoretical. Later in the final interview when explaining the most important things he has learnt for being a mathematics teacher, in addition to problem solving skills mentioned earlier, he reveals something more of his understanding:

There are so many things that I've learned, especially encouragement to teach learners. Eh, there are some of the things that I was not aware before I arrived here in University. So I simply take things as I think, not considering the learners' ability to understand mathematics. The way I understood mathematics initially. It looks like all people must be all like that. But now I've developed a skill that all learners are

capable of doing things. If I'm teaching mathematics I have to bear in mind that there are those learners that are slow learners and those who are more capable. So I must make it a point that each and every time, I must consider those slow learners. Automatically, those capable learners will be included there. So I gain the skill of seeing that, oh, now it's not all learners who understand better, so I must get some way to correct some answers. I was not having the skill of correcting answers, of correcting learners' answers. But now I have it from this B. Ed programme. (IAT-P4)

From this we see that he does consider his university career has changed him, particularly in his view of learners. He needs to consider them when he is thinking about teaching a topic, not only the topic itself. He also reaffirms the importance of being able to assess the learners and to correct them.

In considering Phiri's specialisation into MT, we find that his university career has worked at two levels, the one in courses where teaching is equated with 'presenting' and using teaching aids, and the other while out on teaching practice. The first aspect will be dealt with later when considering the group as it was common to all students' experiences. Phiri visited six different schools during his university career, all in rural areas with few resources. His practice experience is exemplified by his first school practical in his second year of teaching. He recalls,

Phiri: Ah! No. It's just that when I reached the school they seem to take all the work and give it all to me, as if they are proud of me, and I do the work. (...)
Di: Oh? When you are on practice teaching?
Phiri: Yes. Yes. They simply give me even high classes most of them grade 10, 12, and 11 Then they would simply relax and I would have to go and teach. (IAT-P1)

Later in the final interview when reflecting on his practice teaching experiences Phiri explains that he didn't have any opportunity to observe other teachers teaching while out on practice because he was always busy teaching himself. His 'mentor' teachers at the schools generally took practice teaching time as a time to relax and so they did not assist him much in the development of his skills. Over his entire university career he was assessed on his mathematics teaching three times, (once a year during the second practice block). The university lecturers that came to assess him were not mathematics teachers and their focus was on things such as lesson plans. Phiri explains that

we simply see the lecturers and then they go back home. They came to us, the University lecturers, to observe or to assess, to assess. They leave a crit. (...) They do say you have to correct these errors, you have to write this kind of lesson plan (...) So in my lesson plans the complaints was that, there were no complain about how I teach and stuff, but the complaints was on the lesson plans. (IAT-P4)

The confusion for Phiri in all of this was that every lecturer had their own idea of a lesson plan and this was different from what he had learnt in his mathematics education classes. We see here that Phiri's specialisation into teaching while out on practice is purely experiential and he is not assessed on his *mathematics* teaching.

To get a better idea of how Phiri sees himself as a mathematics teacher let's consider how he responded when asked to imagine himself in a classroom situation.

- Di: Just thinking about you, yourself, being a mathematics teacher. Being a mathematics teacher in high school. Teaching FET, grades 10 to 12. Think about that. I want you to describe how you think you would like to be in the classroom. What would you like to be doing and how would you like to be doing it.
- Phiri: Yes, inside the classroom actually. What I'd like to do. After I've introduced maybe that particular lesson. I have to write a particular problem maybe on the board. Then if I see that it's the first time for the learners to see that problem. I can do this problem with them, asking them basic things on it. So once I see that these people now are on the line, I simply point to a learner, take the chalk and point the learner to come and do some other problem on the board. In that case, that's where the learners gain the confidence of doing things. Because once I say you've done it good, the learner feels very much better, feel like as if always I must point at him then there's a certain problem [... inaudible...]. But to the one who has done wrong. I don't have to say, I won't say 'hey you have done it wrong'. I will say, ok let's try another method of doing this thing. So that the learner can identify himself/herself as to where he has done wrong. Then there should be some motivational strategies that I will use as a mathematics teacher to motivate learners. Because sometimes you find that the learner failed mathematics and simply say no, because I am failing mathematics, let me not count mathematics as one of my subjects. So I have to encourage and motivate the learner to like this thing. To like this thing. Because this is some of the fears that learners used to have in school and somewhere somehow they are lacking motivation. Yes I have to motivate them. (IAT-P1)

In this account of himself as a teacher, Phiri presents an ideal of teaching as involving an introduction, followed by examples, followed by learners working on problems. However, the ideal has the learner doing the problem publicly on the board. He tells me that this is a model of teaching that he bases on his own matric teacher.

Because, if you are a teacher, sometimes somebody sort of becomes your role model. So the teacher that was teaching there was my role model, so there was nothing that was much more different. But the difference was that, in my stuff I like to motivate learners before I start to teach this mathematics (IAT-P4)

The account that Phiri provides of himself as a mathematics learner and a teacher suggests that while his university learning has been worthwhile, particularly in relation to his specialised mathematics identity and his commitment to see things from the perspective of learners and deal carefully with their mathematical identities, he has very little specialisation into ME as a field of study in and for itself, and that his specialisation into MT is grounded in his past experiences from school – both in terms of the pedagogic model he uses in the classroom and his commitment to motivating learners.

To summarise, Phiri identifies himself strongly with his 'group' who we will see provides an important space for his development as a mathematics learner and learner teacher. He sees himself as an able mathematics learner and problem solver. He identifies with mathematics as a body of knowledge and skills that must be acquired through hard work, and that is meaningful since it has practical value. Doing mathematics involves critical thinking and problem solving – it is challenging and takes time and effort. Developing problem solving ability involves self-

belief and motivation, without which you will give up, as well as access to mathematical knowledge and skills that can be used to solve the problem at hand.

While it is clear that Phiri has developed a strong identity as a mathematics learner, he does not project any clear orientations towards ME either as a field of research in its own right, or, as providing a theory for learning and teaching. However, given his focus and understanding of mathematics, it appears that his orientation is towards a performance-based pedagogic mode. The elements of the logic of competence so visible in the new curriculum and in the context of CU are not being expressed in this account of himself. His experience of teaching grades 10 – 12 before coming to the university was a motivating factor, and he uses this to construct himself as a successful mathematics teacher even before he arrives at the university. He sees himself as a competent teacher and his experience tells him he can teach. For Phiri mathematics teaching is not problematised, it is about presenting clear explanations using charts etc to assist. Learners need to be treated with care and motivated into being willing to become immersed in mathematics, to pay attention to mathematics as something meaningful. Mathematics teaching is about focusing on the content of mathematics (knowledge and skills) and teaching learners an attitude towards solving mathematical problems. It involves good explanations that leave students with no questions. Its aim is not only to convey the mathematical knowledge to learners but also to motivate them to want to learn. The main means of motivating is to make mathematics interesting by drawing on the history behind what mathematics you are learning and making sure you explain its importance to success in life.

2.2 The Minister: I want to be the kind of teacher that gets his facts right and who has a heart for his learners – I want to make a difference

The Minister is a 25 year-old male student teacher in his fourth year of study at RU. He comes from a small town in a mixed race area. He went to a school located in a ‘township’ just outside of this town. His mother is a maid²²⁹. He gives no information about his father.

The Minister’s account of his career spans a number of institutions including his primary school, his high school where he completed his matric in 1999 and achieved a Standard Grade D in mathematics, the Technikon where he studied after completing his matric, and finally RU and the schools he has been out to on practice teaching during his B.Ed studies.

²²⁹ This is the word The Minister uses to describe his mother’s work. It is assumed that he means a domestic worker in a private home.

The Minister explains that he did not initially choose to become a teacher, and in particular a mathematics teacher. After matric in 1999 he went to the Technikon “to do Electrical engineering (Light current) and I completed the whole year” (TMBQ). However due to financial problems he could not return the following year. He would have returned to the Technikon to complete if he could have, but “on April I got a call that there is a bursary here at [RU] and I started in May 2001” (TMBQ).

When he arrived at RU he chose to take physical science and technology as his teaching subjects, but because “in my matric certificate I had maths and science [... the ...] guidance people motivated me about the need for maths teachers especially FET [...] I took the challenge!” He also suggests that another reason for doing this stream was “... the way my school teachers taught. In some way it had an influence that **I can make the difference**” (TMBQ). What he is referring to when he mentions his teachers is not at first clear. However as he relates his experiences through his school career we see that he has both positive and negative role models that provide him with the belief that he can “make the difference”.

When he reflects on his mathematics learning during his primary school years he remembers his Std 2 teacher:

... maths on that particular point was hated because of Mrs S²³⁰ I could even remember the name of the teacher. She hit us on our back when one could not get correct answers and also Std 3. To be real, one was fearing the punishment behind failing maths. (TMBQ)

However things changed in Std 4 and Std 5 when a new teacher Mr K arrived at his school. He

taught maths differently and he could allow you to explore different methods and ways of solving maths and he was not good in punishing but for pupils to understand and when I was doing Std 5 I really had a love for maths and now it was one of my best subjects and I was passing it very well in such a way that I went to grade 8, I had no fear of doing maths and I had all my confidence that I can do it. Till grade 10 I was excellent having no problems at all. (TMBQ)

The Minister mentions Mr K a number of times across the various interviews, and in this reconstruction of his primary school mathematics experience he produces an argument for his ideal of mathematics teaching and learning. This ideal for maths learning involves *exploring different methods for solving problems* which enables *understanding* and enables him to develop a *love* for the subject. His ideal for teaching involves creating an environment without fear of punishment that enables learners to develop confidence. This image of mathematics learning and mathematics teaching is reproduced across the various interviews, with some additional features being added.

²³⁰ I have deleted the teachers full name which was written in the response.

The Minister tells us he had a difficult time in the final two years of school. During his Grade 10 year his teacher left “for green pastures and we were left with no teacher”. It took a long time to get a replacement and when he came they were not able to complete the Grade 10 work. Then in Grade 11 and 12 things fell apart because they were so far behind and “it wasn’t a good teacher at all, although I am only able to say that now” (TMBQ). In Interview #1, he expands, explaining that this teacher was a salesman from a furniture shop who did not know his maths or how to teach. The Minister however did manage to complete his matric mathematics, mainly because of his attitude, fostered during his years with Mr K, and because he joined PROTEC²³¹ Saturday classes and found additional help in the community:

... also had one teacher in my township whom we requested to assist every evening and he was good to always say to us maths is easy and also motivate us because I think he could see that we had no appetite for it and really struggling but really with the help of these extra classes we manage to pass and the Other disadvantage factor is that maths was only done in standard grade only from Grade 11 to Grade 12 (No option). (TMBQ)

In this retelling of his school mathematics career, he is clear that mathematics learning requires an ‘attitude’ and that learners need to be motivated (have an ‘appetite for it’) to succeed. This attitude he refers to is related to his learning in Mr K’s classroom. In the first interview, when reflecting on writing his response to the biographical questionnaire, The Minister affirms the previous interpretation, the attitude you need to learn maths is related to confidence, believing that you can do it, that you can solve problems and loving the subject.

In his discussion of his knowledge career at the university, The Minister recalls that he struggled at first, however with the help of his group and the various courses he has taken his attitude has changed and now he is positive about mathematics and mathematics teaching. However he is aware that there are many gaps in his knowledge since “some of the chapters are not covered and others they don’t give strategies cause we are doing our presentation”. (TMBQ)

The Minister expresses concern that he has major gaps in his mathematics knowledge on a number of occasions. He recognises these as gaps from his own schooling, where he was forced to take standard grade maths, and from his university learning where has not covered everything in the school curriculum. His major concern is with his lack in terms of geometry learning. However, as he puts it, “that’s where really the group assistance intervene” (TMBQ). The Minister is part of the same group that Phiri belongs to, and for him this also is a central

²³¹ PROTEC was a NGO that worked in the townships and assisted students to succeed in school mathematics and science.

location for developing his specialised consciousness, in mathematics and mathematics teaching. We will pick up on this in the next section.

In the biographical questionnaire he gives very little information about his knowledge career while at RU, however he is very clear about where he stands with respect to mathematics as a subject and to the gaps in his knowledge:

My feelings and attitude had really change completely because now **I'm positive** and I have decided that **whatever I don't know it is my burden** to get help and know it because **there are no excuses at school** and **I didn't want to be the kind of teacher who doesn't get his facts straight** (TMBQ)

In this argument for himself he projects himself as someone who has developed a positive attitude towards mathematics through his university learning as well as clarity around what he feels is the most important characteristic of a good teacher – *someone who gets their facts straight*. He also reveals that as a teacher he is personally responsible for getting to know the mathematics he needs for teaching and that he will not allow his learners to be victims of a mathematics teacher who does not know their maths. He is positioning himself as an active agent who will learn what he needs. He does not express any anger or blame for his ignorance – he accepts it as part of who is; his history.

In the final interview he informs us that there were two things that really influence this change in attitude towards mathematics learning, so much that he really wants to teach mathematics and not science any more. The first was his lecturer (Dr A) and the second his group. We will pick up on the influence of the group a little later. Dr A's influence is described by The Minister in the following way:

... when the lecturer (Dr A) teaches in something, somehow it's not about; it's not all about the topic that he's talking about, but some inspirations. Oh, I could say what is it (...), the way he motivates you. The way he takes (...) your mind, I can say our mindset in the classroom towards the learning of mathematics. Because there are sometimes when maybe the lecturer, not necessarily interviewing you, but speaking personally with the lecturer and he will [...show you that...], he knows that you can teach mathematics (...) (IAT-TM4).

Dr A provides a role model for The Minister, not for how he ought to teach when he is in the school classroom, but rather for a 'way of being'. He respects his students (as learners and people), he trusts them and works with them taking them seriously and believing in them, considering them as able. This motivates them to want to meet his expectations for them.

At various stages during the interview process, The Minister provides us with insight into his M, ME and MT knowledge careers. In particular in relation to M, while he provides little direct

information apart from highlighting gaps in his knowledge, his response to the question asking what the four most important things an FET mathematics learner should get to know, is illuminating.

Ja, (...) maybe can I say something that (...) there's something that I think is (pause) maybe like a **problem solving skills**. Umm, the ability, **the ability of the learners to say use** measurements, numbers, whatever you are it's either geometry or whatever, but at the end of the day, it's got to be something that they can use **in their daily life**, practically, something that they see. And, ja, something, they must be able to use in their daily lives it's either measurements or whatever or playing around with numbers. But they are able to use it. Umm, like when we are speaking of for example (...) percentages something that they will affect them, so that is all what I can say for now. (IAT-TM1)

Here he is arguing for a view of mathematics that has two key elements: it focuses on developing problem solving skills, and the ability to use mathematics to solve problems in everyday life. What does he mean when he talks about problem solving skills and *using* mathematics (measurement, number etc) in daily life? In a later interview he explains that learning about problem solving in one of his mathematics education courses, was the most significant thing he learnt while at RU. He expands on what he means by problem-solving skills, referring to the “four basic steps that one must follow” in problem solving:

... you must try and **analyse** it. What is it saying, the instruction given to it. Second one is to **get started** with the problem. You can use trial and error method, whatever, if you still fail you can't solve it, you **consult your peers** or your educators and the other one is **reflecting back**, you reflect back as to whether did you answer what you have been asked to answer, and ja, those are basic stuff (IAT-TM3)

The focus on problem solving has a dual significance for The Minister, it is both part of his ideal about what mathematics is all about, but also learning about it explicitly has given him access to an important resource for his own mathematics teaching. He reveals that he *loved* learning about problem solving.

His view on using mathematics in daily life appears, not so much to be about using the everyday in mathematics, but rather taking mathematics into the everyday, as he elaborates,

Ja. Because when you learn maybe for, for problems solving ok. They are **in the class** you have to, speaking of mathematics, you solve whatever, so whatever (...) **whatever problem will be mathematics**. But it doesn't end there, **you still get problems** while, while you are whatever, **while you are at home**. And you could even apply that not because this problem solving is for solving mathematics problems only. Whatever problem that you meet with that's in the way, now that you have developed a skill to solve any problems that you are met with. (IAT-TM1)

This appears to be about teaching the learners to transfer mathematics from their classrooms so they can use it in their daily life situations. It is not about using daily life situations to make mathematics meaningful. In the mathematics class you will do problems that are in *mathematics*. This interpretation is confirmed when he explains what he thinks the purpose of learning mathematics is,

mathematics is taught in school, and it's taught, in a way it should bear fruit, or it should be fruitful, (...) for a learner after completing matric, (...) you learn the mathematics so that it might assist you in future. I think in future, and inside the future is the real world, where maybe you learn mathematics to be an engineer. Then go to be an engineer and use mathematics there. (IAT-TM1)

Mathematics is a body of knowledge to be learnt and mastered so that learners can have access to further study and to other life chances. Mastery involves learning problem solving skills so that the mathematics can be practiced and used. This fits with orientation (4) in the NCSM.

With respect to his career in mathematics education, The Minister appears to have taken up a number of ideas from his courses that he is talks about as helpful in understanding how children learn mathematics and that provide him with some resources for talking about mathematics teaching. In addition to problem solving strategies and assessment in math, he specifically mentions using a diagnostic approach, analysing learners' work and using that to assist in making teaching decisions,

... how do you diagnose the learners, maybe the misconceptions that the learner have. (...) we dwell much on misconceptions, it was helpful so far. It was helpful in such a way that (...) it works even if you now are in a classroom. When you are putting into practice now. We saw that learners, we teach them something, but when you, when you check their work or when you ask a question that is interesting, there's an answer that you get that doesn't come from what you've taught! Now it comes back to you to say, yes! Learners, they do not come to class as well, as an empty vessel, something like that. They have got their experiences, the learner experiences and the previous knowledge from the other grades and which makes you, it keeps you with a way to say, 'Ok, now what is it that he was told?' Maybe, 'what is it that the learner was told or that the learner discovered to make him or her to answer that way? You see. So in a way it helps me because sometimes you get frustrated when you teach the learners and they seem not, ok, they seem to understand and when you give them some sort of assessment they perform badly. And you wonder what's happening, so that it was also helpful to me. (IAT-TM4)

The metaphor that learners are not 'empty vessels' and the notion that learner errors and misconceptions can be diagnosed to help the learners move forward and help the teacher to understand why, when you have taught them one thing, they come with something else, clearly fits with a constructivist rhetoric, although the minister does not name this. For The Minister this learning was significant because it helps him, as a mathematics teacher, to take his learners seriously, it helps him understand why they do what they do, and to make decisions about what to do next to assist them in their learning.

His focus on caring for learners is reinforced when asked to imagine himself in a classroom and to describe his practice, however, the image of diagnosing and working with learner errors does not seem to be carried through,

Ok let me say what I was doing (laughing) because I've been in the school. Er, firstly what I do, **I stick with my learners**. Learning the ground rules, how we should act. And most of all is for me, it is **respect**. They must respect me. I must also respect them. That is my final, that is my basic. And then, I try by all means to make the classroom conducive for all. They must **not fear me**, to **approach me** within

anytime, whatever the period, or to stop me when I'm teaching, or whatever. Ja, to stop me when I'm teaching and, er, ja. Then, then when I'm teaching, ja, then I teach. (IAT-TM1)

It is clear that he is describing his ideal regulative environment, one of mutual respect and trust. However, it seems to be one in which the learners will be taught. When pushed to explain what he means by 'I teach', he describes a lesson pattern that begins with an introduction where he asks learners questions to find out what they know about the topic. How this goes depends on the answers they give to his questions, then, he says,

(...) I just leave it like that and continue to teach but I try as soon as possible to ask them questions or to make them to respond to what I'm doing, not for me to tell them. I always try and if I can make an example I do make an example. If I can bring a chart maybe of something, then I give them, and relate it to what they are used to. Ja to maybe what they are used to. At the end of the lesson, then summarise, (...) now do we say, we have said this about geometry, it is this, this, this. And now we have done from here to here. By the way geometry is ... can you see that? Can you understand that?

He seems to be describing a pedagogic approach that uses expository teaching with questioning, rather than a constructivist pedagogic approach. He teachers from the front using examples and teaching aids, such as charts, to assist in linking the new ideas to what they already know. The lesson concludes with a summary. Here we see none of the dominant contemporary focus on listening to learners' ideas, or groups of learners discussing ideas amongst themselves, or discovering maths, or constructing meaning. The teacher teaches from the front, asking questions to assess how his learners are following. To probe further he was asked,

- Di: What if somebody gives you an open response when you ask them a question, and they say something that is fundamentally incorrect?
- TM: Normally. (...). I ask a question and say give me answers. Sometimes it will be quiet and no one will respond and I say 'tell me what you are thinking?' They will say sometimes. I write it on the board just as it is spoken. And I write all that students are telling me until I stop this process. And I don't comment. After I don't comment, Because (....) **they always look how to justify, we don't just describe the answer.** Then (...) After all these responses, then I, I find a way. I don't say this one was wrong. I take maybe if there is a correct answer or respond to this, whatever that they have given me. **I try and explain towards that correct response**, and say, by the way **explaining to them**, maybe **working out something** to them or maybe **making an example** to try and **arrive to the correct response**. Now you see we've got this answer and it means the correct response was this one. And then I try to, to group those who are incorrect together. I don't individualize to say this one gave me the wrong answer, or whatever. I try to work it like that. And sometimes the one who gave the response, will raise up their hand and say, he doesn't understand why. Maybe even although you've worked that out, but because he had something as he was giving this response. We'll be making a follow up questions. But that's how I do it. (IAT-TM1)

We see here that while The Minister will encourage learners to speak, he is the one who will generally initiate the questions. If responses are incorrect he will be gentle, not pointing out any specific learner, but will take the responsibility for leading them to see what was incorrect and to the correct answer. He will listen to the learners explanations, they must not only describe the method but also justify it. However, while having this ideal for practice, he is concerned that sometimes it takes too much time, which he has learnt from his practice

teaching experiences. This is a dilemma for him, and it concerns him because either he makes sure everyone understands before he goes on, in which case he has to leave out aspects of the curriculum (which is what happened when he was at school), or he doesn't worry that they don't understand, in which case he fails them. He has not been able to get any help from teachers when he is out on practice teaching, they simply say "go on don't worry about the one who doesn't know", or from his lecturers who say you must make sure they understand before going on and to use groups and peer assessment to assist. But, he says,

(...) at schools, (...) we have a bigger number, have bigger classes. This thing of grouping them to say, what, work as a group and assess one another, it doesn't work. And especially because they live in different homes, even if you group them sometimes it's a problem, to give them a group work. Because you give them, and you come and teach for a one hour period, and you give them group work. Then when are they going to meet and where and how, that is the problem so for me it's a *real* problem. (emphasis in voice) (IAT-TM1)

So while he is committed to a practice that works to help learners understand mathematics, he has not yet worked out how to deal with time, pace and coverage. However he is very clear, they need to be evaluated by him as the teacher, they cannot learn if they evaluate one another.

Consider The Minister's response when asked to identify the four most important things about being a good mathematics teacher. He suggests,

Well, (...). For me, one, It starts from knowing your, your subject. You really you must **know your subject**, that means the mathematics, and **get all the facts right and straight**. Because whatever position if you don't know your thing, you are, you can't teach anything. That's the first for. Two, I would say you must, you must be, let me put in this way. You must **be committed**, dedicated and have a heart for, let's say your learners. You must **have a heart for your learners**. Because, well at the end of the day you know the stuff, I know the stuff, but it's the matter of **how do I teach** to the learners? How do learners get it? So you must have a heart for them. The third one, it's, what? You must have, when you go wrong or when you don't know, you must be able to say 'now I'm stucked'. I don't know and I need help. **You must be somebody who, who is not Mr knowing everything you see**. When you get stucked, or if however way or approaches or whatever fails, you must be able to get help, to get other people to help you. You must never be the master of mathematics (laughs) something like that. The third one. Ah, the fourth one? Ah those are the three that I've thought of. (...) Or maybe, maybe the last point (...) maybe this thing, the other thing is that you must be a **lifelong learner**. But even in the mathematics you must not say ok I have done the mathematics in high school I've done it in university for 4 years, I know my mathematics now. Because you must, **whatever changes that are there, you must be abreast with them**, so you must be a learner also. As I said, **you must improve yourself**. (...) you must also continue on the side searching. That doesn't mean you must register with the University and do something else. But you must be a learner, you must be updated with your subject, what's happening. (IAT-TM1)

For the Minister, knowledge of mathematics is of utmost importance in teaching – you must be in a position to correct learners and lead them to learn mathematics. But to do this you need to create the right classroom atmosphere and care for them, have a heart for them, because the critical thing that determines whether they get to learn or not will be *how* you teach, i.e., whether they get to understand the maths or not will be determined by the regulative environment in the classroom. There is also a need to be a bit humble, not arrogant, to be aware that you might not know everything, and to be willing to admit when you come face to face

with your lack – to recognise your ignorance, and so be willing to learn. And finally, connected to this but added as an afterthought, to be a life-long learner: someone who keeps abreast with developments in the subject and teaching.

In discussing his specialisation into MT he relates a similar experience to Phiri in terms of his experiences of teaching as presentation in his lectures and of being ‘critted’ by the university lecturers who have come to visit him while out on practice. He was however fortunate to have Dr A come to visit him during his final practice teaching experience and here he was assisted in developing his mathematics teaching consciousness. He has also had experience in a variety of schools, and in particular in his first practice teaching experience he went to a ‘model C’ school near his home where he was mentored by his teacher and had the opportunity to observe different teachers. However that experience did not necessarily leave him with good models, particularly in terms of *how* to teach. He found that the teachers (mostly non-African) did not treat their learners (mostly black African) with respect. His other experiences follow the same pattern as Phiri’s experiences.

In summary, The Minister identifies himself as someone who *wants* to know his subject well and gets his facts straight. He recognises he has large gaps in his knowledge of school mathematics, however, he is dealing with these (e.g. through his group) and projects himself as someone who is responsible for his own learning and an active agent for ensuring he gets access to *what* he needs. He projects an image of mathematics as a body of knowledge and methods of working that need to be learnt and understood. Learning mathematics involves engagement with problems in particular topics, learning different ways and methods of these solving problems. Learning problem solving involves learning an approach to working with mathematical and other problems in real life which may require application of mathematics (i.e. taking mathematics into real life, rather than bringing real life into mathematics). Mathematics is meaningful and relevant to real life because it provides opportunities to further study and prosperous careers.

The Minister’s specialisation into ME as a field of study is limited. However, he projects himself as someone who has access to some discursive resources for interrogating his practice, in particular, in relation to problem-solving strategies, assessment, and diagnostic approaches using error analysis. His specialisation into MT is mostly experiential, however, he argues for an image of himself as a mathematics teacher who: has a *heart for learners*, someone who is committed to providing a learning environment in which they can grow in confidence and

develop the kind of regulative attitude that will enable them to succeed in solving problems mathematically. He wants to be the kind of teacher who sticks with them through difficult problems, believes in their potential and is approachable, and not someone who uses fear or belittles them to control them. His favoured pedagogic approach is expository teaching (using charts/ aids) together with questioning. His major dilemma in practice is how to deal with time - pace and coverage of the curriculum – while at the same time taking care that his learners are succeeding in learning the mathematics.

2.3 Mazet: I want to be well equipped in mathematics but “my hope and my dream is not fulfilled”

Mazet is a 28 year old black African female student teacher in her fourth year at RU. She is pregnant and is due to deliver her second child soon (she is hoping that she will be able to complete her examinations before he/she arrives). She grew up in a deep rural area, and went to school in that area. Both her mother and father are unemployed. She struggles to cope with her responsibilities as a mother and a student, staying in the residence during the week and going home to poverty on the weekends.

Mazets’ account of her locational career includes her high school, which is located in the rural area where she grew up, a stint working in a Wimpy restaurant as a waitress, and RU and the various schools she has experienced while out on practice teaching.

She explains that she completed her matric in 1998 with a Higher Grade F that was converted to a Standard Grade E in mathematics. After completing she tried to find work but was unsuccessful, and spent the year “waiting at home” (MBQ). In 2000 she worked at a Wimpy Restaurant as a waitress for a minimal salary (R 350.00 per month and tips). She explains that she did not have any desire to become a teacher:

Being an educator or a teacher was not my dream while I was at or in school level. And the department of education what it was doing was discouraging, the redeployment and the last in is the first to be out in the school²³². (MBQ)

However her personal situation was such that when she heard over the radio that she could get funding to become a teacher at RU, “I decided to take that challenge rather than staying at the garage. It is that announcement that motivated me” (MBQ). She decided to take mathematics

²³² During the late 90’s there was a major ‘redeployment and retrenchment’ exercise in public schooling in SA that was demoralising for many teachers. The student teacher ratio was increased and ‘excess teachers’ were identified on the basis of the LIFO (last in first out) principle, in agreement with the unions. These ‘excess’ teachers, once identified, had to be redeployed to other schools where there were vacancies, or take voluntary retrenchment packages and leave the profession. Here Mazet refers to this process as a reason for being discouraged from entering the profession.

as she had completed it at school. She was acutely aware of her own “ignorance”, which she mentions throughout the interviews. She reconstructs her motivation for being a mathematics teacher from her current position as a fourth year student teacher, writing,

As of now I like mathematics even though **I am not yet ready**, the problem facing our schools and pupils is a challenge to us. The Nation needs a lot of mathematics teacher and whom they are well equipped. And **I worked very hard to achieve the goal of being a good mathematics teacher**. (MBQ)

In her reconstruction of her mathematics career, Mazet explains that in the lower classes she found mathematics easy and it was only in Grade 11 that she began to have some difficulty. It was then that she realised that “mathematics is not easy” and “maths needs time, it needs commitment and dedication, without it I cannot understand maths.” (MBQ). In Grade 12 she struggled with mathematics. She explains that she did not have a teacher for the first part of the year and there were also no books. When the teacher eventually arrived they had to rush to finish the syllabus and there was no time for doing problems themselves. She suggests that

teachers were teaching for the sake of finishing the syllabus, and that kind of teaching and learning was not effective and sometimes teachers were spoon-feeding the pupils with information instead of letting the pupils participate in the process (MBQ)

This recollection, from her present position suggests that for her a key to effective mathematics teaching would include providing the context in which learners can work through problems, and in this way, become involved in their own learning (participate in the process). It also suggests a view of mathematics as a subject that requires practice. We later see that participation here is equated with the opportunity to practice and to ask questions for clarification.

In reflecting on her M knowledge career at RU, Mazet expresses some disappointment. In particular she is concerned by the fact that they have not studied all the topics that they will teach:

When I first came to university and knowing which subject I am going to choose, I was hoping that when I go out to the world and to the community or society I will be the best of best mathematics teacher. But **my hope and my dream is not fulfilled because some of the things are not dealt with**. (MBQ)

Across the interviews and in the biographical writing she expresses that she feels particularly let down by *mathematics* courses where they were not taught and assessed (especially Geometry,), and where the lecturer gives them work for the whole semester, dividing it amongst groups and expecting them to teach each other while the lecturer evaluates their teaching²³³. She does acknowledge that this was not the case for every module and that there

²³³ This fits with the description given by Dr B in Chapter 9 when describing her approach to teaching mathematics in the MTE context, and with the observation of a first year geometry class observed during the empirical site visit.

were some modules where mathematics was taught and assessed, however she is concerned because they have not covered what they need for teaching at schools and she suggests that there is a

...need to focus to a school situation where we are going next year. In school **we are expected to know everything since we are coming from the university** and we are not. These issues are of paramount important to us and looking at the world needs outside. **If as a teacher I'm not well equipped to some concepts in mathematics how can I produce the learners whom they are well in mathematics** then how effectively am I to that situation. (MBQ)

In this piece, she argues for a self as she would like to be, but one that she recognises she has not yet become. As a teacher she wants to know her mathematical concepts well so that she can help learners get to know maths well. She recognises that when she goes back into schools in the community she will be under a spotlight because she studied at university – she does not think that she will get much help from other teachers in whichever (rural) school she attends, as they will consider her with suspicion. Her experience while out on practice teaching has alerted her to this. I will return to the issue of practice teaching experience a little later.

Mazet expressed anxiety at her lack of mathematical knowledge a number of times over the interviews particularly when discussing the NCSM statements. Often during the interviews there were long, long silences where she became immobilised by her realisation that there was yet another thing she did not know how to respond to. I will pick up on this issue of ignorance and lack a little later when we discuss the group identity. For now, it is relevant to note that Mazet is also part of the same group as Phiri and The Minister. For her the group forms a place where she can learn mathematics and she identifies strongly with the group and acknowledges its importance in her success. We note that although she has been successful and has been identified as a 'good' subject of the institution, she does not project herself as confident and is not a 'good' informant in the sense that she tends to provide very little information when probed, and tends to silence when faced with something she is not sure of. This may be related to her position as a female within a fairly traditional context. During the group interviews she also remained fairly quiet and allowed the men to talk for her. I will pick up on this issue when discussing the group identity as well.

Mazet gives very little information about her M knowledge career. She does tell us the calculus course was extremely difficult. The following exchange about her calculus learning illustrates how little information she tends to provide,

Di: What, how did you feel about doing it (calculus), why was it so hard, what was hard about it?
Mz: It was difficult even to understand it?
Di: Was it?
Mz: Ja, differentiation that was doing here, it was hard.

Di: Was the differentiation?
 Mz: For me.
 Di: And the integration?
 Mz: And the integration for me.
 Di: It wasn't easy work?
 Mz: It was not easy.
 Di: But did you learn it in the end, you managed it?
 Mz: I did pass.
 Di: But you don't feel like you knew what you were doing?
 Mz: And I don't want to do it again.
 Di: You don't (laughing)?
 Mz: (Laughing).
 Di: (Laughing) so I can I ask you to tell me what an integral is, can I ask you?
 Mz: (Laughing) I was feeling so terrible when I was going to that class now that eish.
 Di: And you didn't know what it was?
 Mz: Even though Dr (A) was teaching us, eish, when we do it in class and we discuss it you feel as if ooh it's easy when you are alone now it becomes a problem and you feel like as if, I must leave that.

When asked how she managed to pass in the end, she says the group helped her do it.

From her response to the question asking “which are the four most important things a FET mathematics learner should know?” we get a small purchase on what is important to her. She picks out ‘measurement’, ‘space and shapes’, ‘data handling’ and functions, explaining that these are chosen from the NCS document and these are important because this is “where learners they have showed the weak background of that concepts and it's forms a core” (IAT-M1).

She is clear the national curriculum should be the place she looks to see what is important. When pushed to find out what skills and ideas she is thinking of, she becomes visibly nervous, unable to select what *she* thinks is important – wanting to refer to some material for support. While she says it is important to focus on areas where learners have a weak background she gives very little of how she views mathematics itself.

Later on however when asked to reflect on her whole experience of becoming a teacher over the four year B.Ed she does provide a response that illuminates to some extent her view of mathematics:

Di: I asked you (...) to think about identifying the most important thing or things you learned by studying here, for your development as a mathematics teacher.
 Mz: But the thing that inspires me most of the time, we claim to be as mathematics teacher, and we are not practicing. If I say I am a mathematics teacher I have to practice that. I am a mathematics person always using mathematics, because if I'm not using mathematics all the time I might forgot that, how to solve this problem. When I come across with this problem, how can I solve it mathematically, yes.
 Di: And you've learned that?
 Mz: Sometimes, ja, some of it we've learned it here because we had to practice all the time, but without practicing it I cannot claim that I am a mathematics teacher. It must shows that I am a mathematics teacher. (IAT-M4)

For Mazet, becoming a mathematics teacher means that she must be able to do mathematics. Doing mathematics involves practicing mathematics, using mathematics to solve problems. If you stop practicing you forget it, so knowing it involves working with it all the time. Here we see an orientation towards mathematics as an external body of knowledge and problem solving skills that must be learnt through practice, though solving problems, and a view of being a mathematics teacher that involves continually practicing mathematics.

When pushed to focus on some specifics she reveals a little about her ME career,

I: If you think about mathematics, mathematical ideas, the mathematics that you've while you are here. Were there any particular mathematics ideas that you thought, wow this is fantastic, this is the thing I enjoyed it, I love this?

P: I think it was a while ago, I think it's 2002, to see the misconceptions that learners might have done, and how to maybe correct those misconceptions because they are a lot of misconceptions in mathematics, maybe the learner maybe doesn't understand the concept that is being there.

I: You did a whole course on, on misconceptions?

P: Mmm. (.....) and I've see that this is the thing that educators must be aware of this misconceptions. (IAT-M4)

She does not reveal anything further, and we do not get a feel for how this has influenced her teaching in anyway. It is something that she learnt about that was interesting. However her response also reveals that for her learning mathematics is fairly instrumental and she does not express anything of her personal relationship to the subject. In terms of her specialisation into MT, her response to being asked "what are the four most important aspects of being a good mathematics teacher?" is illuminating.

Mz: Okay. I said, **effectively use and manage learner support material** like charts and other media, that will make a huge contribution to the teachers' ability to extend theory to practice and teach mathematically concepts in a practical and concrete manner. And also it will make learners to understand more clearly when there is support material. Yes. Then **to manage assessment effectively** - like doing the continuous assessment that are day by day, whatever assessment may be. And then number three, **to promote the critical and independent thinking of learners**. And number four, I think is to **subscribe to mathematics organisations for personal development**, for example the AMESA.

Di: That's interesting. When you say learner support material you gave an explanation, but assessment. Why is assessment so important. Why is it important?

Mz: Yes to assess. How the learners are performing? How am I teaching? Is my teaching effectively? And the learners is getting that knowledge, that knowledge that they get are they going to help them in the outside world?

Di: Okay. And when you say promote critical and independent thinking. How would you describe critical thinking and independent thinking in relation to mathematics, what is it that?

Mz: The learners, they have to think deeply. Like if maybe I'm, I'm giving them some problems, maybe some problem in words, they have to understand firstly what it means, what is needed, what are they supposed to do to solve these problems, without me telling them how should they do it. But I must give them the guidelines, or guide the way how are they supposed to do, not giving them the real answers. But I must give the way, so that they can go towards the correct answers. (IAT-M1)

The first two points are directly related to the 'roles' in the NSE (designer of learning programmes and materials; assessor); the third refers to one of the main critical outcomes in the national curriculum and the final one an acknowledgment of her need to learn and develop

herself so that she can meet her ideal of being a teacher who knows her mathematics. This final point is also related to the NSE (being a scholar and life long learner).

The focus on learner support material is something that is mentioned a few times over the interviews and she talks about this with some passion. It appears to point to two things. Firstly that using charts and aids will help her convey what she wants to teach in a way that the learners will remember, as she put it,

And I have to have some material to put that concept so clearly, and in a concrete manner so that the learner might not forget, he or she must always remembers that oh, in that day I've learned this and this and I won't forget it because I was having that picture of it. (IAT-M1)

We see here that this focus on material (the use of charts etc, but also physical resources such as geometric solids) firstly emphasises the use of visual and concrete models and metaphors to make mathematics more sensible. Secondly she emphasises that the learners need books and problems to work with in order to practice the mathematics she teaches. Her experience of teaching in relatively deprived schools (and her own experience as a school pupil) have shown her that it is usually only the teacher with a book, and that this is a real problem, because without practice the students cannot learn mathematics.

One of the obstacles is that how can I teach if only I the educator who have a book? Learners don't have a book. How are they going to do their homework, how are they going further doing their activities without a book? They only rely on what I give them in the class. (IAT-M1)

Her argument for assessment is linked to assessing her own teaching and whether the learners are getting the knowledge that is going to help them succeed (in the outside world). Here she does not suggest that she could use assessment to understand learners thinking and so help her direct their learning. The ideas related to misconceptions mentioned earlier are not connected to assessment here.

Her argument for critical thinking gives us further insight into her position. She emphasises the need to guide the learners into methods that they can use to work with problems, but she is clear that they must actually do the problems themselves. However as a teacher she must guide them towards the right answer.

The image that is being built suggests that Mazet identifies with mathematics mostly as a set of skills to work with problems (orientation 4 in the NCSM), and that these are learnt through practice exercises. She therefore sees her work as a mathematics teacher to be focussed on providing learners with the skills and the opportunities to practice mathematics. This is

confirmed in the discussion around her ideal image of herself teaching in a classroom where she describes the learners as active participants – practicing the problems. She also suggests,

I think one has to develop the love of mathematics towards learners since most of the learners they run away from mathematics, because maybe there is no one who motivates them, how important it is to learn mathematics. I think my role is to motivate them, (...) effectively so that they can understand how mathematics is helpful (...) in the outside world. (IAT-M1)

This reinforces her idea that mathematics is external to the self, it is to be learnt, and what motivates you to love it and do it is that it is important for future prospects. That is what must be understood to motivate one not to ‘run away’ – it is not about understanding and developing a relationship with mathematics itself.

In summary, Mazet is very reticent and does not project herself as confident in M, ME or MT. She finds it very difficult to articulate her position and tends to be uninformative. She *feels* her ignorance with respect to gaps in her acquisition of contents of topics in school mathematics, presents herself as a hard worker and she clearly has a will to succeed. She lives with hardship and poverty and tries to be practical in her view of life and with respect to mathematics and mathematics teaching. Her specialisation into M at RU, such as it is revealed through this research process, is through an orientation to practicing problems and her interactions with her group. This orientation is what grounds her image of MT. She knows what she would like to be – a teacher who has strong knowledge in mathematics and who could contribute to the problems out there that learners in deprived circumstances have with mathematics learning. But as she tells us, she is about to go out to teach and her “hope and dream is not fulfilled”.

Mazet sees mathematics in terms of skills to work with mathematical problems (orientation 4 in the NCSM), which must be learnt and remembered through and in doing lots of practice exercises. This requires commitments and motivation. The motivation to be dedicated to this practice is not intrinsic to learning mathematics itself, but is located in its potential to open doors for learners in the future. MT involves providing learners with the knowledge and skills - through good explanations of concepts using aids (charts/ concrete objects) to assist in visualisation - and the opportunities to practice mathematics so they get access to these.

2.4 `Makhosi: I want to be a teacher who is committed and loves their work

Makhosi is a 26 year old African female student teacher in her fourth year at RU. Her mother is a cleaner. She gives no information about her father. Makhosi provided her biographical writing and attended the first interview. However, after that she dropped out of the process as she had a problem at home. Here I give a brief overview of aspects of her story.

She gives some information of her locational career across a number of institutions, her high school, a finishing school where she wrote her matric, places she worked between completing and attending RU, a short stay at a community college where she did a computer course, RU and the schools she has practiced in while at RU. She also spent a semester at Chicago State University at the beginning of 2004 after being selected to participate in a study abroad programme.

She recalls that she was very young, only 15, when she completed her matric in 1994. While she now resides in a township on the border of a medium sized South African city, she only moved here the year she matriculated. During the majority of her schooling she lived in a poor rural area. When she moved to the township she went to a 'private' finishing school in the city centre to complete her matric. She achieved an F on Lower Grade²³⁴ in matric mathematics.

She tells of her frustration at not being able to continue with studies after completing school due to lack of finances and of being unable to find a job for almost two years. She eventually found temporary work at Pie City as a cashier towards the end of 1996. She worked there for three years but had no prospects for advancement and so eventually left and enrolled in a three month short computer course at a community college towards the end of 1999. With her certificate she was able to get employment in a Lawyer's office as a junior secretary. She writes:

It was in that year that I strongly felt the urge **to become an asset to my community** and not just be an ordinary employee. I always wanted/ liked to become a teacher, and even my mother was influencing me a lot into becoming a teacher during my school days, seeing the talent and patience I had when teaching my peers on subject/ lesson I knew at home. But due to problems the Department of Education had and the high rate of unemployment of teachers at that time, I had declined that idea and wanted to be a Psychologist instead. (MKBQ)

Makhozi heard over the radio that RU "had loans for people who wanted to become teachers and I grabbed that opportunity, and that is how I got here and have no regrets for now" (MKBQ). She talks about her decision to go into teaching as connected to "a way of giving back to the South African community especially the previously disadvantaged community in rural areas" and suggests that she choose to become a Science and Mathematic teacher because this is where the greatest need is, and

which were the most dreadful subjects in learners as well as teachers because they lacked the skills of teaching them. Even my mathematics results are living proof that help is needed in mathematics teaching. [...] And as a product of poor mathematics teaching, **I will make sure not to repeat the same mistake to learners. I will make learners love mathematics** in a sense that the classroom environment

²³⁴ This is extremely low maths result and it confirms the earlier suggestion in Chapter 8 that RU tried to attract anyone who had attempted mathematics, regardless of their result into math teaching.

will be friendly, **use teaching aids to try and emphasise the concepts**, which is something that previous teachers did not do. I am not proud about my matric maths results, but in a way they gave me a reason to want to learn more on maths. (MKBQ)

In this reconstruction of her motivation to become a teacher we recognise her position now as a fourth year student teacher, someone who will not put learners through the deprivation and degradation that she suffered while at school. Someone who will help learners *love* mathematics, because they will *love* her classes, that is, the friendly environment where they will not be fearful, and her use of resources (aids) that will help her provide explanations that they will understand.

In reminiscing about her school mathematics experiences Makhozi explains that in her early high school years (Grades 8 – 10) she had

...this wonderful teacher who used to make sure that **she explained each and every concept and facts in a manner that will be understood** by almost everyone in the class. So she was **not intimidating anyone**, she made all learners feel the need to know, understand and love mathematics, hence we enjoyed the subject so much. (MKBQ)

In this account, she reveals her position with respect to mathematics teaching and learning as she sees it now. Mathematics teachers need to explain well so that learners can understand. They need to be encouraging and help learners develop a disposition towards mathematics and a relationship with it. Learners need to understand and love the subject. That way they will enjoy it.

In as much as her Grade 8 to 10 teacher provided a role model for her, her Grade 11 teacher provided an image of what she does not want to be. She recalls that her whole attitude to mathematics changed. She became negative and her “love for maths” decreased because this new teacher was

very aggressive, and did not want to be disturbed by questions when teaching when we did not understand what he was explaining, and used to beat learners so hard when struggling with correct answers. (MKBQ)

Again this reveals much about her current position: teachers need to listen to learners’ questions and help them with so that they can work correctly in mathematics. It emphasises the need for teachers to provide clear explanations and not use fear to motivate.

Makhozi writes that when she moved schools in Grade 12 things became even worse because she found that she had a mathematics teacher who was not committed to teaching them and who was busy with other things leaving them alone for much of the time. They all recognised that they needed help and invited people from a local university to assist them, “but that was

not enough because we needed a full time teacher. As a result not many of my chapters were covered and I was doing standard grade level”. Her experience,

taught me that **commitment and love for work is very important when you are a teacher** because **your mistakes might kill the whole nation**, as a teacher is a foundation of success of a nation, and therefore must live up to that standard. (MKBQ)

In writing about her knowledge career at RU she names all the modules that she has done over the years, suggesting that she found Errors and Misconceptions in Mathematics , in her first year, “very interesting” and the two Calculus courses, one in her second year and the other in third year very difficult. She writes:

In my second year (...) in the second semester I did Calculus which I really struggled with because I did not have a good background of it, most of the things we learnt were like new to me and it did not make me feel good because my colleagues/ classmates were saying its like they were revising because they learnt most of it in high school. In my third year first semester I did Calculus B which I really struggled with as well. (MKBQ)

She gives very little insight into her specialisation as a mathematics learner or teacher in her writing. In discussion she reveals that she is also part of a fairly strong group of student teachers that she strongly identifies with, although she is not in the same group as the other students involved in the research project. While she suggests the influence of the group on her learning has been positive, this aspect of her identity formation while at RU was not probed any further, since she dropped out of the interviews before they were complete.

In the first interview, we do get some purchase on her views of mathematics from the response to the questions dealing with the important mathematics that an FET learner should get to know, where she responds,

I guess you should try and surprise the, the learners to **think critically and creatively** and try to **analyse** it, each and every step the because **mathematics is done according to the steps**, there are steps you cannot just get the answers, **you need to know the different types of methods or steps that need to be followed**, to do well (IAT-MK1).

Here we see that Makhozi identifies with mathematics as a step-by-step process, understanding thinking and analysis as being connected to getting access to the steps. It seems that for her mathematics has its methods and steps and these must be followed. Creativity here is not thought of in terms of construction of individual methods or thinking, its about being able to analyse mathematical problems in a way that will provide access to its methods.

No insights were gained into Makhozi’s specialisation into ME, as this was not a specific focus of the first interview. However, as far as mathematics teaching is concerned, we get some

purchase as we consider her response when asked what the four most important aspects of being a good mathematics teacher are, she replies,

For starters it's, you have to **know your content well**, you've got to know your content and **be able to integrate mathematics** with other disciplines because it's, in a way it relates to each other mathematics, it's just, it's just not an individual discipline it relates with so many disciplines for instance the geometry with science. I can't really, you know, name them. And the **use of different types of tools and techniques** is really important because my times, many things that are useful just neglected, they weren't seen as things that are useful to learn with. **And love and commitment**. For a teacher it's very important because learners a sense of, belonging and whenever, each and every time that you have some problems you know that you can count on a teacher, you can consult I, even in, not during the classroom period and after the classroom period. (IAT-MK1)

She emphasises being a teacher who knows her content well and who provides learners with access to that knowledge (does not deprive them as she was in her past). The importance of 'integrating' maths with other disciplines appears to be located within official discourses (NCSM), as is the focus on using 'different tools and techniques', although she recognises this as connected to being deprived of these in her own past. Her focus on love and commitment to enable learners to approach one is also stressed. This appears to be a common thread in most of the stories and will be picked up in the next section.

Makhozi's image of herself in a classroom provides some further information about her orientation to integration, although here we do not see a commitment to integration with other disciplines, rather to integration with the everyday,

Mk: Ok I'm standing in front of the classroom with my teaching material and trying to explain, as to the concepts in mathematics and steps required to go on (.....) and find the angle (pause). Anyway I'm integrating the mathematics concept with a real life situation, a maths concept with easier life situation in order to make it easier for learners to grasp those facts and, and, and concepts and now I'm going to ask students to ask questions all the time if they, they encounter some problems (pause)

Di: What are those ideas, what will learners do?

Mk: A learner, a group and work according to their groups in order to when you talk of, about mathematics there's this kind of tension that learners have so when they are grouped to their groups it makes it kind of easier for them to ask their peers or their colleagues and actually having the right kind of material that I might think it's useful like for a particular lesson, mmm (IAT-MK1).

This image is revealing. It confirms her commitment to mathematics as a step-by-step process. It confirms that teachers need to know the concepts and methods (steps) well so they can explain them. But we see that in terms of integration she is identifying with the idea that you need to use everyday life situations to teach mathematics, because they are *easier* to understand, and by using them you will make it easier to grasp the mathematics. She wants to use the everyday to make mathematics more *sensible* to learners. She wants learners to ask her questions so they can clarify their ideas, and gives an image of using group work so that learners can ask each other questions. She also wants the right kind of material (learner support material) to support learning.

In summary, the limited picture that is projected suggests that Makhozi sees herself as a teacher who wants to know the facts and methods of mathematics. She sees mathematics in terms of concepts to be learnt and step-by-step processes to follow. There is little from which to infer her possible specialisation into ME discourses. However she projects an image of MT as involving the ability to explain the concepts and methods of mathematics clearly to learners, using resources and everyday examples to make them more sensible and so enable access. In addition to clear explanations, MT involves creating a classroom climate that is conducive to learning: one that is without fear of intimidation and personal degradation; a climate where learners can ask questions to clarify their understanding and where they will be listened to and answered. She projects an image of herself as a teacher who is committed to and loves her learners and her work.

3 Identity formation and Identification within the ideological field generated at RU

As with the previous chapter, I do not have the space here to do a complete and comprehensive analysis of all the information collected, rather I will focus on some points that enable me to provide insight into pedagogic identity formation within the institutional context of RU. This section therefore examines patterns in the narratives produced in the previous section, and adds to them, in order to expose discourses circulating in the local ideological field generated at RU within which the pedagogic identities of the good subjects of the institution converge/ diverge.

3.1 Quilting points in the local identify field

3.1.1 Deprivation, degradation and Rurality

In all the narratives, poverty and rurality feature strongly as basic underlying threads which snake their way through these pedagogic subjects' lives. They have all experienced poverty, three of them deep rural poverty. Three of the four experienced the difficulty of being unemployed or being in very low paying jobs after completing their matric and experienced the pain of hanging around with no prospects. They were all attracted to RU and to teaching by the promise of finance for their studies, three of the four hearing about it over the radio. One of the four became committed to teaching through his experience of being appointed as a temporary unqualified teacher, itself a feature of rural poverty and deprivation – the school could not attract a qualified mathematics teacher.

There are at least two features within this background of poverty/rurality that are visible in the students' teachers' talk and significant to the development of their identities as novice mathematics teachers: deprivation and degradation.

Deprivation is linked to *lack* – what was not made available in their education through lack of resources, particularly material/physical and epistemic/knowledge resources. This is visible both in their past histories of schooling and in their present careers as experienced through RU. They are explicitly aware of some aspects of this lack as a major absence in their careers and it provides them with motivation to “make a difference” and change things for future generations of school learners. There are also some aspects of which they are not aware, i.e., they don't know they have been deprived of these aspects in their education. These are visible by absence in their talk and link into their future possibilities as mathematics teachers.

Degradation is linked to that which once existed but that is not maintained – which is degraded, whether deliberately or through neglect. This could be related to material aspects of their lives as well as to issues related to their pedagogic identity formation. In this discussion degradation will be specifically linked to aspects of their identity formation.

In what follows I will begin by briefly discussing issues linked to degradation and then lead into a more substantial discussion around deprivation. I will show that while RU in some ways represents a location in which both degradation and deprivation could be negatively constituted, the context of the teacher education programme at RU opens spaces which makes it possible to turn around some of the negative effects of this past and present – as Phiri puts it – the negative becomes a positive.

Degradation

It is clear from the narratives that all the students had experiences of school mathematics that were difficult and sometimes brutal. At the level of pedagogic identity formation this is seen in the narratives around the experiences of their mathematics teachers who used fear and intimidation as a major resource for motivation. Here the student teacher recognises the damaging effects that such degradation, or lack of respect, has on learners. As they reconstruct their stories in the present we see them linking this use of fear and intimidation to the development of a personal lack of confidence in their ability to do mathematics and their recognition of these negative models as being images to avoid.

They recognise the importance of their lecturers at RU in turning this around for them – at RU they are treated with respect. Their lecturers have confidence in them and in their ability and project images of them as able mathematics learners and teachers. This enables the student teachers to recognise within themselves the potential to become something more, and motivates them to see themselves as life-long learners who take responsibility for their learning. It also provides major motivation for their view of the way in which teachers ought to treat their learners and influences their view of what it means to create a learning environment that is conducive to learning mathematics.

Deprivation

All the student teachers recall school teachers that were unable to provide them with the kind of help they needed to do well at school mathematics – they have had deprived school mathematics careers (in terms of material/physical and epistemic/knowledge resources), however, within this they have all had at least one school teacher who provided them with a role model and this model has persisted through into their RU careers. I will come back to this positive image produced within the general environment of deprivation a little later, for now I will focus on the effects of deprivation on the pedagogic identity of RU's good subjects.

The first obvious aspect of deprivation is linked to what they refer to as their *lack* and their *ignorance* produced through their past and present mathematics learning opportunities. This is constituted by all the mathematics content and skills they did not access while at school, for a variety of reasons; including that their teachers did not know the work themselves (as The Minister puts it, did not have their facts straight), their teachers were so busy trying to catch up gaps from earlier deprived learning experiences that they were not able to cover required aspects of the curriculum (e.g. Mazet's matric experience); they simply had no teacher, or their teacher did not bother to attend class, and they attempted to teach themselves by bringing in resources from outside. Thus while at school they suffered gaps in their mathematics careers due to being deprived of teachers, deprived of qualified teachers, deprived of dedicated committed teachers, and deprived of resources such as textbooks. In particular they mention geometry and trigonometry as areas of the school curriculum that were areas of major neglect – these were simply left out, and they all express their dismay that they are also areas of major neglect in the RU curriculum. This was mentioned for the first time in the first focus group interview and then throughout all the interviews, as shown in the extract below,

- Mz ... we are expected to know everything (..) like we don't know some things, some things are left out
- TM Like geometry. We left geometry out! Whereas this is something that is known that even teachers at schools right now are afraid of it – they jump those things they don't do them. Then we find that even here they jump those things.
- (...)
- TM (...) I went to school and the teacher said to me – this is a very big problem can you teach us transformations. And I said, 'What is transformations?' [All laugh]. Mathematics? Mathematics and transformations? And he took his book and said this is it. We never did it!
- (...)
- P and we did not get proper information on geometry itself. Geometry, we weren't taught it.
- Mz but we were given work to present.
- P (interrupting Mz) actually, actually, in geometry. We were given some tips as how to teach geometry, not the content. We were given some tips on how to use some media. So we didn't do much. (GVT1-RU-B.Ed)

In their narratives all the student teachers tend to focus on *what* they know they need to know for teaching school mathematics – and this is for the most part focussed on the old outgoing curriculum – the one they know. They are largely unaware of what is in the new NCSM documents and do not recognise many of the aspects brought up in the discussions of the statements and in the some of the assessment questions presented for discussion. I'll return to this a little later in the discussion of the points of breakdown in the narratives. For now the focus is simply on the fact that all the students, in significant ways, were deprived of the opportunity to learn large parts of the school mathematics syllabus while at school, and then when they attended university some of those aspects that were most neglected as school level were ignored once again. The point that the RU Geometry course focused on grade 8 and 9 theorems and that they were put into groups and asked to present these using different media (principally charts, the chalkboard and OHP) was made on numerous occasions and underscores the student teachers' position that they were "given some tips as how to teach geometry, not the content" (GVT1-RU-B.Ed), and in a number of courses they were assessed for their teaching/ presentation rather their mathematical work (see Mazet's narrative).

This recognition of what mathematical knowledge is 'missing' in their careers is a major influence on these students' projected identities as teachers. These students do not want to be the kind of teacher "who doesn't get his facts straight" (The Minister, MBQ), who is lacking and can't answer the questions that learners ask (Phiri). They don't want to be like some of the teachers that taught them while they were at school and don't want to deprive their learners of huge chunks of mathematics learning (all).

This desire to know the content of what they need to teach and their recognition that they have not been able to gain access to all relevant content areas in their university experience is

expressed in a number of different ways throughout the narratives. However, what is striking about all their narratives is that for the most part the student teachers accept this as part of the way things are, it is part of their history. They recognise these gaps as a major problem but do not point fingers or angrily bemoan their situation. They see the problem, recognise gaps in their knowledge and then proceed to deal with this in a practical way, positioning themselves as active agents responsible for sorting this situation out. For example, The Minister explains that he can have no excuses for not knowing the mathematics he must teach – he sees himself as having the responsibility to find out what he needs to know, through whatever means he has available. I'll return to this issue of attitude towards gaps in their mathematical knowledge and discuss how these students deal with this a little later when the importance of the 'group' is discussed. For now I want to focus on the context of RU and expand on the ways in which it continues the deprivation of knowledge and resources experienced at school level.

Another feature of deprivation within this rural context is lack of access to the technology that is taken for granted in more affluent settings. For example, all the student teachers in the sample see the absence of any courses or formal learning about how to use computers effectively in education as one of the areas in which there is a major "lack". This lack however, unlike the others that involve aspects of teaching or doing school mathematics where there are resources to be shared, cannot easily be dealt with through getting help from the community. The issue of ICT first came up at the end of the first group interview,

- TM A question? At your university where you are with your students? Do you teach them computer skills? Is there any module on the computer?
- Di Everybody's got to be computer literate. So in first year if they are not computer literate they have to do it. If they come in and they are already computer literate they have to prove they are. They have to write their test. Or they have to bring, you know, this international computer driving licence - the ICDL
- TM okay
- Di They have to bring that. If they have it they don't have to do that course. Otherwise everybody in first year must do it.
- All Eish!
- P Its a crisis.
- Di Don't you do computers?
- All Ja.
- TM We are not doing computers. But now you go to schools. You are going to teach in rural areas where there is no electricity and no computers. But when you are doing teaching practice you don't always go to rural areas, you go to schools that have facilities. When you get there everything is computerised [...]. And it helps to have. But we do have access to a computer lab and we do go there. But we are never taught. You just grab whatever you grab and use it. (GVT1-RU-B.Ed)

While there is a general computer LAN at RU, the students reveal that this is a resource that is under pressure, all students want access, and often many computers do not work. Using the computers is not an everyday occurrence. All examples of work that the students selected to present to me as representing important areas of work they had done during their four years of

study at RU were written by hand – nothing submitted was typed (which is usually a requirement in more affluent universities). All students wrote their biographical questionnaire by hand. Within the RU context there is little opportunity learn to use computers for general teaching or administrative purposes (e.g. producing a worksheet, or for putting together a mark sheet), nor to specialise a consciousness with respect to the use of computers in mathematics learning and or teaching. While these student teachers were aware that they have been deprived of access to learning basic computer literacy skills, they had no awareness of their deprivation with respect to the use of technology in teaching mathematics. Tools such as the graphical calculator, spreadsheets, or specialised programmes such as Sketchpad were unheard of.

In the interview situation it became apparent that none of the students could even imagine how they might use technology for teaching/learning mathematics. For example, during the interview, while discussing an aspect of the curriculum statement²³⁵ this issue was raised with The Minister:

- Di: How do you see technology in teaching mathematics?
 TM: Come again?
 Di: technology
 TM: Eh?
 Di: When you think about technology?
 TM: Yes.
 Di: And you think about using it for teaching mathematics. Can think of that in terms of very simple things, like just even using ‘tools’ like a calculator, or a ruler and compasses, or a computer ...?
 TM: How do you think about using it?
 Di: Yes, technology to teach mathematics.
 TM: To teach mathematics?
 Di: Have you used any, have you thought about using any?
 TM: No to be honest with you no. Except, well, except with the modern calculator, it’s a calculator obviously.
 Di: It’s a calculator?
 TM: Except calculators, I say no. I don’t know whether OHP’s is a technology.
 Di: That’s more like a media for teaching?
 TM: A media?
 Di: Have you?
 TM: No I haven’t even thought about it! To use technology to teach! I’d say to teach mathematics, except obviously the calculator, (....) obvious you use the calculator when you are teaching them. It’s only the calculator, the calculator so far but (....) even if, I haven’t even thought about that, you see.

(IAT-TM1)

In probing the idea of using the calculator it became clear that the student teachers had simply worked with the (scientific) calculator themselves and it was obvious to them that they would have to use it for teaching trigonometry for example. However any ideas for how it might me

²³⁵ The NCSM encourages the use of technology for mathematics teaching, suggesting that learners in the FET would work towards the “use of available technology (the minimum being the modern scientific calculator) in calculations and in the development of models” (DoE, 2003, p. 10)

used productively for teaching and learning mathematics had not been considered at all, as Mazet put it,

Di: ... you were talking about learner, learner support materials what about using technology?

Mz: About technology?

Di: Ja. Have you thought about using any technology in the classroom (.....) for teaching mathematics, for learning mathematics?

Mz: (mumbling in a low voice – inaudible)

Di: An example of technology is a calculator.

(...).

Mz: I've seen that the calculator is more important now, you see when you are doing trigonometry, a calculator is more important on that one, since you have to use the Sins, Tan, and we only find these in a scientific calculator.

Di: So you've worked with calculators and you've thought about using them, how you'll teach with calculators. Have you worked with them and done something around that?

Mz: In a class in a school situation?

Di: In a school situation and here at University?

Mz: I think there's one [module] that we have done with a calculator when [Dr A] showed us how to use a calculator that was in 2004.

Di: So you feel you might know how to use a calculator in your teaching?

Mz: Not all the signs that are there.

Di: (Laughing) not everything there?

Mz: Not every, not everything. (...) Yes there's quite a lot to learn still. (IAT-M1)

There is an almost complete absence of technology as an aspect of contemporary life²³⁶ and education in RU student teachers' University experiences. The Minister's concern about not learning computers came from his experience of going to an "ex-model C" during one of his practice teaching experiences where he saw how teachers were using computers for preparation and administration. However there was no consciousness about the use of calculators and computers in and for teaching mathematics. For example there was no awareness that spreadsheets might be used or that there were programmes such as Sketchpad and Autograph that could be utilised in classroom contexts for learning mathematics. The experience of the calculator was of a general scientific calculator, not a graphical calculator, and it appears this was focussed on their personal use of the calculator.

They saw the issue of lack of access to computers as separate from their knowledge of mathematics or mathematics teaching. While they identified lack of opportunity for learning to work with computers as a 'crisis', it was not a crisis for the development of their mathematical or mathematics teaching identities. It is also interesting that, unlike the areas where they recognised lack of knowledge of mathematical content, there was no talk amongst the students at all about how they might use alternative resources, e.g. teachers in the community or fellow students, to gain access to computer technology – it was the one area where they felt the needed the faculty to provide them with the learning experience. This was not the same with

²³⁶ It is noted that all the students had cell phones and did keep in contact using these – however the use of e-mail and ICT is absent.

respect to other forms of knowledge where they recognised their ignorance, and where they acted proactively through their group to address this.

A further common feature of their experience of mathematics teaching can also be described in terms of deprivation. At RU practice teaching is constructed as experiential. The student teachers are allowed to select the schools they go to on the basis of proximity to their own homes, so they experience the same kind of deprived circumstances in the practice experience as they did when they were learners at school. The university (through lack of resources – funding for travel for students and lecturers and organisational capacity) do not organise practice teaching, select the practice schools or deal with mentor teachers. The Minister is the only one who reports having spent one practice teaching experience at a better resourced school and having the opportunity to observe teachers in practice. He was also lucky in that he was once visited by Dr A to be observed teaching mathematics. In general practice teaching experiences are characterised by the student teacher being left up to their own devices, attending the closet school to their home where they are expected to take over full teaching loads and to teach. The notion of practice teaching being a space for teacher learning under the mentorship of an experienced teacher is virtually non-existent and if it does occur it is the exception rather than the rule. Specialised assessment is also neglected and the student teachers' mathematics teaching identities are not shaped by any expert intervention or assessment. There is also an expectation that, since they come from the university, they know everything/ or that they know too much for their own good. When university lecturers come to assess (crit) them they really only look at their lesson plans and general teaching skills but there is no specialised help or tutoring. They are given high classes (Grades 10 -12) and expected to perform.

The location of the university within a rural context clearly intersects with specific opportunities to learn (and not to learn). General deprivation and degradation are features of rural life and the effect of these is to produce in these students a desire to fill the gaps created by their past careers and to provide opportunities for their learners in their future careers to have learning experiences that are not as deprived; to make a difference in their learners' lives. Their experiences of personal degradation (through punishment, intimidation, lack of respect and general neglect) in relation to their school mathematics careers has provided them with models of teaching that they reject and a desire to be different, to have as a basic feature of their teaching an ethic of respect and care.

3.1.2 The group

That this institution is located in a rural context also means that the majority of students live in residence during the term and this creates possibilities for the student teachers to form close relationships outside of the teacher education lecture theatre. This is also made possible by the general university time table – student teachers have approximately 15 contact lectures per week across all their modules and so have time during the days to interact and work outside of the lecture theatre. In addition the general rural context means that there are few opportunities outside of the University for entertainment or other aspects of contemporary social life, and that none of the students have the opportunity to become engaged in part time work which would take them off campus. This context provides a surprisingly fertile ground for the students to take responsibility for their learning and to create their own space to overcome some of the burden of their past deprivation.

In the very first focus group interview it became apparent that three of the four student teachers (Phiri, The Minister and Mazet) belonged to a specific ‘group’²³⁷. The following transcript extract from the first focus group interview held with the students at RU gives some indication of how important the group was to their development as teachers within this teacher education context. During the interview, The Minister mentioned that the three of them were part of a group and then went on to explain that this was not only something that was simply connected to their work for the modules, it was central to their University life and development as teachers:

- TM Hey we are close. You see if you want to find me, you can touch this one [pointing to Mazet] you can touch this one [pointing to Phiri - all three laugh]. They will know where I am. [All laugh] Also if you want her – I can sure be able to find her were she is. So even the experiences at school as we are coming from the teaching, when we haven’t even started our study group, but we will share our difficulties, how did we solve the challenges [...] of the experience.
- [.....]
- Di and do you think this is working?
- Mazet yes
- TM For us its working. **Really** working [strong emphasis in voice]. Because in our group you can’t find someone who is scoring eighty in mathematics and find someone who getting forty. [all laugh]. If one is failing all are failing. We don’t sit with information. If she knows something, it’s shared.
- Phiri You might find someone is getting 68, 72, 75.
- Di Okay. So in your groups you find you are all doing well and getting similar marks.
- All yes
- Di So do all students have good groups? Are their some groups that don’t work well?
- All [all say something at the same time - not clearly audible]
- TM Actually in ours when we formulated the group and were 12. But when we realised it was getting out of hand we put rules, because we are serious about working. If we decide we are working from 7 to 10, then you have to be there or apologise. And then if you go and you jol

²³⁷ Makhozi also indicated that she belonged to a similar group. However as she dropped out of the process she was not probed on this and so this discussion refers to the three students who belong to the specific group under discussion.

outside and don't come to group – we cut you out one time [claps hands – all three nod in agreement and laugh]. (GVT1-RU-B.Ed)

The group is mentioned consistently throughout the interviews and it appears to be the most important space for the negotiation of these three student teachers' pedagogic identity construction, as mathematics learners and as mathematics teachers. Over the years this group had taken on a particular identity as successful, and the students belonging to the group use various strategies, or micro technologies of power, in order to strengthen their group and themselves within the context of their own self-development as mathematics teachers.

Hardy (2004), drawing on Foucault's *The Archaeology of Knowledge*, explains that discursive practices differentiate people in relation to cultural norms that have become regulatory and often self-regulating ways of knowing. Knowledge is seen as produced through a process describing and ordering things in particular ways. It is this process that produces "subjects" – which are understood in both senses: as persons and as bodies of knowledge. Hardy (2004), explains that it is normalising mechanisms, which are technologies of power, that operate to produce what is taken as natural, taken for granted as an uncontested truth (as knowledge). Examples of such technologies are 'totalising' and 'individualising' strategies. These are used to delineate the normal from the abnormal. *Totalisation* is a group specification – it asserts a collective character (eg. we in the group do things like this). So individuals and their behaviour are ignored through the mechanism of totalisation and it therefore regulates group behaviour and asserts group characteristics. *Individualisation* is the technique of giving individual character to oneself. It may be an attempt to resist unwelcome totalisation, or it may be a mechanism for pointing out deviant behaviour from the norm and therefore establishing 'abnormality'.

In the formation of their 'group' we see the good subjects of RU changing 'the negative into the positive', using the space that they have and the resources they have access to within this, to constitute themselves as powerful agents acting in their own interests. This is illustrated in all the discussions with the three students about their 'group' and the role it played in their development. All three students identify strongly with their group. The group initially formed as a stable group because, as they reconstruct it now, they all had a similar 'mind', were committed to their studies and to becoming good teachers (a totalising strategy – establishing belonging). A core of them formulated a set of rules for belonging to the group – and if someone did not adhere to the rules they were defined as uncommitted and were kicked out (an

individualisation strategy to exclude aberrant behaviour). So a stable group (or community²³⁸) of students was formed – and they are all successful. They meet *every* weekday from 7pm to 10pm to work on various aspects of their courses, but particularly mathematics. If someone has a problem they have to explain to the others why they cannot come, and maintenance of membership is dependent on being reliable through regular attendance and when attending, on keeping focus on the work at hand. If need be they will also meet at other times, which often happens.

The group acts as the centre of these students' academic and social lives at RU. It is where they practice and discuss their mathematics, it is where they overcome their concerns over topics that they have not studied but know they need to know for their teaching, it is where they discuss their problems over teaching, and it is where they build their self confidence. The core of the group got together right at the beginning of their RU careers and they have stayed together throughout, As Phiri describes it,

Our group we simply said no let us work with a permanent group and then let us become friends so that we trust each other. Yes, yes. Its because it's better there. Even if you are not in a study, you seem to socialize relative to what you are doing inside the class. It's unlike if you are doing something with a person who stays away from you so you'll meet only when you are doing this work and then you go away, no. No, no! We get together, then we develop friendship, so that we might trust each other and correct some errors, even in social life. (IAT-P4)

The group appears to have a number of different functions in the lives of the student teachers. It forms a place for the students to deal with their course work and assist one another with problems they may be experiencing. It forms a place where they can investigate and assist one another to overcome their lack of knowledge in a particular areas that they recognise as important for their own development and growth as mathematics teachers It also acts as a place where they have all been able to develop strong mathematical and mathematics teaching dispositions.

The influence of the group for learning and succeeding in the various courses they do at RU is described in terms of sharing information – all three students explained that they would take turns in leading discussions and problem solving sessions. They use each others strengths to improve the whole group's performance and understanding. The Minister explains,

It works positive towards you because you gain, you share information, automatically when (...) I don't know exponents or something (...) Somebody will know it, definitely sure, somebody will know it. And it is different from the teacher standing in front of you teaching you because this person will be taking

²³⁸ I note here that this group looks like a 'community of practice' that seems to exhibit some of the qualities that Wenger (1998) highlights in his work. In this thesis I do not attempt to theorise the construction of the community – I simply signal that it does appear that what took place here was a development of a community of teacher learning which was productive for these 'good' subjects within this context.

you step to step in your pace, asking if you are not afraid to ask. You (.....) get to know one another, this one is good in mathematics, is good in this part of mathematics, is good there and this one is a slow learner, but something like that. (IAT-TM4)

Phiri's perspective confirms this attitude to the group and its role,

Phiri: These groups they are so much important because it's not everything that I know in a particular module or subject. So by sharing information, that is where the groups intervene, because you can find that I like a certain chapter in mathematics, then one member of the group likes a certain chapter, then by sharing this particular information it's where we put heads together and (...) we mix them together it becomes one thing.

Di: Is there anything else about the groups? I mean other than sharing of your information?

Phiri: Ja, it's just that it's so wide. Because it's where we learn some communication skills. How to communicate. It's where we learn each other, each other. And then giving each other some strategies because we are going to be teachers. Some strategies, as to which difficulties that you come across, maybe in practice teaching. Then how can we overcome those particular difficulties, because only to find that sometimes that the lecturers do not have time to check feedback from practice teaching. So it's where we try to solve problems on our own. So to socialize as a group. Yes(...) And then what I've discovered, about this thing is that if you are alone you may sometimes not see that you have done a wrong problem, you have the problem wrong. But if you are many and getting yourself in a debate of that particular problem, it's where everything started to be, to be clear to you that, oh, I've done this particular problem wrong. Sometimes you don't reach a consensus at the end, only to find that tomorrow you are going to go to the lecturer and confirm these answers that you have. Yes. (IAT-P2)

That 'the group intervenes' to solve problems is a common comment. This is particularly the case when speaking about gaps in their school mathematics knowledge. The group is what turns things around, what makes the negative positive. While the students do consult their lecturers for assistance in their courses, they also use a range of other resources including text books, the library and experienced (recognised) teachers practicing in local schools to develop their knowledge in the areas in which they recognise their lack. Phiri explains that the group brings in expertise to help them,

Di: So here you talked about the aspects of being a good teacher, and the kind of mathematical knowledge you think is important for the school curriculum. To what extent have you worked with this mathematics while you've been here at University?

Phiri: While I've been here at University? Working with this mathematics at school or working inside the University?

Di: I think both, like working inside the University. What mathematics have you been doing?

Phiri: Ok, ooh, ok I understand it now. Well we have done a lot in algebra (...). But we didn't touch on trigonometry stuff, trigonometry that I am using is from my past experiences. The trigonometry that I've done at home. And also analytical geometry there is not even a single day whereby we touched on analytical geometry. And in Geometry. In geometry we used to get maybe one problem when you're writing the exam, without learning anything on geometry. But it just used to be a minor problem that can be easily solved. So these are the things that we didn't do at all, geometry, analytical geometry, trigonometry. But anyway **we do have some understanding of what is happening there because we do make some study groups, looking at the things that are not scheduled for us in that particular module**, and try to cover it in camera and **sometimes we invite teachers that we know are better in that particular thing. Invite them at night.**

Di: That is interesting. That is because you want to know the stuff when you're out of school?

Phiri: Yes, yes **we want to know the stuff**. Sometimes this thing generates whereby when you are at school one can simply come with a question paper and say, "hey sir I'm having a problem of this particular geometry stuff". That's where **you start to think** and say, no **I'm lacking here**, so **I have to try some means to get this problem solved**. That's where **you came back and say and guys I'm having a problem** with this particular thing, so **let's try to organize and see what is it that we can do because this thing is not there in our modules**, yes. (IAT-P1)

Both The Minister and Mazet mentioned the group intervention in their Geometry learning, and The Minister in particular, in the final interview believed that this had assisted him to become confident to teach it.

For Mazet the group has provided her with a resource for dealing with her problems, as well as a place that has enabled her to learn how to practice mathematics and become a *mathematics person* – someone who continually does mathematics and works on problems. In particular she sees Phiri as a central figure in the group:

Mz: This group is so helpful to me especially mathematics, Phiri aaihh, he's the good one.

Di: Is he the leader?

Mz: Ja in mathematics he is the leader.

Di: What is it about him, what's he doing?

Mz: What he does is if you have a problem you can ask him anytime. Anytime he's willing to assist you. Even though he might not be sure of that now he will go and try to find it and he will come back to you, just look at it now you were supposed to look like this and that, you see and you have a clear picture. (IAT-M4)

The influence of Phiri in the group and of his attitude to mathematics in the specialised identity formation of the other group members is evident in the Mazet's and The Minister's accounts. The Minister sees the group, and Phiri, as central to his development as someone who knows mathematics, can solve problems in mathematics and who can:

... go to school and be a mathematician [laughs] or be a mathematics teacher and even the chapters that I was afraid of that how can I teach. Geometry! Geometry for me it was a big thing and I get motivated. (...) The group, you remember when I talked about my group. And my group was, ah, what **in terms of weaknesses and in terms of ignorance my group motivated me** as I was going there and **it makes me to say I can teach mathematics**. And there was one guy, not one guy because you know him, **Phiri** that we're with here. He's the one with whom we work with the problems who was also **inspired me to say no I can do it**. Right now **I'm not afraid**. Let's say I go to school and they give me a mixed class I take it, I have no problem for that. (IAT-TM4)

When asked to explain in more detail what it is that the group enables him to do, The Minister expands both on his understanding of what it means to solve problems in mathematics and on the role Phiri plays in pushing the members of the group to develop dispositions that make them see mathematics as a central part of who they are.

TM:(...) Whatever the problem you come with in mathematics, you know they [the group] could explain it to you until it's clear, up until it's clear. And **they've encouraged me to do lots of practice**, doing lots of practice and not hesitating to come to them if ever there is a problem you see, ja. And especially with Philani **we could do problems at any time even at night**. We were doing some of the problems with him last night.

Di: Which problems?

TM: We were doing something in Calculus, discussing some of the things that here and there give some problems (...) actually it emanated from those card games that you gave me, we were trying to analyse those things, how do these things work. So then it leads to some of the problems that we were doing with Doctor. So then there and then we see that we are puzzled in everything, Philani says "what is this? (...). I can't answer this thing! What is this?" And try to analyse it you see. So that worked and even if he says he grasps it earlier, faster than me then he would explain it to me. And at sometimes you don't even understand that day but we come back and say I've seen this at night, and he would say, I've seen this at night and it was this and this, can we try it? So even if

something I've given up, ah, ah, let me leave that by the way, this thing will not affect me. He won't let it go! Something like that, up until I get used to it too (.....) In such a way that I automatically, that injected me, and now (...) I cannot sleep when I don't know something, mmh. (IAT-TM4)

This reminds us of Phiri's description of when you have a mathematics problem that troubles you, you cannot let it go, you have to work on it even if you don't sleep until you have solved it, and the reward is the joy of getting the solution. What this transcript also illustrates is the commitment that these students have to learning mathematics and to finding out what they recognise they don't know. The card game that is referred to in the transcript was one in which the graph of function had to be matched with the graphs of its first and second derivative functions. The students had not seen anything like this before, and it made them go back to work they had dealt with in second year and the year before. They worked on it for a few days before coming to an understanding, at which stage they came to speak to me to discuss their solution.

While the group is clearly focussed on the academic and all the students who belong are committed to their work and to their own self development, it also forms a centre for social life. They are all friends and have build trust in one another. Mazet however does reveal that somehow the five boys in the group are different from the three girls. She sees the boys as generally more confident and suggests that they participate more fully in all the activities on offer at the university, particularly soccer. They don't have to go home at the weekends and are more mobile than the girls. She herself has family responsibilities with a child at home and another one on the way. One of the other girls has a husband who doesn't like her to spend too much time with others. That there are major gender differences within this context is clear. It was visible in the first focus group interview, where the men were far more vocal and relaxed in their communication than the women, who while clearly listening and participating were very quiet and allowed the men to speak on their behalf. While gender in rural teacher education contexts could be an avenue of research and exploration, in this study I am not able to deal with this issue. I just flag it here as something to consider, particularly in more 'traditional' contexts, as RU appears to be.

Across the interviews it became more and more apparent that for each of the students the group had become an anchor for their specialised identities – the place where they mutually negotiated their way through the various demands of learning from the institution and from themselves. The space that enabled the formation of the group and facilitated this form of 'empowerment' is an important aspect of the teacher education context that flourishes at RU.

It may seem that the constitution of the group and this space for specialisation *outside* of the teacher education lecture theatre was simply a consequence of living conditions and location. However, I would argue this is not the case. The attitude of the students, their confidence in being able to take on this burden and their commitment to mathematics and mathematics teaching is also directly related to their interaction with their lecturers and the confidence that their lecturers place in them and the expectations they have of them (as expressed in the narratives, most clearly by Phiri and The Minister). In all the students narratives we see mention, particularly of Dr A, and his influence on their identity formation, especially with respect to the way he interacts with them and builds their self confidence, the way he *cares* for them, the effort he puts into them and his constant willingness to interact with them, talk to them on a personal level. Another influence, and one that pushes them, is the message that he sends about them needing to take responsibility for their learning and for the need for them to be scholars and researchers within the context of deprivation (they will after all become higher grade teachers, even if the majority of them only studied maths at standard grade) and change in the system as a whole.

3.1.3 Problem Solving in Mathematics and motivating mathematics learning

A common thread snaking its way through all the narratives is the conception of mathematics as a subject made up of topics to be learnt and of problem solving as an essential component of learning and practice in mathematics. All the students identify with mathematics as a well structured body of knowledge that they must get to know – it is made up of topics containing both theoretical parts (facts/concepts/ definitions/ theorems) and methods and skills for solving problems in the topic. The way to get to know mathematics is to practice it using various problem solving methods and skills that are part of the subject itself. To learn this well you need to be assessed and corrected, preferably by a teacher who gets the “facts straight”. Critical thinking is essential in this, and from the place that the RU subjects construct their stories this is not about being creative in the sense of finding their own methods or constructing their own knowledge, but rather it is about being able to use the contents and skills together in ways that enable problems to be solved. Perhaps, in its ideal, this view could be likened to the idea of developing adaptive reasoning and strategic competence as described by Kilpatrick et al (2001).

All the students recognise that to learn and remember (not forget) mathematics, it must be continually practiced. They must do problems and apply knowledge and skills. This could be

described in terms of the idea of developing procedural fluency. The kind of problems that one should tackle in the classroom context are mostly seen as ‘pure’ mathematics problems, although all subjects do mention a commitment of some sort to relevance to ‘real life’ and the ‘practical part’ of mathematics. However as we saw in the narratives, for the most part this is about mathematics’ value in the ‘real world’ of their futures beyond school, but not necessarily about solving ‘real life’ problems. In glancing through the examples of work that the various students provided, we see the workings of a large number of problems they have solved, and in regard to these they are all problems in mathematics, with a few that are of the puzzle type requiring lateral thinking. The most dominant idea that comes through the narratives is that mathematics is relevant to life because it has the potential to get you access to further learning and careers. It is practical because it refers to measurement and shape and these are things you can see in your environment. It is not simply an abstract meaningless subject.

Connected to this is a further common thread: to learn mathematics you need to be motivated. In the narratives motivation to learn mathematics is connected to its value as a way out of poverty and access to future prospects – it is not generally connected to notions of enjoyment on a personal level or relevance to everyday life. (Makhozi is the exception within this context, she wants learners to love her classes and she wants to make learning mathematics meaningful/easy through bringing in the everyday. However, as she only attended one interview it was not possible to confirm this as a commitment by cross referencing to other discussions.)

To summarise, the students identify strongly with mathematics as received knowledge. They have specialised their mathematics identities and become ‘mathematics persons’, which they see as essential for mathematics teachers to be, through practicing mathematics. Learning mathematics is a challenge and requires a disposition: you must pay attention to mathematics (not yourself), you must concentrate (more than in any other subject), if you tackle a problem that causes trouble you have to persevere. You must seek help from others if need be and, as Phiri explained, you won’t sleep until it is solved; and when solved you will feel the joy, you will celebrate.

3.1.4 Mathematics teaching as presentation and providing opportunities for practice

Within all the narratives, mathematics teaching is described in terms of *presentation*. In the lectures where the students are put into groups and then expected to teach each other, what they are doing is presenting their work. What is meant by presentation in this context can be interpreted as presenting clear explanations of the concepts, facts and methods of mathematics.

Teaching aids (e.g. charts which are mentioned a number of times by all, and models mentioned by Mazet) are important to enable clear explanations. The general pattern for mathematics teaching projected by RU's subjects is expository teaching with questioning and opportunities for learners to practice (problem solve).

This image of teaching is entirely compatible with the image of mathematics projected in the previous section. Mathematics as a subject is a body of knowledge to be learnt and received, to learn mathematics you need clear explanations of theory and methods and then time to question and practice so that ideas are clarified and it is not forgotten. Thus mathematics teaching requires a teacher to provide good explanations for learners and the opportunity to answer/ ask questions (so their interpretation of what you are teaching can be monitored/ they are left with no questions) and to practice (so they remember the facts and gain the required skills).

3.1.5 Pedagogic practice and the ethic of care

While the description of mathematics teaching seems quite stark, and certainly not in line with policy images of 'learner-centred' teaching, neither is this projected image of mathematics teaching in line with the caricature in policy of 'bad' traditional practices, 'rote learning' or meaningless memorisation. While the description certainly does not evoke images of learners in groups constructing their meaning, nor of 'activity-based' learning as being central principles, it does provide an image of teaching that is concerned with learners' acquisition of mathematics. Learner's participation in lessons and their learning is a central feature of this practice, however the place from which this image is constructed suggests that in this ideological field, participation is listening in class, answering the teachers questions, asking questions for clarification, and practicing mathematics problems. It also means that as a learner you are motivated, willing to submit to mathematics, to persevere with problems and pay attention to mathematics. We recognise within this a description of a performance-based pedagogic modality (see Chapter 4 where this was discussed), a visible pedagogy with explicit texts to be mastered and performance evaluated against these texts.

However, this is coupled with a strong ethical orientation to care for the learner – a therapeutic identity that considers teaching as a vocation and that as a teacher you have to be committed and dedicated to your learners. You have to be available at all times to assist them if they require help. You will encourage your learners to ask you questions, even outside of class time. You will not intimidate learners, belittle them or show them up in front of others as lacking. If they make errors or mistakes you will guide them to the correct answers and you will help

them build confidence in their abilities, whether they are slow or fast learners. You will understand that they have backgrounds in learning mathematics and that sometimes they will not understand and learn what you have taught them because of a gap in their prior leaning or from previously incorrect learning. All the narratives recognise respect for, commitment to, love and compassion for learners as central to creating an environment conducive for learning. As The Minister puts it – you must have *heart* for your learners. This strong commitment to respectful interaction with learners appears to be based on two specific aspects of the student teachers' moral careers, firstly a rejection of their own past experiences of brutality and lack of love as school pupils *and* on their experiences of being taught at RU, particularly modelled on an image Dr A as caring and showing her belief and confidence in them and their ability.

3.2 Points of breakdown in the narratives

We have already seen that the RU subjects *feel* the gaps in their knowledge of mathematics and recognise their lack and ignorance in relation to all those aspects of school mathematics that they have not had the opportunity to learn in their school and university careers. They expected not to know some of the content of the school mathematics curriculum as described in the NCSM. However, there were still numerous points in the interview discussions around the new curriculum where they found they were unable to talk intelligibly about the mathematical ideas behind the assessment standards in areas they expected they would know well. The students did not all react in the same way.

Mazet was visibly nervous and began sweating whenever she was confronted by a mathematical question which she could not deal with and she would often become silent - there were often long pauses in the transcript. As the interviewer I needed to help her through some of these moments and 'let her off the hook', so to speak, letting her know that this was not an assessment and that she could say "I don't know how to answer that". At the end of the process as she was looking back she acknowledges that this has been an issue. She does not blame anyone for her predicament. She simply states that the process (of being interviewed for this research project) has helped her see where she is lacking:

Di: Just thinking about the whole process [being part of this research project] how do you feel having being involved in it?

Mz: Hee hee (nervous laughing).

Di: I saw you put your hand over your head?

Mz: It's interesting, very interesting because I have been able to see where I'm lacking.

Di: Is that what it's done to you, it's made you see?

Mz: Yes.

Di: Has it shown any of your strengths, has it shown what you know?

Mz: Not really much, ja.

Di: Not really?

Mz: Because there are some questions that I'm struggling to answer, yes. (IAT-M4)

The Minister went through a mini crisis at one stage, questioning whether he was ready to go out and teach. He had to be placated and then, after accepting that this was a new curriculum and that he couldn't be expected to know everything, he started interacting in the process wanting to question me every time I produced something he did not recognise. In reflecting on this process in the final group presentations he expressed this as something the whole group felt, suggesting that being involved in the research process provided an opportunity for him to grow and made him realise just how much he still has to learn. It reinforced for him that just because you have "finished a degree doesn't mean that you know everything, [... and ...] as a teacher you will have to continue to learn up until the day you die" (GVT2-RU).

Phiri also became visibly stressed during the process. At first his reaction to probing questions was to talk fast and try to fabricate reasoned responses²³⁹, until eventually he had to say, he had no explanation. Once this had been openly admitted, every time he got to a similar point, he would immediately admit it, say it made him feel a bit uncomfortable, and then proceed to question and attempt to use the interview for his own purposes.

The way in which these subjects reacted to these points of breakdown was very illumination. It supports the earlier conclusion that they are willing to recognise their ignorance when they confront it, and then to use the opportunities they have to turn it around, to address this ignorance through their own initiative and positioning as active agents in determining their future knowledge careers as mathematics teachers.

3.3 Identification with official discourses and projected policy identities

Within the narratives the dominant text for mathematics is strongly connected to orientation (4) in the NCSM; mathematics as induction into the subject so as to gain access to further study. While there is some talk about the 'practical part' of mathematics and relevance to the real world (orientation 2) this is not strongly articulated. There is also some orientation towards (5), mathematics as developed in historical contexts by different cultures – for example, all the students mention Pythagoras, not only in terms of Pythagoras' theorem, but as a figure in history, and Phiri specifically discusses how he would use history to motivate mathematics learning (as Dr A has done in his lectures).

²³⁹ More than any of the others, I felt that Phiri wanted to show me that he was informed and somebody who knew his stuff.

While the NSE roles appear to be strongly embedded in the design of the curriculum, the key aspect that is visible in the students' narratives is the role as life long learner, scholar and researcher. There is also some mention of the assessor role, and assessment is generally seen as important in assisting learning. Learners need to be corrected so as to see where they are lacking (as suggested by Phiri) so they can see how to improve. Assessment is not necessarily seen in terms of providing information for teaching, although all the students were attracted to the idea of analysing learner errors and misconceptions to see where these originated.

In terms of the general regulative discourse circulating in the ORF, the idea that mathematics teaching involves developing critical thinking is found throughout all the narratives. However, as was noted earlier, what this means is specifically related to the ability to work with mathematics and to use mathematics to further themselves later in life, and not necessarily to the idea of critical citizens. The commitment to social justice and inclusivity can also be recognised, however, these are seen in terms of providing opportunities for their learners to get access to the (real) mathematics they need for opening opportunity to future prospects and to the commitment to treating learners with respect and as thinking human beings, and the commitment to include all learners, fast and slow. It is clear that in the context of RU the idea of inclusivity is not linked to diverse cultural/ language – RU's subjects do not imagine themselves in the situation whereby they may be teaching mixed racial/cultural groups.

3.4 Reflecting on the content of the distributive rule in contemporary society

We find that the ideological field in which RU's subjects pedagogic identities are negotiated does not conform to Davis' (2005) discussion of the content of the distributive rule in contemporary society. This is a surprise, especially since originally this empirical site was selected on the basis of its curriculum design which appeared to be 'in line' with official discourses.

In particular we find that within this context the pedagogic subjects see themselves as sublimated to the subject of mathematics. Mathematical texts are recognised as external to the individual and require the individual to pay them attention. The focus of pedagogic practice is on the reproduction of specific texts and performance of skills, and evaluation based on recognising what is lacking in the performance; a performance-based pedagogic modality.

Confirming this is the orientation of RU's subjects to authority and tradition. These student teachers show a general respect for authority and tradition. They all refer to DR A and Dr B in terms of their titles and surname; no familiarity expressed. At the same time there is an atmosphere of mutual respect created within the pedagogic context. All the subjects present images of what could be recognised as 'traditional' teaching practices and are committed to becoming authorities within their classroom contexts – taking control of the direction of teaching and learning. Within this context, while there is a clear rejection of punishment as a means for controlling learning, there is respect for tradition. There is acknowledgement of the authority of mathematics, and of the lecturer/ teacher in the pedagogic context.

The contemporary commitment to utilitarianism does echo with one of the descriptions (Makhozi), however on the whole mathematics is valued for its ability to give access to future prospects and careers, rather than a focus on school mathematics as useful to every day life. The pedagogic subject of mathematics in this ideological field is someone who is disposed to hard work and engaged with mathematics, who recognises their weaknesses and ignorance in the subject and works to improving their knowledge, who will put mathematics first and will work tirelessly on mathematics problems that are troubling them, and when at last they succeed they will be filled with joy and celebrate.

In Davis' terms, these subjects fit the description of 'ego ideal' – still linked into more traditional ways of being – respecting authority (of their elders and of the subject mathematics). Access to mathematical knowledge for these subjects is through bending themselves to engage with a body of knowledge, and finding satisfaction in the discipline of bending themselves to its authority.

4 Conclusion

In this chapter I presented reconstructed narratives from four student teachers who were selected by their lecturers as 'good' subjects of RU. These narratives provide insights into their specialised identities as they 'become' mathematics teachers. The narratives are understood as arguments for who they would like to be (and not necessarily reflections of who they are or were), and are therefore projections of themselves through their speaking and writing. The analysis shows that the 'good' subjects of RU identify strongly with a fairly traditional conception of school mathematics. They present themselves as strengthened by their experiences of learning mathematics at the university and in particular empowered to learn and take responsibility for knowing the mathematics they need to teach well. They

recognise in themselves that they are not well versed in all aspects of the curriculum they will have to teach, but they mostly project confidence in themselves as skilful and able to find out what they need to know. They see themselves as people who practice mathematics, who work with mathematics and with problem solving on an ongoing basis. They recognise that not all mathematical problems are easy to solve. They have the disposition to persevere with a problem and work together as a team, to share knowledge, and to struggle to find out what they need to know. In this sense they see themselves as belonging to a community engaged in the practice of mathematics, skilled in its methods and able to learn. They are scholars and lifelong learners with the confidence to continue learning, humble enough to recognise their ignorance and strong enough to know that they must take responsibility for these gaps as they go into teaching. While it is not possible to say whether, when they get into a school, they will be able to realise these ideal images of themselves as able to ‘get their facts straight’, there is a commitment to mathematics as body of knowledge to be acquired and to be taught. To teach well they need to provide clear explanations and methods and motivate their learners. Their commitment to teaching mathematics is specifically connected to their desire to provide learners in deprived schooling contexts with opportunities to enter into careers that require mathematics; to provide opportunities for future employment. They need to be able to provide good explanations of the facts and methods that learners need to know to succeed in school mathematics, and they need to provide opportunities for them to practice these without fear, and to build their confidence by showing their care and their belief in them.

This account of the ‘good’ subjects of RU, fit to some extent with the hopes of their lecturers. Their specialisation as mathematics teachers is rooted in the opportunities to practice presenting their mathematics ideas in their lectures with Dr B; in their confidence to provide good explanations and models for their explanations; in their pride at being able to cope with university level Calculus and the new mathematics learning that they experienced within these lectures with Dr A; with the confidence they have developed through their lecturers’ belief in their ability to do mathematics and to teach it, and in the recognition given to them as capable and able; in their personal commitment to learning mathematics and mathematics teaching in their study group; and, the recognition they gained from BSc students doing mathematics for other purposes.

The images they present of themselves do not match well with all aspects of official identities projected from policy – however they are possibly realistic in terms of the realities of the majority of schools in the South African context. There is congruence with policy in terms of

understanding themselves as life-long learners and scholars, in terms of recognising the importance of providing access to mathematical knowledge which will lead to entry into further mathematics learning and career opportunities, and having an historical perspective of mathematics. However, in other aspects the images do not fit neatly with the official discourse.

The arguments these subjects present for themselves are not incongruent with their experiences at the institution. They have a fairly limited mathematics and mathematics education knowledge base (directly related to the limited time available for mathematically related courses in the curriculum and to the pedagogic practices instituted in the mathematics and mathematics education classes). However, they have deep commitment and access to a strong regulative discourse rooted in an ethic of care. The overall conclusion is that the ‘good’ subjects of RU have been specialised into forms of mathematical knowledge and mathematics teaching practices that would fit comfortably with the ‘good’ practice associated with the ‘old’ outgoing curriculum rather than the new global ideals. They do not appear to have gained access to the goods of contemporary society and their resources are generally localised to the people and knowledge already existing within their communities. While there are some aspects that are clearly recognisable in terms of wider ME discourses in the field, particularly the focus on errors and misconceptions and the tendency towards some form of constructivism in the ME classes, this is not clearly articulated in relation to mathematics and mathematics teaching and learning, where a didactic model is favoured.

Reflecting back on the selection of the case, we see that while the positioning of the institution at first appeared to be ‘official’ in terms of its formal documentation (see Chapter 5 on the selection of cases), it turns out, at after this analysis, not to be in line with official discourses. It is rooted within a context in which traditional relations remain deeply respected, on the periphery of modern technological innovations in education and society, in deprived circumstances where there is time for enabling good strong relationships and a level of care and ‘heart’ that is overwhelmingly positive, but where there are too few resources (human and material) to enable access to the ‘goods’ of modern global society and educational discourses. The practices of the institution while being consciously aligned with the official discourse, is unconsciously structured by traditional relations. The official discourse of OBE, where it is visible, is related in a few lectures that focus on outdated aspects of the original C2500 curriculum which were discarded with the review in 2000. The mathematics and mathematics teaching practices that are located in the fabric of the pedagogic space are

retrospective. In other words while the institution appears to consciously position itself as official, following the NSE in the design and organisation of its curriculum, the patterns of discourses visible at the level of the institutions pedagogic practices and at the level of the acquirer are unofficial – they support more traditional practices; practices that are more in line with the realities of mechanical solidarity that structure the social relations within the context than the forms of knowledge for a modern globalised world embedded in the official discourse.

In the next chapter I look back at the analyses of CU and RU and look across the cases to highlight similarities and differences within the knowledge discourses and practices. I consider what we can learn from these accounts for our work in mathematics teacher education, and in particular for the production of curricula for specialising the consciousness and conscience of mathematics teachers in and for South Africa.

Chapter 12

Cross-case analysis

1 Introduction

In Chapter 10 and Chapter 11 the analyses of the pedagogic identities projected by the ‘good’ subjects of each institution were presented and briefly reflected against the findings of the institutional analyses that had been in focus in Chapters 7 and 8 respectively. For each case this enabled the reinterpretation of the pedagogic context, and a final summary account of the pedagogic subjects projected from, and produced within, each site of MTE practice.

In this chapter the accounts of the two cases are presented in contrast to one another in order to illuminate similarities and differences between the contexts, the curricula, pedagogy, assessment practices, and the subjects produced. This is not done to evaluate what is offered by each institution, nor to evaluate or judge the pedagogic subjects who are the products of the institutions. Rather it is done in order to highlight different possibilities constituted in the field of MTE and to highlight questions for the field of mathematics teacher education. Specifically I consider how the knowledge and practices for specialising the consciousness and conscience of secondary mathematics teachers are distributed differently within each institution. The contrasting accounts are used to probe possibilities and challenges for MTE that seem pertinent in a country that continues to exhibit stark inequalities and differential distribution of material and epistemic educational resources.

The chapter begins by summarising and contrasting the analyses presented in Chapters 7 to 11. This is followed by a discussion of selected differences and similarities, and absences and presences, found across the two cases. These are used to illuminate the way in which the selections and organisation of specialist knowledge discourses and practices, recontextualised within each institution, are differently distributed and differentially open and close spaces for the specialisation of secondary mathematics teachers across the two contexts.

2 CU and RU: contrasts across cases at the extremes of the SA mathematics teacher education landscape

In this section the findings of the analysis presented in the previous chapters are summarised and some direct comparisons between the two cases are presented. The purpose of this is to present what might arguably represent two extremes in the field of MTE as it has been constituted in South Africa since the incorporation of the colleges of education into HE and the introduction of the four year B.Ed.

2.1 Context: the comparative advantage of the cases

Recall that the two cases were selected for their comparative advantage representing two extremes within the field of MTE. The cases were selected since they appeared to represent two institutions positioned differently in relation to official discourse of the ORF. While both institutions were compliant and had taken their B.Ed programmes through the formal processes in line with the regulatory policy of the state, RU was analysed as taking an official position with a holistic interpretation of policy based on the roles of a teacher, and CU as taking an unofficial position rooted within its own institutionalised curriculum traditions. The comparative advantage in the selection of the two institutions was ensured not only with respect to the institutions positioning to official discourses, it was also with respect to other features including: their history under apartheid (advantaged/disadvantaged); geographical context (urban/rural); campus (ex-college/general). Both institutions had incorporated a college and therefore experienced the structural changes in the teacher education landscape. Table 37 provides an overview of the context of each institution highlighting salient similarities and differences.

The contextual features of the cases confirm that the case study institutions are at extremes in the system. The most striking difference is with respect to resources. City University (CU) is urban, wealthy, and well resourced with both the physical and human resources to support its four-year mathematics teacher education curriculum. Rural University (RU) on the other hand is under-resourced in both aspects. While its mathematics education staff are well qualified (both lecturers have doctoral degrees as opposed to CU where the staff all have Masters degrees), these human resources are clearly stretched to their limits. Two staff teach all the specialist modules in the B.Ed curriculum to approximately 400 student teachers over the four years of study, as well as having other teaching responsibilities in the faculties.

Table 37: A comparison of some contextual characteristics and resources for MTE at CU and RU

Context	CU	RU
Geographic location	Urban	rural
economic position of students	differentiated (relatively wealthy and poor)	general poverty
student accommodation	mostly off campus (all students in sample live off campus); homes mostly in the City and surrounding townships	mostly in residences on campus (all students in sample in residences); homes from across province and neighbouring province
student funding	all students in sample have bursary; all students in sample have part-time employment to earn additional money (after school care; waiting tables)	all students in sample have bursary; none of the students in sample have additional employment; only financial support is from funding;
economic position of institution	previously advantaged; wealthy	previously disadvantaged; relatively poor
physical resources	dedicated computer LANS for education students specialised ICT software for mathematics teaching and learning ICT fully integrated into teaching/learning of all M related modules	shared ICT resources with general university (general LANS) limited access to education students ICT not used at all in MTE
	extensive dedicated education library (however it is noted that the students do not mention its use at any time during the interviews and none of the formal MTE assessment items explicitly require them to go to or use the library)	shared library with whole university, limited education collection (however it is noted that while none of the assessment items direct students to use the library, the students all mention going to the library to find resources to assist them in their work and learning, and the lecturer mentions directing them to the library to find resources)
human resources (no. of lecturers teaching specialist on-campus modules in 4-year initial teacher education programme)	5 permanent staff for the undergraduate programme (plus additional contract staff to assist with teaching large compulsory courses, i.e., the first year courses for all student teachers, the first year specialist courses that included primary maths teachers, and to develop course materials for the new courses ²⁴⁰). These staff members only teach the B.Ed students and do not have other teaching responsibilities. All staff have Master's degrees – one in pure mathematics, others in mathematics education	2 permanent staff members teach all specialist MTE modules in the B.Ed without assistance These staff members also teach on a variety of other programmes including the ACE, NPDE, Hons and Masters programmes. Both staff have PhDs, one in mathematics the other in mathematics education
Incorporation of college	one college incorporated in 2001; ex-college campus site of MTE; significant numbers of ex-college staff employed by institution; ex-college HDE phased out over time; new B.Ed phased in; first intake of B.Ed 2003; historical continuity in institution and curriculum	two colleges incorporated in 2001; both colleges closed; all teacher education functions taken over by existing university staff; no staff retained from the colleges; general university campus site of MTE; completely new B.Ed designed by university staff started in 2001 (delayed start; May 2001).
no. of SP/FET M students across all years of programme	less than 70 SP + FET mathematics student teachers across four years of study	approximately 400 SP + FET mathematics and science student teachers across four years of study
First language (home language)	mixed races/ mixed home languages	one race/ one dominant home language
Language of teaching and learning	English	English

²⁴⁰ For example: Mr/s Z explained that someone had been contracted to develop the linear Algebra materials; Mr/s Y had, before becoming a member of staff, been contracted to develop the statistics materials; Mr/s Y also indicated that contract staff were brought in to help her with teaching the first year Geometry/ Trigonometry module which had fairly large numbers. Mr/s X explained that this was made possible through efforts of the mathematics department to raise funds through a development project – an example of the department's ability to make contacts with and be networked into spheres of influence which enabled them to secure such funding.

The other stark difference is in the ICT resources available for the student teachers' personal use and for teaching and learning purposes. At CU these are available to all student teachers and are integrated into the teaching and learning contexts of all specialist modules. At RU access to students is very limited and ICT does not feature at all within the formal B.Ed curriculum. While basic lecture rooms, overhead projectors (OHPs) and chalkboards are available at each institution, we find that at CU there is a dedicated education library and access to general resources such as adequate photocopying facilities. At RU the education library is integrated into the main campus library and general resources are limited. In the field notes from RU it is noted that basic photocopying facilities were under pressure with all lecturers having to use the same copier located in the Dean's offices, and with paper rationed to each lecturer.

These contextual features form the backdrop for understanding the possibilities within the MTE programme at each institution. They highlight the positioning of CU as wealthy, urban and connected into networked society and the knowledge economy. Thus the institution is not only historically advantaged in terms of its apartheid past, but is also advantaged in the present with respect to its access to contemporary cultural, social and intellectual capital and the 'goods' of global capitalism. RU on the other hand, is understaffed, and its rural positioning is marked by general poverty and deprivation, both in terms of the personal positions of its student population and in terms of its ability to marshal resources to enable it to connect into global discourses and resources. Although the lecturers are well educated, they are fairly isolated and under extreme pressure from daily teaching loads which mitigates against their engagement and specialisation with respect to new forms of knowledge in the field. The culture of the institution and the schools that the institution serves are marked by poverty, deprivation and traditional authority relations.

In the next section I present a comparison of the contrasting aspects of the two cases, with respect to the general design of the curriculum in terms of the modules and credit values given to different aspects, the entry requirements and the general assumptions made with respect to student teachers entering each MTE programme. General comments are also made with respect to the differences in the organisation of time, teaching and learning spaces, class size and authority relations.

2.2 General design features and assumptions underpinning the curricula

Table 38 compares the overall curriculum design of each institution. These curricula were discussed in detail in chapters 7 and 8 respectively, and the details will not be repeated here. However, I will highlight some of the differences in design and interpretation of official discourse that become visible when the two designs are put up against one another. Table 39 compares the entry requirements for the secondary mathematics teaching degree, as well as assumptions made by lecturers about their students and the influence of this on the design of the programme. It also provides information about teaching spaces, class sizes and authority relations in the MTE lectures.

Firstly, as seen in Table 38 RU's curriculum is designed around the roles as described in the NSE. The roles are interpreted as distinct *contents* in the curriculum. Each role is allocated a number of different modules. The specialist role is allocated 45% of all credits. In the case of CU, while aspects of all roles can be identified, to a greater or lesser extent, within various modules, contents are not organised in relation to roles. The specialist role is allocated 50% of all credits. In terms of the overall figures both programmes appear to privilege the specialist role.

Secondly, we see that while both programmes have the same number of school-based teaching experience blocks, RU allocates no credits to this aspect and there is very little supervision or assessment of student teachers when out in practice. Thus practice teaching is completely *experiential*. Assessment of practice is summative and carried out by a lecturer who is not necessarily a specialist in the field. The rationale for this is connected to a belief that the NSE did not mention practice teaching – in other words it was not in the policy. The lack of credits meant that practice teaching could not be considered an independent course for which students should register and pay, and therefore no specific funds could be allocated to it. On the other hand CU allocates a substantial proportion of its credits to teaching experience and the programme is supervised and assessed by specialist lecturers. By allocating credits funding is made available for supporting the tutoring and assessment aspects connected to practice teaching.

Table 38: Comparison of general curriculum design features of the B.Ed at CU and RU

Design of the Curriculum described in terms of the NSE	CU	RU
specialist role (total of all credits focused on specialisations)	180 + 60 C = 240 across the first and second subject specialisations [i.e. a total of 50% of all B.Ed credits]	216 C across mathematics and science [i.e. 45% of all B.Ed credits] (note: Science includes Biology and Physical Science)
Basic competences (mathematical literacy; languages; ICT)	English (24C); second language (24C); mathematics (24C); ICT (12C) [total of 84C or 17.5% of B.Ed credits]	no basic competences specified
specific to role of 'mediator of learning'	no specific modules – integrated across a variety of modules	Communication and presentation skills (12 C); Language across the curriculum (12C); [i.e. total of 24C or 5% of B.Ed]
specific to role of 'designer and interpreter of learning materials and programmes'	no specific modules – integrated across modules (e.g. Curriculum (general and specialist modules, and Teaching Experience)	Introduction to design and interpretation of learning materials(12C); Theory and practice of learning programme design (12C); Media in Education (12C); Design and implementation of Learning programmes (12C) [i.e. total of 48C or 10% of B.Ed]
specific to role of 'scholar, researcher, life long learner'	Research project (12C) (possibly integrated into all other modules as well)	The philosophy of educational research (12C); Educational practice and research (12C); Basic elements of research (12C); Planning your research projects (12C); Data presentation and publication (12C); Research Design (12C) [i.e. a total of 72C or 15% of B.Ed credits]
specific to 'pastoral role'	Life studies in Education (12C)	Education for citizenship (12C); Health and environmental education (12C); Education for equality (12C) [i.e. 36C or 7.5% of B.Ed]
specific to role of 'assessor'	Integrated across modules (e.g. Educations Studies and Curriculum modules)	Introduction to school assessment (12C); Assessment in OBE (12C) [i.e. 24C or 5% of B.Ed credits]
specific to role of 'leader, manager and administrator'	integrated across modules (e.g. School in Context and Curriculum modules)	Introduction to school administration (12C); Managing the school as an organisation (12C) [i.e. 24 C or 5% of B.Ed credits]
Study of Education	6 modules of 12 C each [i.e.72C or 15% of B.Ed credits]	may be included in the 'mediator', 'researcher' and 'designer' modules – not seen as a study in-and-for itself
General Pedagogic and Curriculum Studies	2 modules of 12C each [i.e. 24C or 5% of B.Ed Credits]	Curriculum studies not visible, but general pedagogy in 'mediator of learning' modules
Practice teaching	6 modules of 12 C each [i.e. 72C or 15% of B.Ed credits] – students are assessed in practice at a variety of schools over 8 distinct teaching experience blocks. They are assessed on at least 24 separate occasions (three times per block) by specialist university based tutors across the four years of study. 4 of these practice blocks are focussed on mathematics teaching	no specific credits allocated – but students do go to practice in schools on 8 separate occasions, and are assessed 3 times for each specialisation while out in practice by university based lecturers (not necessarily specialists)

Table 39: Entry requirements, assumptions about students entering the secondary MTE programme, and the organisation of time and space in the curriculum

	CU	RU
Mathematics entry requirement	at least a SG C for matric mathematics	any attempt at matric mathematics (final result not considered a problem; fail in mathematics accepted)
assumption about students' prior learning	impoverished and authoritarian, procedural/ rote mathematics learning, mathematical meaning/ conceptual understanding not a focus of prior learning	impoverished and possibly teaching by specific examples directly from text books, little expectation of independent work and problem solving in practice
assumptions about mathematics learning	it is possible for all students, including those with weak mathematical schooling backgrounds to <i>become mathematical</i> (learn to think mathematically, and develop conceptual understanding) and to become competent 'modern' mathematics teachers through the programme (able to assist learners to develop their understanding through implementing discussion-based pedagogic practices)	it is possible for all students who have some background in learning grade 12 school mathematics, no matter how weak, to relearn school mathematics more thoroughly through the programme and to become competent mathematics teachers through the programme (able to solve a range of school mathematics problems and provide clear explanations for the methods used; to teach these to learners using their own explanations and aids and not to relay worked examples/ definitions directly from a text book)
assumption about students on programme	students recognised as being mathematically weak on entry and therefore in need of major teaching input through pedagogic contact; major context for learning is therefore the MTE classroom/ lecture theatre/ computer lab; independent homework is done, but the major place for learning mathematics <i>differently</i> is in the MTE classroom	students recognised as 'not knowing' mathematics on entry and therefore in need of practice; however they are constructed as 'able' and responsible for learning the required mathematics; they are expected to become independent learners; a focus on self reliance and use of resources in the community; most mathematics re-learned outside of contact sessions (individually and in groups) and class time used to build self confidence in teaching (presenting and explaining solutions)
teaching spaces	all MTE modules taught in computer LAN or flat seminar rooms with movable furniture; chalkboard/ white board and OHP are standard	all MTE modules taught in large lecture theatres with fixed rows of chairs and long horizontal desks; immovable furniture; chalkboard and OHP are standard
Size of classes	all MTE specialist groups relatively small (+/- 15)	all MTE taught in large groups (4 th years +/- 40, first year +/- 120)
Time	+/- 8 lecture periods per week per module therefore a total of +/- 35 periods per week (7 periods <i>contact</i> time per day); little time outside of classes for interaction with other students or self study during the day	+/- 3 lecture periods per module per week +/- 15 periods per week (3 periods <i>contact</i> time per day); plenty of time outside of classes for social and academic interaction
	480 C B.Ed of which 160C are specialist M, ME and MT [33.3 % of all credits for a first subject specialisation ²⁴¹] and a further 24C for compulsory M modules, i.e. a total of 184C [total of 38.3% of B.Ed C focused on mathematically related contents]	480 C B.Ed of which 108 are for M, ME and MT [22.5% of all credits]
community of M/ME/MT learning	strong community inside the lecture theatre (class discussion)	strong community outside the lecture theatre (the group)
authority relations	traditional authority rejected	traditional authority respected

²⁴¹ In a second subject specialization the number of credits is reduced (100C or 20.8 % of all B.Ed credits).

Thirdly, Table 39 shows relatively low school mathematics entry requirements into both programmes – a SG C at CU and any attempt at mathematics at RU. Both institutions make the assumption that students with low levels of achievement in school mathematics, can through their programme, become competent and confident to teach secondary school mathematics²⁴².

The way in which access to mathematics learning is made possible is differently structured at each institution. Firstly this links to the time made available for developing the mathematics specialist role in the curriculum. Time is directly related to the resources that are available within the context for developing the specialist role (in particular the number of lecturers involved, the time they are able to dedicate to teaching, and their access to specialised discourses for mathematics teaching and learning). Secondly it links to the way in which the distribution rule works to selectively make different forms of knowledge and practice available to pedagogic subjects across these two institutional contexts – that is, which groups get access to what forms of knowledge.

A key difference is related to contact time allocated to the specialist lectures (M or ME/MT focus), and time outside of the lecture theatre for independent and co-operative teacher learning. CU works on an assumption that students come into the institution weak in mathematics. This weakness is related to their schooling background in which they learnt mathematics in ways which focused on instrumental rather than conceptual understanding and the development of mathematical reasoning. Therefore students entering the programme require major teaching inputs so that they can relearn mathematics differently and through this learn to become more mathematical. Significant time is allocated to each module (approximately 8h of contact time per module per week). In addition a large number of credits are allocated to mathematics (particularly as a first specialisation). If the compulsory mathematics courses are also counted into the specialist role, the total proportion of the curriculum spent on M, ME and MT (including specialist practice teaching credits) stands at almost 40% of all credits. This use of time has both positive and negative consequences. On the positive side students are able to engage deeply with selections of mathematics during

²⁴² I do not challenge this assumption directly here. However, it is noted that recent international studies on the best performing school systems suggest that the quality of teaching is directly linked to the quality of teachers and the best performing systems only take successful school leavers (in the top third of their class) into the profession (Barber & Mourshed, 2007) and in particular those who demonstrate high levels of numeracy and literacy. A common assumption in RU and CU is that *any* matric mathematics student can relearn mathematics and become an effective mathematics teacher. This assumption needs further research – to what extent do weak mathematics school leavers make successful tertiary mathematics learners and successful mathematics teachers?

contact sessions; they have an opportunity to develop understanding and connections across a wide range of mathematical topics, covering selected aspects of most topics in the new school curriculum; and, as was shown in the analysis in Chapter 7 and 10, a strong mathematics teacher learning community is enabled *inside* the MTE lecture/ classroom. On the other hand this emphasis on contact with the lecturers means less time for independent learning communities to develop outside of the lecture theatre. Students become dependent on their lecturers for input and enjoyment of mathematics. They tend to dislike mathematics if they are studying it with a lecturer who does not work within the dominant pedagogic mode operating in the mathematics department. When faced with gaps in their understanding and knowledge, they tend towards blaming this on past circumstances, their teachers, or certain lecturers (see Chapter 10).

On the other hand at RU, contact time for the mathematics specialist modules was extremely limited. Each module was allocated 3 lecture periods per week and the proportion of credits for mathematics specialist modules stood at 22% of the total number of credits for the degree. Here it was assumed that while students came into the programme with poor matric results, this was mostly due to poor teaching in schools and meant they did not have the opportunity to learn the mathematics they needed. Students were therefore seen as ‘not knowing’ school mathematics (as opposed to being mathematically weak or incapable), and therefore in need of opportunities to get to know it. The lecturers positioned students as able and capable of learning mathematics independently however, they recognised that lack of opportunity in their impoverished backgrounds meant that they would need to (re)learn a large amount of school mathematics to get to know mathematics. The lecturers expected their student teachers to spend time learning old school mathematics outside of the lecture theatre, independently of the lecturers, and showed confidence in their ability to do so. They did not attempt to re-teach this mathematics in the contact sessions, and the contact sessions focused on providing the students with opportunities to gain confidence in presenting (teaching) their ideas to their peers. Some new university level mathematics was taught and worked on in lectures. This approach also had positive and negative effects. On the positive side it enabled the students to take responsibility for their learning, and the institutions ‘good’ subjects²⁴³ were able to develop self confidence and very strong communities for teacher learning *outside* of the lecture theatre, expanding their resources for learning mathematics beyond the lecturers influence into the wider community, including practicing teachers, students studying

²⁴³ We cannot say from this what happened to students who were not ‘good’ subjects. Whether or not they were able to marshal the same sort of resources cannot be gleaned from the data.

mathematics for other purposes, and resources from the library. These students presented themselves as empowered and while aware of large gaps in their knowledge in relation to school mathematics, positioned themselves as ‘life-long learners, scholars and researchers’ who would take responsibility for finding out what they needed to know. However, at the same time the limited space for the specialisation in the curriculum resulted in very limited coverage in terms of the contents of the curriculum, limited opportunities for students to be evaluated in relation to their mathematics learning, and limited opportunities to learn new aspects of mathematics. The students did not get access to covering the basics of many of the new topics included in the NCS. In addition their access to outside resources was limited to what was available in the local context.

The formal learning spaces and resources used for developing mathematical identities within each context were also differently structured. At CU, given the small numbers of student teachers in the classes, far more intense and close relationships could develop between the lecturers and students than was possible in the context of RU. The social relations between the lecturers and students were relaxed and there was a flattening of hierarchical social relations. The teaching spaces at CU were all flat seminar rooms with movable desks which facilitated the discussion-based pedagogic practices instituted and enabled an orientation to learning mathematics, and a relationship with mathematics, as meaningful and connected. The students also had access to dedicated computer LANs and ICT resources that were integrated into their mathematics studies and enabled access to different ways of thinking, visualising and doing mathematics that would not have otherwise been available. The lecturers’ specialisation was such that they had access to these resources and were connected into networks and positioned to utilise these resources to structure productive mathematics learning opportunities. Lecturers spent a great deal of time responding to student teachers on an individual basis, for example through assessing written work and projects, a practice that would probably be unsustainable with large numbers of student teachers.

On the other hand at RU all classes were held in large lecture theatres with fixed furniture. Respectful and more traditional social relations were developed between lecturers and students. Lecturers had to deal with large classes with limited time available for interaction. The strategy for coping involved students taking responsibility for relearning ‘old’ mathematics outside the lecture theatre and gaining confidence in their teaching abilities by presenting ideas and solutions during contact time. This was all done through the use of ‘groups’. Student teachers thus had the opportunity to develop confidence in their ability to

learn independently (outside of the lecturer theatre in self organised groups) and to present their solutions and ideas to their peers (inside the lecture theatre *as a member of a group*). Presentation skills, explanations and use of teaching aids in these ‘teaching practices’ were evaluated, as a group. This group teaching method worked to enable co-operative learning as well as to create time for the lecturer to manage the numbers of students involved. The method was used specifically for working with school level mathematics that ought to have been learnt previously. In other mathematics classes where students were learning new university level mathematics, there was direct teaching as well as opportunities to work on mathematical problems under the gaze of the lecturer. While RU students did not have extended access to new mathematics learning opportunities within the contact sessions, because of their positioning and their desire to overcome their ignorance, and through the constitution of their group as a strong learning community, they were able to access resources from outside of the formal learning context to provide assistance in areas where they identified gaps that their curriculum had left open (e.g. lack of access to knowledge of geometry and trigonometry). At RU there was no access to computer facilities or other technology (such as graphic calculators) and apart from the ordinary scientific calculator technology did not feature in the structuring of learning opportunities.

The interesting contrast between these two institutional contexts highlights the point that possibilities for access to knowledge and practices in MTE are highly contextual. The resources available within a specific location, both human (number of lecturers, time lecturers have for preparation and teaching, lecturers’ specialisation into mathematics, mathematics education and mathematics teaching and connection into networks) as well physical and material (e.g. lecture spaces, technological resources) and connected to this the availability of time inside and outside of the lecture theatre, makes certain relations more possible and others less possible. What was possible in each institution in this study opened different spaces for teacher learning – at CU the spaces *inside* the lecture theatre and access to technology for teaching and learning mathematics, and at RU, spaces *outside* of the lecture theatre and access to community resources for teaching and learning mathematics. In the next section I consider selections of specialist contents into the curriculum and contrasts between the pedagogic modes through which these were made available.

2.3 Mathematics, Mathematics Education and Mathematics Teaching discourses, practices and identities

Earlier I suggested that what was possible at each case study institution was influenced by the context and the availability of human and material resources. This is reflected in the selection of knowledge and practices in the curriculum, and how these are made available. Table 40 provides a comparison of what is constituted as mathematics at each institution. Table 41 provides comparisons of what is constituted as mathematics education and mathematics teaching respectively. These selections and means of making them available are recognised in the identities that the selected ‘good’ subjects of each institution project, as described in Chapter 10 and 11. In each case, aspects of the descriptions produced through the analysis of the institution’s curriculum, observed pedagogic practices, and formal assessments are reflected in the ‘good’ subjects’ narratives. The descriptions assist in understanding how the differential distribution of knowledge and practices, at each site of MTE, have worked to differentially specialised pedagogic identities.

At CU the dominant discourse for specialisation in mathematics, mathematics education and mathematics teaching is underpinned by a form of pedagogic constructivism informed by particular orientations to mathematics teaching and learning and an approach to MTE. This orientation sees the mathematics initial teachers need from a perspective of mathematics for teaching (*MfT*). This perspective, as projected within CU, explicitly undervalues learning mathematics from a disciplinary²⁴⁴ perspective, and in particular it considers traditional university mathematics as an inadequate basis for subject knowledge for teachers and teaching. Relevance for mathematics teaching from this perspective is informed by an interpretation of what is required to support selections of official knowledge within the school curriculum (NCSM) and a commitment to provide teachers with a deep conceptual understanding of the basic mathematical resources to enable them to work with this curriculum in teaching. *MfT* is explicitly recognised in terms of learning to ‘unpack’ (decompress) mathematical meaning as opposed to learning to work with compressed mathematical forms. Cohesion in the ideological field in which identity formation of the good subjects of CU takes place is stitched together through these orientations as evidenced in the account produced in Chapter 10, and exemplified in the model of good mathematics and mathematics teaching practice presented by Mr/s X.

²⁴⁴ Recall that a disciplinary perspective refers to mathematics as a discipline produced and reproduced by mathematicians – this is not to imply that *MfT* does not have a disciplinary focus – however it is different from the focus of the discipline of mathematics.

Table 40: Mathematics in the teacher education curriculum

	Constitution of M				
	What	How	Why	Who	Time (nsh)
CU	compulsory M contents (Maths for Life; General Mathematics in Teaching)	large lectures; tutors; directed at all initial student teachers, regardless of specialisation; practical work;	All teachers need to know maths taught lower down in the primary schools and have access to basic competency for living in a mathematised society	professional practice lecturers	240
	M to cover all areas of the new NCS; (implicit: model of MT and selections consciously structured through specific orientation(s) to ME)	small lectures; discussion-based pedagogic mode; focus on understanding and 'unpacking' meaning; making connections across maths topics and between ideas; use of computer technology to assist with visualisation and investigations; focus on getting deeply into the concepts and understanding – less focus on fluency and more emphasis on relational understanding and productive disposition; use of student productions and error analysis to evaluate and direct teacher learning;	teachers need to re- learn old school maths differently, learn new school maths and some university level maths in non-traditional ways; as a basis for learning to teach the NCS, teachers must know how to “unpack” maths concepts and understand connections within and between different aspects of mathematics; they need to develop their mathematical reasoning abilities and learn to explain mathematical arguments in 'non-compact' ways using ordinary language	College mathematics lecturers (Mr/s X, Y and Z)	720
	M to cover some university level mathematics: calculus and linear algebra. (implicit: model of MT and selections consciously structured through specific orientation(s) to ME)				240
non-traditional relations to knowledge; flattening of hierarchical social relations; structured by official and ME discourses; global and local influences					1200
RU	to cover some school mathematics (no clear link to NCS; selections mainly focus on aspects of old HG algebra syllabus)	large lectures; independent and group problem solving; students' presentations of solutions to peers (a from of MT); student use of teaching aids to assist with visualisation and to provide clear explanations (evaluated); problem-solving (doing problems) and a focus on procedural fluency; focus on building self confidence in problem solving and developing presentation skills (relatively explicit model for MT developed in lectures through student presentations)	teachers need to re-learn selections of old school maths (particularly HG topics which they may not have learnt while at school) in a different way from which they might have experienced it at school: they must do the maths themselves (problem solving); they need to gain confidence in their ability to stand up and present their ideas to an audience in English; they need to present clear explanations and use appropriate aids to assist (e.g. charts) as a basis for learning how to teach better (than they were taught)	students: group presentations of solutions; and evaluation of solutions and teaching skills (by Dr B) Dr B	360
	to cover some university level mathematics (calculus) (implicit model of MT)	large lecture theatre; lectures and lecturer lead problem solving; students work on problems with lecturers assistance in class; student productions as a basis for exploring solutions; large amount of independent work outside of lecture and group discussion and problem solving (doing problems); focus on procedural fluency, and possibly strategic competence and adaptive reasoning; focus on building self confidence.	teachers need to learn maths differently: they need to work through problems and develop problem solving skills; they need to learn confidence in their own abilities to do mathematics; they need to use a wide range of resources outside of the class to assist as time is limited and everything can't be done in class	Dr A	240
traditional relations to knowledge; positional respect in social relations; care, community and self confidence; structured by local needs and old school M					600

Table 41: Mathematics Education and mathematics teaching in the teacher education curriculum

Constitution of ME					
	What	How	Why	Who	Time (nsh)
CU	Curriculum modules: integrate M and ME, models MT; working with aspects of school mathematics as a basis for teaching and learning; some ME discursive resources; practical ideas and pedagogic arguments grounded in experience of M learning and teaching	small group; discussion-based; use of student productions as a basis for developing ideas for mathematics teaching and learning; privileged pedagogic mode modelled by lecturer through her teaching; some reflection on the lecturers practices and choices	integration of ME and MT in a context where students can reflect on the school curriculum, their own knowledge of M and their experiences of learning M, teaching M and learning to teach M in a 'different way' guided by a 'master' teacher (Mr/s X)	Mr/s X	240
RU	Planning for Mathematics: some OBE type training (knowledge about that) and a focus on selections from school maths (algebra: exponents and logs;)	large group; student presentations; focussed on doing school mathematics outside of lectures and presenting (teaching) ideas and solutions to peers	get to know topics in school mathematics better (exponents and logarithms); develop confidence in presentation; develop competence in planning and delivering lessons	Dr B	120
	Errors and Computation; Instruction in Mathematics; Assessment in Mathematics Education	large group; class discussions and working towards a consensus; open ended and draws on student teachers knowledge and experience	to develop a 'basket' of ideas and practices for different contexts that can be drawn on to make teaching decisions in practice	Dr A	360
Constitution of MT					
	What	How	Why	Who	Time
CU	Model of teaching/learning (image) implicit in delivery of M and Curriculum modules; practical and experiential; self reflection (includes: discussion-based pedagogy; listen to (hear) and use student productions – errors and misconceptions; selection of tasks and appropriate examples; unpacking definitions, etc)	small groups: through lecturers' modelling of M teaching in formal courses (M and Curriculum Studies); use of teaching 'laboratory' (observing lecturer teaching a class brought in for the purpose), video and reflective discussions; <i>individual</i> : specialised teaching practice (placed by maths department in selected schools; specialist tutoring; and assessed at least 12 times over the four years of study by specialist tutors)	to learn to teach students need to reflect on their own experience of learning, examine and discuss expert practice (Mr/s X and mentor teachers as models) and practice in classroom contexts under the guidance of a practicing teacher and university tutor	modelled by lecturers in M and Curriculum classes (Mr/s X and Y); tutoring and assessment by all <i>specialist</i> lecturers/ <i>specialist</i> contract staff (assessed 12 times in 3 years); mentor teachers in schools (selected)	720
RU	teaching as 'presentation' (expository; explanation using visual aids; teacher led question and answer sessions); participation of learners in question and answer sessions and problem solving activity ; awareness of learners prior knowledge and ways of thinking	<i>large groups</i> : modelled in practice by students presenting solutions to problems in Dr B's M and ME classes (group 'presentations'); building confidence through respect for individual ideas and belief in their capacity to succeed (modelled in Dr A's classes); <i>individual</i> : experiential practice in self-selected schools; no specialist tutoring or assessment; 3 formal assessments by generalists over 4 years of study)	to learn to teach students need to practice their presentation skills, build their confidence to stand in front of a large number of learners, explain and discuss M and solutions to M problems; experience in schools will help develop MT confidence and ability (lack of supervision in schools is due to insufficient resources)	specialist evaluation in M classes (Dr B); assessed by generalist lecturers in practice (MT assessed 3 times in 4 years); student teachers in self selected schools	no specific credits allocated; approximately 24 weeks of experiential practice over 4 years

The resulting dominant mathematical identities projected from CU's good subjects are ones which favour conceptual understanding as a major aim of learning and teaching mathematics, a relationship with mathematics as personal and meaningful, an orientation to mathematical knowledge as connected and best learnt through discussion-based pedagogic practices. Personal competence in mathematics is considered in terms of conceptual and relational understanding (and technical competence and procedural fluency are not considered as necessarily important). The privileging of discussion and understanding tends towards a practice in which pace and coverage in the MTE class is often compromised in the face of the requirement to understand. While it is not possible to measure the scope of the implemented curriculum, it is probable that a narrow deep focus across a selected range of mathematical topics is privileged. The extent to which the substantive structure and syntax of the discipline itself (as discussed in relation to Shulman's work in Chapter 2) is accessed is not possible to determine. However, the spread of modules does cover the basis of all major aspects of the NCSM and takes the student into a limited selection of what would be recognised as first year level university mathematics.

From the evidence analysed it is not possible to say anything about the *realisation* of these privileged forms of mathematical knowledge and understanding, or about the student teachers' internalisation of these. However, the analysis of formal assessment items suggests that 'unpacking' may not always be realised as an autonomous internalised ability. While there were a wide range of formal assessment tasks in the CU archive, many required procedural reproduction. In general the analysis of assessments items showed a tendency towards detailed scaffolding of questions which may or may not have led the student teachers into processes that enabled them to unpack the mathematical ideas independently. Nevertheless, the selected 'good' pedagogic subjects projected a view of themselves as motivated by the enjoyment of coming to understand and discuss the meaning of mathematical ideas through forms of 'unpacking'. They were not enthused by 'traditional' teaching and most found it difficult to learn effectively when faced with what they recognised as traditional teaching, which three out of the four good subjects saw as necessarily leading to boredom and meaningless learning. The observed pedagogic practices in the MTE class suggested that ME and MT were constituted in terms of these images of mathematics. While *MfT* itself was constituted in practice as a disciplined activity drawing on the discipline of mathematics itself for justification and meaning, ME and MT were integrated and more practical accomplishments drawing on experiences of learning mathematics in the MTE class, observations of examples of teaching, as well as reflections on teaching practices.

In contrast to this, discourses which appear to underpin the specialisation of mathematics, mathematics education and mathematics teaching at RU are not recognisable in terms of a specific dominant epistemological or theoretical grounding within a discursive field, nor in terms of specific policy or official discourses. They appear to be driven more by ontological realities of the context and to depend on traditional understandings of ‘good’ practice. Social cohesion for the good subjects at RU seems to be underpinned by an ethic of care and commitment, a common experience of poverty and deprivation and a need to make a difference in the lives of the disadvantaged, stitched together by the development of a community spirit constituted by practices within the ‘group’ for learning mathematics and mathematics teaching. This is supported by more traditional authority relations, values and mutual respect, and draws in the resources of the wider community (of existing teachers and network of local relations and relationships). The lecturers’ specialisation in mathematics and mathematics education does not appear to be as influential within this context as it is at CU. Teachers do not clearly reveal their own positions, although there is a tendency in Dr A’s practices in ME classes towards a competence-based pedagogy that works on the basis of experience, sharing of ideas, and consensus, a form of social constructivism which takes its grounding in the collective experience. In general, having to deal with the practical realities of large numbers of students with few resources and with large gaps in their knowledge, means lectures do not have the luxury of pushing a specific approach to knowledge and practice in their mathematics classes. Rather there is a more practical orientation and the ideological field is stitched by lived realities within a context of rurality and scarce resources. Lecturers are concerned that their student teachers have experiences of learning mathematics and teaching mathematics that will develop their self confidence and self belief. This approach emphasises the importance for teachers to become life long learners and to develop confidence in themselves to become knowledgeable and successful mathematics teachers in the future.

The pedagogic subjects of RU are therefore specialised through a discourse that recognises mathematics as a powerful body of knowledge that is constituted through its own rules and methods and that is reported to provide access to opportunities in a modern technological world. Mathematics must be mastered, its facts and contents must become known and methods and skills for solving its problems must be learnt so that they can be explained and presented in ways that are understandable and will provide access to these opportunities to school learners. Selections of mathematics to be mastered include aspects from school mathematics that the institutions pedagogic subjects were possibly deprived of in the past (HG topics) as

well as what is understood as the basics of university level mathematics. These selections are limited by time and space in the curriculum and while retrospectively filling some gaps from the past, leave out much of what is new and different in the new official school curriculum (for the future). In particular there is no access to new forms of technology for learning mathematics and developing ways of thinking in mathematics, and to new ways of thinking about and learning geometry, trigonometry and algebra. The experiences of learning mathematics at RU develop a different view from what might have been experienced at school level by the student teachers – in particular that to learn mathematics it has to be practiced independently. While good explanations and the presentation of different methods for solving problems are important and essential part of good teaching, learners must work through problems and exercises themselves to become proficient and to develop understanding of mathematics.

The resulting dominant mathematical identities projected from RU's good subjects favour personal competence in mathematics as related to the ability to solve mathematical problems (exercises), to know the content of mathematics and have all the 'facts straight' in relation to the topics to be taught. Understanding is understood in terms of being able to work with the facts and mathematical methods within a topic to successfully solve specific problems and exercises. In this context mathematics is understood in terms of received knowledge and teaching as a didactic practice. While from the evidence analysed it is not possible to say anything about the realisation of these mathematical forms and understandings, or the student teachers' internalisation of these, the analysis of formal assessment items suggests that procedural competence and ability to reproduce standard exercises is privileged with no expectation seen within the assessment items for any explanations that require the production of syllogistic chains of reasoning or explanations for the underlying deeper meanings attached to specific forms. All assessments in the RU archive required procedural reproduction of well established mathematical forms. Within this context MT is constituted as a practical activity related to the delivery of good explanations with the assistance of teaching aids and the development of confidence in the ability to present correct solutions to a large audience using English as a medium of communication. While recognising that learners may come to the classroom with different experiences and backgrounds, and that it is important to understand these differences and the errors that may be produced through prior experiences, access to mathematics will be enabled through providing good explanations and examples, clear facts and methods for working with mathematical problems and the opportunity to practice mathematics so as to internalise these facts and skills. The teacher needs to be there for their

learners – available at all times to provide explanations and assistance, to motivate learning through conveying the importance of mathematics for advancement in life. Teachers should be respected and recognised as authorities in the subject and should provide caring environments in which learners feel able to ask questions without fear of punishment or personal degradation. Mathematics Education is constituted in this context as a domain of practical ideas and tools/tips for enabling such an environment. The ‘basket’ of tips for practice is produced through discussion and consensus. There are no right or wrong ways of doing things. Choices should be rooted in, and relevant to the realities of the context.

To conclude this part of the discussion we reflect on each case in relation to discourses circulating in the ORF. Table 42 provides a comparison of the orientations to school mathematical knowledge in terms of the analysis of the NCSM (see Chapter 4). Orientations to mathematics education/ teaching practices are compared in Table 43 by considering meanings attached to specific terms circulating in the official discourse of the ORF; for example, what is meant by ‘learner –centred’ teaching; ‘participation’ in a mathematics classroom; ‘facilitating mathematics learning’; ‘activity-based’ learning; and so on.

The two tables highlight the conclusions reached in Chapters 10 and 11 with respect to the positioning of CU and RU relative to the discourses in the ORF. CU is largely ‘in line’ with images projected from the ORF, which are in turn reflections of global discourses in mathematics education and education more generally, responding to demands for flexibility, creativity and ability to work in the contemporary information society and knowledge economy and with non-traditional forms of communication. Thus while CU appeared at first (in the selection of the cases in Chapter 5) to take up an unofficial position with respect to the images projected by the ORF, after the analysis it turns out to be the opposite – its practices are official. On the other hand RU is generally ‘out of line’ presenting a more traditional view of mathematics and mathematics teaching, rooted in the need to work within traditional authority relations and with more traditional forms of classroom communication. Thus, while RU appeared at first to take up an official position, it turns out in the end to be unofficial in practice.

Table 42: Orientation to mathematics (as analysed in Chapter 4 in relation to official school mathematics from the ORF)

Orientation to math (NCS)	CU	RU
1. mathematics for critical democratic citizenship	not observed as a focus	not observed as a focus of mathematics; good subjects see social justice in terms of providing access to future economic empowerment
2. mathematics as relevant and applicable within different contexts including real life	applications are mentioned as a way to make mathematics relevant and meaningful; understanding of application is nuanced; relevance is connected to the mathematics in and for itself and not necessarily for use value;	interpreted in terms of practical relevance; linking mathematics to the everyday through sensible metaphors; everyday does not seem to be a way proving sensible entry to M ideas, rather as a motivating factor – an assertion that mathematics is practical and meaningful
3. mathematics for inducting learners into mathematical practices	very strong on mathematical practices; particularly developing conceptual understanding, adaptive reasoning and productive disposition; mathematical thinking and reasoning, investigation skills etc	not emphasised in own M learning; a focus is found in some ME modules (e.g. Instruction in Mathematics); appears to be part of knowledge 'that' in MT/ME but not visible in the practices of doing M or MT
4. mathematics involves mathematical structures, conventions, skills and algorithms to master	weakened focus – while mathematical structures are seen as significant, time is not spent on developing mastery of facts, skills and algorithms; procedural fluency is devalued	very strong focus; problem solving seen in terms of developing methods and skills and applying these to exercises and problems; development of procedural fluency seen as the basis for developing understanding
5. mathematics as a human activity produced historically in cultural and social contexts	is seen as a human activity since social learning is important – but the idea of social production of mathematics as historically situated is not visible in data	historical focus is emphasised (reflecting on people who were involved in producing mathematical ideas) however it is not clear if these are seen in terms of the development of the mathematics ideas or simply as stories of mathematicians and their ideas.

Table 43: Mathematics teaching practices in policy and institutionalised discourses

	CU	RU
learner-centred	listen to learners, work with their conceptions, misconceptions and errors to guide them to understanding; use discussion as a means to guide them; important to evaluate learner's thinking through discussion and negation; do not engage in direct teaching, rather structure learning opportunities to ensure that learners engage in their own learning and remain involved and motivated; provide plenty of opportunity for them to be involved in talking about and explaining their ideas; use carefully selected examples likely to lead through cognitive conflict to understanding of important mathematical ideas	understand where learners are coming from and realise that they may have had prior teaching/learning experiences in which they were treated badly or through which misconceptions were taught; help them to correct misconceptions and errors in their understanding and thinking by providing clear explanations and plenty of opportunity to practice mathematics so that they can overcome difficulties; care for them and be there for them when they require help (at any time even outside of normal classes and on weekends); answer their questions
Participation	involve learners in discussions (whole class and in small groups) to unpack the meaning of concepts and link these to other concepts so	make sure that learners participate in class by getting them to answer questions; make sure that they work in class; they should

	as to develop understanding in mathematics; involve them in individual work and encourage them to develop their own mathematical arguments (they must be able to convince others of their solutions and ideas on mathematical grounds); encourage learners to write solutions on the board and to share their ideas with others; create an enabling environment where all ideas are considered seriously and students are never ridiculed	spend time on solving problems so that they can get to understand and practice mathematics; teach them a variety of methods for problem solving and make sure they participate by doing problems themselves; practicing the mathematics they learn is important for mathematics learning; encourage learners to come to the board and share their solutions with others; create a caring environment where learners are not afraid to participate and ask questions.
facilitate mathematics learning	facilitate understanding by listening carefully to hear the (different) conceptions which underlie the students' talk so as to use questioning to get them to think more deeply and come to correct, or more appropriate, solutions and arguments; listen for the differences in what learners say; examine their (incorrect and correct) solutions and productions to understand the underlying ideas, procedures and concepts through which they have come to these; use these as the basis of dialogue and discussion to move them to a better understanding; pedagogic evaluation in the classroom should be strongly framed to negate inappropriate solutions and arguments on mathematical grounds; however social relations should be more weakly framed so as to enable discussion and thinking; keep learners motivated by making classes interesting, mathematics enjoyable and ensuring that everyone listens and respects one another	provide clear explanations; use charts and other aids to make the explanations more meaningful; link to examples of everyday life to ensure relevance; provide plenty of examples and problem solving methods to practice and assist them by being available to answer questions whenever needed; keep learners motivated (to want to learn mathematics) by explaining how important mathematics is to life and to their future prospects of employment; while classification is fairly strong in relation to the mathematics selected, allow a weakening in framing to allow for students to participate in class, and in particular to feel free to ask questions at any time including during breaks and after school
activity-based	carefully choose examples and tasks to enable conceptual development; students need to work with these tasks individually and in groups to develop their understanding; activity can be related to discussions or to working with mathematical problems and ideas; good activities will lead to meaningful participation and conceptual learning; use technology to enhance participation and thinking (for example working with sketchpad to generate multiple graphs)	learners are actively involved in doing mathematics exercises and solving problems;
problem –solving	be creative, make connections, and use mathematical ideas and practices to solve mathematical problems	finding solutions for mathematics problems (exercises and non-routine problems) using mathematical facts, tools, strategies and methods
Understanding	being able to conceptually unpack the meaning of a mathematical object or fact in relation to other mathematical objects or facts; to link ideas, make conjectures and provide mathematically convincing arguments to back these, produce solutions and provide mathematically convincing arguments for the correctness of the solution and the method	being able to work fluently and meaningfully with mathematical facts and procedures to successfully solve given problems or exercises; being able to independently explain the methods used and why they are appropriate (although this is more instrumental than relational)

3 Similarity and difference across the cases

In the previous section I contrasted some of the findings across the two cases. I now take the contrast to a deeper level by considering selected instances of similarity and difference across the cases. A field of differences is produced through the analytic space constructed by considering similarities and differences according to two axes, as shown in Figure 43²⁴⁵. The space created in the first quadrant represents those aspects which are similar between the two contexts, not only in terms of the terminology and wording used, but also in terms of the connotations/ meanings attached to them. These are called *similar similarities*. The most prominent similar similarity found between the two cases is the focus on learner errors and misconceptions as a resource for understanding learner thinking and a basis for further learning. This was interestingly also a finding across the different instances of formalised in-service mathematics education examined in the QUANTUM project (see Adler et al., 2005b). I suggest that these similar similarities are likely to represent commonalities across the system more widely, and in a sense could be considered as quilting points within the field of MTE more broadly.

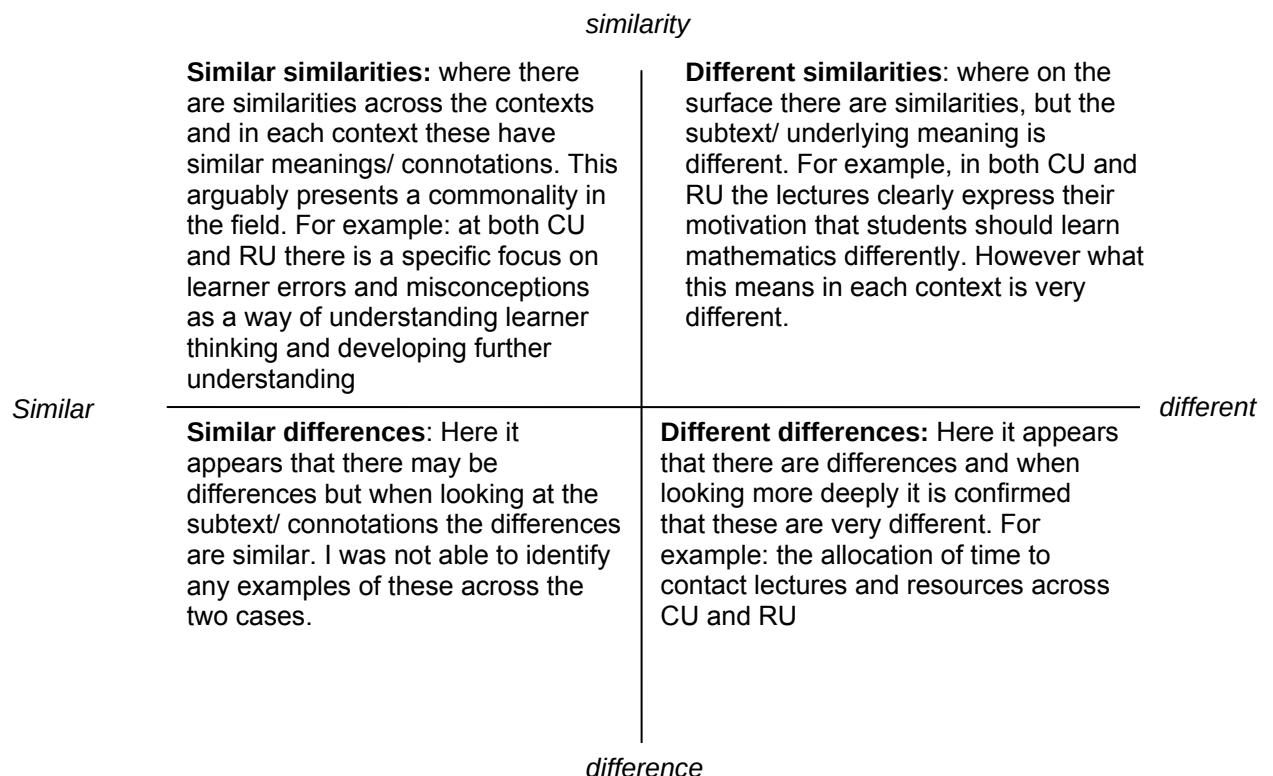


Figure 43: Examples to illustrate the analytic space for the field of differences

²⁴⁵ The idea for this analytic space was produced through a conversation with Lynne Slonimsky in relation to the work being done in the QUANTUM project.

The second quadrant defines a space populated by *different similarities*. On the surface it seems things are similar, but when the subtext/ underlying meaning is looked at more closely they turn out to be different. For example, in both CU and RU the lecturers clearly express their motivation for selection into the curriculum to be based on what their students *need* and express the motivation that students should learn mathematics *differently*. However what this means in each context is very different. At CU, the needs are related to the perception that students need to relearn mathematics so as they can undo the instrumental/procedural (rule bound) learning experienced in their past and begin to relate to mathematics in new and more appropriate ways (recognisable in terms of international ME discourses and in relation to the content of the ORF – specifically a form of pedagogic constructivism in the shape of discussion-based teaching is advocated). On the other hand at RU the needs are seen in terms of the deprived backgrounds of students (what they were not given the opportunity to learn previously and so do not know) and a perspective on the realities of contexts in which it is expected they will go and teach (where mathematics is often learnt as a memorising subject and teachers present textbook examples for students to follow ‘by heart’ and reproduce thoughtlessly). Thus at RU the needs are related to students practicing mathematics (doing it themselves), learning to solve a wide range of problems and to use different methods for problem solving, and to provide their own explanations so that they will not have to rely on directly teaching examples from textbooks. What is most interesting is that both of these practices are based upon the need to ‘undo’ what has been identified as a problem of education within the ORF – caricatured in images of ‘rote’ traditional learning practices that circulate at a general level and are best described in the dichotomy of ‘good’ and ‘bad’ teaching presented in the roll out of curriculum 2005 in the late 1990s. Other examples of different similarities are described in meanings ascribed to such notions as ‘learner-centred’ teaching, ‘participation’, ‘facilitating’ learning, ‘activity-based’ learning, and so on circulating in the ORF and PRF generally. The different meanings attached to these are contrasted and highlighted in Table 43.

The space in the third quadrant, populated by *similar differences*, is made up of those aspects that appear to be different across the cases, and yet on closer scrutiny have underlying similarities. I could not recognise examples of this within the case studies presented. An example of this however is seen in Brodie’s (2000; 2004) work, where she describes pedagogic forms that look very different and yet when examining the practices and their effects more closely, both are recognised as instances of *learner-centred* pedagogic practice. In these cases the forms are different (e.g. in the one learners’ are seated in groups and working productively together in a group guided by their teacher who is more or less invisible

in the background, while in the other, learners are sitting in rows and working productively, either independently or in pairs, visibly guided by their teacher), but in both cases there is productive *mathematical* activity and the learners are working and taking control over their own mathematical productions, and thus the substance/ effects of the practice are similar.

Finally *different differences* populate the fourth quadrant. Here there are aspects that appear to be different, and when looked at more closely it is confirmed that they are different. The most striking different differences identified when contrasting the two cases were the allocations of time to contact lectures and the availability and use of resources (both human and physical). In CU there is significant contact time in lectures for interaction with the lecturer and because of the small class sizes, amongst students as well. There is considerable space to use physical resources (from specialist ICT programmes such as sketchpad through to basic resources such as paper models) and human resources (five lecturers plus assistants) to enable this. At RU the opposite is the case: little formal contact time and very few resources both physical and human are available, yet informal time and community resources are available and utilised productively.

In reflecting back on the discussion and considering the contents of each quadrant in the field of differences, I recognise a pattern that may be constructive for understanding the way in which the field of MTE is constituted more broadly. It appears from the examples identified that similar similarities may be constituted within discursive/ academic fields or spaces, that is, through symbolic identification²⁴⁶. In a sense these similarities are based in the epistemological. Where there is some kind of commonality across the cases in terms of meaning it appears that the intersection may be generated within discourses that are based in the field of mathematics (teacher) education research or within mathematics itself. On the other hand, it appears where there is similarity at the level of the name or word, but where clear differences in meaning are apparent below the surface across the cases (e.g. learner-centred teaching; activity-based learning; critical thinking), meanings seem to be based in policy images generated within the ORF or in common sense understandings, rather than in discursive fields. That is, in the case of different similarities, imaginary identification is dominant. Further, where there are different differences, it appears that these are related to

²⁴⁶ It is recognised that in this analysis there was only one example identified in ME. In the discussions on the contents of mathematics there were more commonalities – for example the meaning of a real number or a rational number. However in both cases the basis of the commonality was located in the same mathematics education research space and therefore meaning was similar. What was differently constituted was the way in which this knowledge was used in each context to support different teaching practices.

material differences related to the context of the institution. In this sense different differences are ontological. This is summarised in Figure 44.

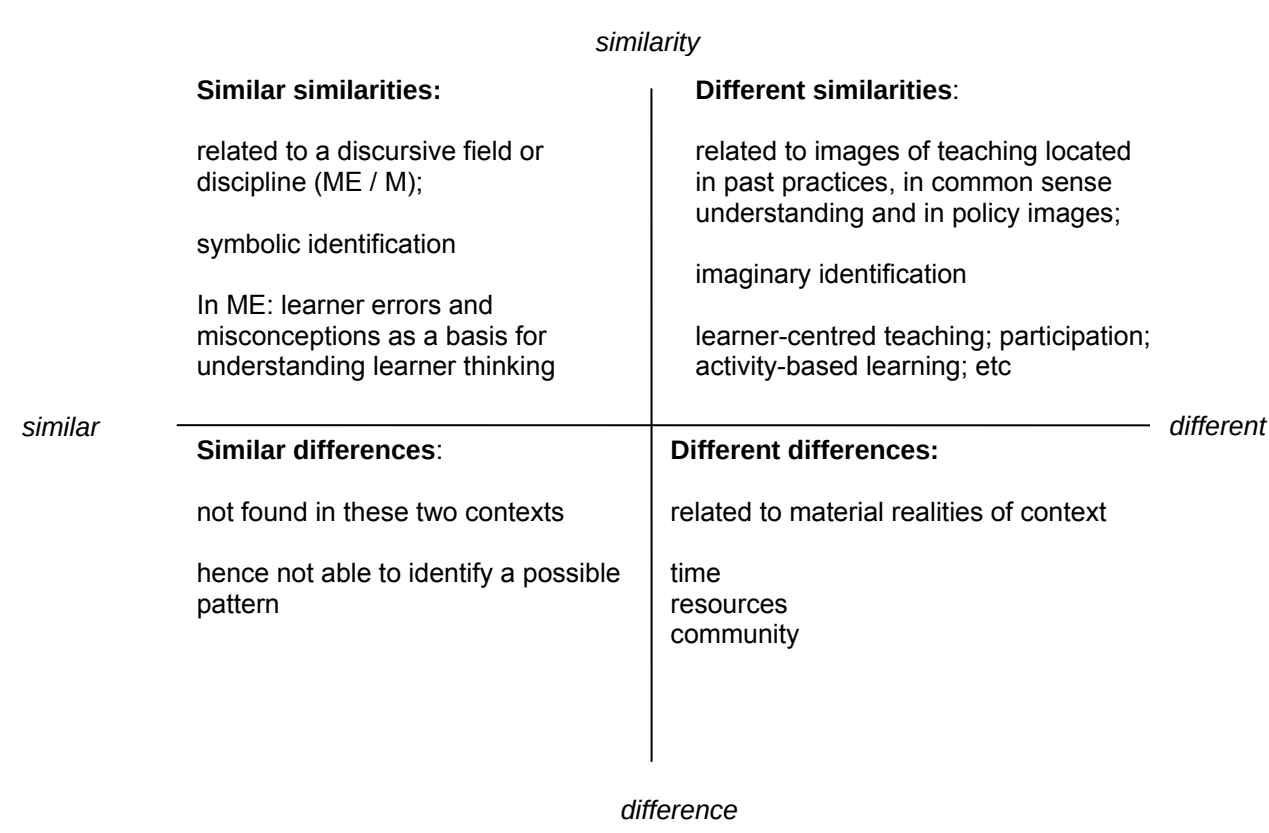


Figure 44: Patterns in the field of difference across sites of MTE practice

In considering these patterns, I suggest one possible implication. It is likely that commonality in meaning (or possibility uniformity in quality) across different contexts could not be based in policy demands, regulation or images – as these descriptions, precisely because they are necessarily constituted to speak to all steak-holders, have no way of conveying a discursive base and are open to multiple interpretations that in the end will be determined by the ideology of the interpreter. To ensure any commonality (and depth of quality) across the system it would be important that the social base for the teacher education programme be located within the field of (mathematics) teacher education research and the discipline (mathematics) itself, and that policy images and prescriptions, could only be ‘implemented’ in any coherent sense if the basis for attaching meaning to them were also located within a discursive field. So for example, if the meaning of a mathematical investigation (as described in the NCSM) is to have commonality (or if not commonality a level of quality) and depth of meaning across contexts, then it needs to be based within a discursive field of knowledge related to mathematics education research (or mathematics itself) which identifies and gives meaning to a particular

mathematical practice called a ‘mathematical investigation’. Otherwise a multiplicity of meaning is likely to proliferate, based in ‘commonsense’ conceptions which are, by definition, un-reflexively underpinned by particular ideological positions. If not consciously recognised in terms of a discursive base, ideologically driven images of what is ‘good’ and ‘bad’²⁴⁷ are likely to influence the practice and increase the possibility of strategic mimicry (as discussed in Chapter 2 and 3), lack of substantive meaning, and poor quality.

What this seems to suggest is that to achieve similarities across the field (in the form of similar similarities and possibly similar differences), which it could be argued is the purpose of attempting to define quality teacher education through appeals to some kind of uniformity in standards and understanding of relevance, meaning needs to be based within, and generated from, the field of production – that is through research in (mathematics) education and (mathematics) teaching, or at least to draw on the discursive fields of knowledge produced through such activity. This is where meaningful commonality (or distinctiveness) is likely to be produced and reside.

4 Absence and presence across the cases

In this section I highlight the field of absences, which is constructed in a similar way to the field of differences discussed in the previous section, as illustrated in Figure 45. While the field of differences created an analytic space in which similarities and differences across the cases highlighted what were visible and felt presences within the pedagogic contexts and consciousness of the students, the focus here is on contrasting the visible and *not* visible: visible (present) in the context and curriculum offered by the institution but not visible in the talk of student teachers (absent from their conscious projections), or visible (present) in the consciousness of each institution’s ‘good’ pedagogic subjects (student teachers), but not visible (absent) within the pedagogic context (curriculum, pedagogic interaction and formal assessments) and so on. The space is constructed along two axes, what is present and absent in terms of consciousness and context, and produces four possibilities, illustrated in Figure 45.

²⁴⁷ e.g., the image that group-work is necessarily ‘good’ and should be equated with learner-centred practices, while whole class explanation/ exposition is necessarily ‘bad’ and equates with bad teacher-centred and ‘rote’ practices – not recognising a discursive base for the meaning of ‘learner-centred’, which would recognise a distinction between form and substance, for example as described by (Brodie et al., 2002).

On the other hand at CU, ICT is completely present within the pedagogic context both as part of their every day existence (use of word processing and other programmes for the production of all formal assessment tasks, use of e-mail as a standard way of communication, and as computer programmes such as excel, geometers sketchpad and so on as part of the mathematics learning experiences). ICT is integrated into their ordinary life and their pedagogic experiences and so exist as part of the fabric of their context, so much so that it is never explicitly brought to the surface – the students do not consciously realise their access to this is remarkable; it is so taken for granted as part of their world. They are networked into the global village and the local context. This is illustrated in the third quadrant of Figure 45 as an *absent presence* – absent in the consciousness of the students but completely present in the pedagogic context.

The second quadrant contains *present absences* – where something is explicitly recognised as being absent – it is a burning presence in the consciousness of the students. Thus while it is absent in the context – not part of the curriculum, it is completely present in the consciousness of the student teachers. In the case of RU students there is a continual recognition of gaps in their curriculum – lack of access to certain areas of knowledge such as geometry and trigonometry, and to certain resources such as computers. In the case of the B.Ed students at CU, there is a continual recognition that their time is used up by contact sessions (which they are required to attend, registers are taken and Duly Performed (DP) certificates are attached to attendance) and they lack time outside of lectures to interact with peers, both socially and in pedagogic relationships.

Finally in the fourth quadrant, we have those aspects that are *present presences*: they are recognised ‘up front’ by the students as key aspects in their development as teachers and are also completely visible within the pedagogic context. The example at CU is of Mr/sX as a ‘model’ of what mathematics teaching should be and the presence of the importance of personal understanding of mathematical concepts and using classroom discussion (as modelled by Mr/s X) as a way of delving into meaning to develop understanding.

Examples from the field of absence constructed for each case are highlighted in Table 44. This is a partial list selected to illuminate an aspect of the case or to speak to the field of MTE more generally.

Table 44: Selected examples of aspects populating the field of absence at RU and CU

	absent absence	absent presence	present absence	present presence
RU	• ICT in-and-for teaching/learning M • knowledge of the NCSM and the difference between these expectations and the 'old' curriculum • ME as a field of study–in-and-for itself • M from a disciplinary perspective as taught by mathematicians in academic math departments	Degradation and poverty	• ICT for use in general life and generic professional work (e.g. prepare notes/ worksheet) • gaps in knowledge of school M (geom & trig) • pride in learning the same Calculus as 1st year M students • academic interaction with maths students in the general BSc	• the 'group' • respect • care • the M contents of the 'old' outgoing curriculum (e.g. HG algebra content in M) • M teaching as 'presentation' and the importance of using of teaching aids • M working with different problem solving methods, as doing problems and knowing the facts • Dr A as a role model of how to be • time for social and academic interaction outside of the lecture context • teacher as 'researcher' and 'life-long learner' • independence from lecturers and interdependence wrt the group
CU	• community as a resource for learning and teaching M • ME as a field of study–in-and-for itself • M from a disciplinary perspective as taught by mathematicians in academic math departments	• ICT in-and-for teaching/learning M	• time out of lectures and contact sessions to be students (space for general social and academic interaction)	• Mr/s X as a role model • discussion-based pedagogic practice • understanding as a basis for learning mathematics • rejection of 'traditional' M teaching and learning practices

These are aspects that I have been conscious of when thinking about the two cases at this point in the process. I recognise that there may be some aspects that I have not ‘seen’ that the methodology I used in the analysis of the cases may have obscured. Nevertheless the process of comparison undertaken in this chapter so far, has been fairly systematic and has lead me to these observations and I present them here as another partial account of aspects illuminated through the cross case analysis.

In considering the field and its characteristics, we note that the analytic space created by considering presence and absence of an aspect in the consciousness of the pedagogic subjects against its appearance in the pedagogic context is productive for illuminating both the cases and the field of MTE. The examples found suggest that those aspects that are absent in both consciousness and context are critical aspects for the case itself – it illustrates either complete ignorance or deliberate exclusion at the level of the case, and where an aspect is common across the cases there is a possibility that this is illustrative of the field as a whole. With respect to aspects that are present presences, many are recognised as productive aspects of the cases and highlight issues for MTE that can be fed back to the field as a whole. I will return to discuss specific examples of these two spaces after presenting the patterns across all quadrants in the field of absence. These are summarised in Figure 46.

It is not possible to mention all aspects within the analysis of absence and presence. However there are some that stand out for me and I think are important to highlight, particularly those that illuminate the field.

Present absences present aspects that the students are fully conscious of and yet are not visible in the context – in both cases these are aspects that raise major problems for the pedagogic subjects. In the case of RU the pedagogic subjects’ lack of access to mathematical knowledge is a major issue. Although the ‘good’ pedagogic subjects of RU have been specialised through a pedagogic discourse dominated by a strong regulatory discourse to be personally disposed and committed to taking on the challenge and dealing with gaps in their knowledge to ensure they ‘get the facts straight’, this aspect of the pedagogic context is deeply problematic and deprives them of knowledge foundations they need for teaching. While they recognise gaps in their knowledge and experience are a major problem, they present themselves as empowered as ‘life-long’ learners by their experiences (which they clearly are at the level of confidence and self belief). The issue that is raised by this relates to the fact that the students who entered RU’s B.Ed programme were initially disadvantaged by their schooling, not having had the

opportunity to learn mathematics effectively (through poor teaching and deprived conditions) and at the right level (HG), will now leave the programme not having had the opportunity to learn sufficient new mathematics to enable them to be equipped with the breadth of knowledge that would enable them to go back into the classroom at an advantage. While the ‘good’ subjects may be able to cope with this because of the strong mathematical and mathematics teaching identities they have developed through the programme and their belonging to a strong group able to marshal resources in the wider community (inside the education faculty, other students inside the general university, and from teachers outside the confines of the university), we cannot say with any confidence that this would be the same for students who are ‘weak’ subjects but who have passed their course and would go out to teach the following year.

		<i>Context Absence</i>	
<i>Consciousness</i>	<i>Absent</i>	<u>Absent absences</u>: where the aspect is absent in the consciousness of the ‘good’ pedagogic subject and absent from the pedagogic context where these are common to the two cases they are possibly common across the field and highlight absence (ignorance or exclusion) in the field that raise issues for MTE more broadly where they are specific to the institution they highlight an area of complete ignorance or deliberate exclusion	<u>Present absences</u>: where the aspect is present in the consciousness of the ‘good’ subject but absent in the pedagogic context these are possibly problem areas for the specific cases – at least from the point of view of the learner teachers seen in the ‘lack’ described by the pedagogic subjects
	<i>Present</i>	<u>Absent presences</u>: where the aspect is absent in the consciousness of the ‘good’ pedagogic subject, yet completely present in the pedagogic contexts this highlights aspects that have become embedded within the context and naturalised as part of the way things are; these may be productive or a constraint in the context	<u>Present presences</u>: where the aspect is present in the consciousness of the ‘good’ pedagogic subject and in the pedagogic context these seem to represent some quilting points which stitch together the ideological fabric of the context and give it its coherence and meaning these highlight issues for the field as a whole
		<i>Context Presence</i>	

Figure 46: Consciousness and context - Patterns in the field of absence across the cases

At CU on the other hand, the students’ lack is due to an overabundance of what is not present at RU – time in the classroom and coverage of mathematical topics relevant to the school curriculum. These ‘good’ subjects are confident in their ability to think mathematically and to

discuss their ideas and so on, but do not recognise the gaps in their knowledge and understanding easily and when confronted with these are not as confident in their ability to overcome them on their own. The lack of time to meet outside of the classroom context to socialise, do academic work and develop pedagogic spaces independent of the lectures gaze is a constant presence in this context amongst the B.Ed students. The pedagogic context itself (through the lecturers talk and the curriculum) does not recognise this as a difficulty – in fact the lecturers feel they have insufficient time to teach the students everything they need in the contact time they do have. One consequence of this appears to be that the students work more or less in isolation outside of the classroom context (very much as individuals). In this sense while they appear independent and self reliant in relation to their peers they show a dependence on their lecturers and their successful learning is dependent on a specific pedagogic approach. In a sense this produces for the CU students an absence of the possibility of developing teacher learning communities outside of the classroom context, or of using the community as a resource. It also ties them to being taught by specific types of teachers (non-traditional) as the means of accessing, enjoying and making meaning of mathematics. Thus it is not mathematics in and for itself, but rather how mathematics is taught that becomes a critical factor for maintaining their interest.

As suggested earlier I will now return to consider particular examples of absent absences that are common across the cases. We find that in both cases a conscious focus on ME as a field to be read and studied in-and-for itself as part of the initial teacher education programme, to provide motivation for and understanding of mathematics learning and development of mathematics teaching practice, is substantially missing both from the students talk and writing, from the descriptions given by the lecturers, and in the examples of formal assessments²⁴⁸. In both contexts any formalised ME and MT knowledge becomes integrated into one ME/MT type course within the curriculum which constitutes this field as a practical accomplishment based in reflections on practice.

At CU as shown earlier, this is constituted through an experience of re-learning old school mathematics in the MTE classroom, through images provided by the lecturer, and pedagogic arguments which rely on these experiences as well as any other experiences of teaching, the curriculum, knowledge of children etc, brought into the lecture by the students and the

²⁴⁸ I note here that the field is visible in some senses – but not as a field to be studied in-and-for itself. It is visible at an implicit level within Mr/s X's selections and approach, it is visible in terms the mention of van Hiele by students and lectures, in a few 'easy readings', and in the focus on misconceptions and errors that seems to be a quilting point for MTE more generally across the field. At RU is it visible in the focus on misconceptions and errors and in some of the specific selections in the ME modules.

lecturer, and in some cases by brief notes. While the lecturer has a clear agenda and aim with respect to the approach to be learnt and constructs the practice in relation to specific discursive resources – this is not explicit and the grounding for arguments provided by the students is not expected to be based within the discursive field. At RU ME/MT is constituted on the basis of experiences of learning and teaching and through discussion and consensus. These discussions produce a series of localised idea, tips, tools, practices that are to be collected in a ‘basket’ and used when appropriate in specific contexts. There is no favoured mathematics teaching practice consciously projected by the lecturer (although the learning of ME is seen as best done through discussion and sharing of experiences). In both cases, while there are differences, ME and MT are constituted as more or less horizontal discourses: localised contextual knowledge and practical accomplishments.

Thus in both contexts ME as a discursive field of knowledge to be studied and acquired in-and-for itself is ‘washed out’, and appears to be constituted in the consciousness of the student teachers through imaginary identification. Access to the arguments and the base of knowledge that could assist them in developing *reflexive* competence in teaching is not provided for in any substantive way. For example, being able to consciously consider their practice from a perspective of mathematics education (theoretically and in terms of knowledge *from* practice) and therefore to be in a position to analyse their own practice (in order to improve practice or to make a decision to discard a theory), or, alternatively, being in a position to make selections for their own practice based in findings from the field of ME research. Reflection on practice is used in both cases to highlight the sensible and the intuitive in relation to mathematics education and mathematics teaching, rather than the intelligible (or as Bernstein put it the thinkable (mundane) rather than the unthinkable (esoteric)).

In addition, in both contexts mathematics is constituted in terms of what is assumed to be needed by the teachers (selections from school mathematics and some calculus) and is rooted within the symbolic (although access is structured differently both in terms of coverage, depth, and pedagogic mode). However, we also find that in both cases there is complete absence of any contact with academic mathematics departments in the university. Students are completely silent on this as a possibility and the pedagogic context excludes the possibility. Specifically, mathematicians are deliberately excluded from having an involvement with teaching mathematics to secondary student teachers within both contexts. In both cases the lecturers express their belief that the mathematicians are not well placed to teach teachers mathematics. This is rooted in a belief that most mathematics traditionally taught by

mathematicians in undergraduate programmes is not relevant to teachers (it is far removed from official knowledge of the school curriculum; they emphasis on working with highly abstract knowledge forms is not appropriate to knowing mathematics for teaching), and that anyhow mathematicians are not good teachers and would present the wrong kind of images of teaching to student teachers. This last point is linked to the view that mathematicians, because they expect their students to be mathematically inclined and competent to engage with the mathematics they present, do not worry about their pedagogic practices, and that students coming into teaching are generally weak and not in a position to engage with mathematics and therefore would not cope if taught in that way. It is possible that this stereotyping of mathematicians occurs across the field. At CU this position is explicitly connected to a need to teach mathematics differently (in non-traditional ways and focussed on understanding), and the belief that the traditional teaching in mathematics departments would be counter productive and lead students to think in the opposite way to what was needed by a teacher (compressed and abstract thinking rather than decompressed and expanded thinking). At RU it is more connected to a worry that the students, weak as they are, would not be cared for in those departments, and would be left to drown and believe that they were incapable, which would be damaging to them.

A consequence of this exclusion is that secondary student teachers within both contexts have no experiences of university level mathematics as taught by academic mathematicians or at least mathematically orientated tutors who have experience of teaching mathematics to other university students within a general university environment. It also means that the possibility of developing productive relationships between mathematics departments and mathematics education in the university more generally is closed down. This was something that also came through strongly in the survey of the field discussed in Chapter 4. It is recognised as an area that requires some exploration.

It is possible that this suspicion of mathematicians is a characteristic of field of MTE in South Africa: secondary mathematics teachers educated through B.Ed degrees probably (at least from the evidence in this thesis) do not access disciplinary knowledge of mathematics through academic mathematics departments. We could ask: Do the views expressed by the mathematics education lecturers here have merit? Are there no 'good' teachers who are also mathematicians or at least employed in mathematics departments to tutor and teach undergraduate mathematics in South Africa? Are mathematicians generally not interested in developing new teachers for the schooling system (and through this ensuring their own

existence)? Is it really good thing that these teachers never experience university level mathematics as taught in a university level classroom by an academic employed in a discipline specific mathematics department? And, what are the consequences of not having this experience, particularly given that these teachers will be preparing the students of the future for careers in mathematics, where it is expected they will go study mathematics in these very departments? These questions are not answerable but do some raise issues related to access to mathematics in-and-for itself as opposed to access to mathematics-for-teaching (*MfT*), also discussed in Chapter 2.

5 Pedagogic spaces opened and closed for mathematics teacher education across the contrasting contexts

The previous subsections highlight similarities and differences and presences and absences across the two cases, and reflecting back on these we can recognise pedagogic spaces for the development of specialised identities for teaching and learning mathematics, that are opened and others that are closed within each institutional context. In this section these spaces are briefly illuminated.

5.1 Spaces opened at CU and RU

Pedagogic spaces productively opened at CU include spaces:

- inside the classroom for developing a deep connection to, and understanding of, a wide range of mathematics relevant to the new school curriculum structured through a pedagogic practice framed by a lecturer with a strong basis in mathematics education
- inside the classroom for a community of teacher learners able to discuss mathematics and mathematical ideas critically within a climate of mutual respect
- into which technology, including ICT, graphic calculators, use of the internet, is fully integrated into the pedagogic context
- for specialist practice teaching experience, in selected schools, under the eye of a mentor teacher, and tutored and assessed by a specialist in mathematics education connected to the university

Pedagogic spaces productively opened at RU include spaces:

- outside the classroom for a strong community of teacher learners to develop and to specialise their mathematics, mathematics education and mathematics teaching

- to become competent in doing mathematical problems and exercises, a disposition towards learning mathematics-in-and-for itself, and to develop a self belief in oneself as a ‘mathematics person’
- to develop a strong mathematical disposition and respect for mathematics as a subject and to submit one’s self to the discipline of doing mathematics
- to develop the self confidence to present ideas and solutions to large groups: a space for practicing presentation skills
- to speak English and develop an ability to use English in teaching: a space for practicing speaking English
- to listen respectfully to one another and to work co-operatively to plan and present mathematics problems and ideas to one another
- to develop a strong ethic of care for learners and their future life opportunities

Pedagogic spaces productively opened at both CU and RU include spaces:

- to become mathematics teachers committed to teaching the subject and to making a difference in learners lives

5.2 Pedagogic spaces closed at CU and RU

At CU the pedagogic spaces closed include spaces:

- outside the classroom for a strong community of teacher learners to develop
- to develop high levels of fluency in solving mathematical exercises and the disposition to submit to the authority of the discipline without consideration of self
- to act independently in mathematics without interaction with ‘non-traditional’ lecturers

At RU the pedagogic spaces closed include spaces:

- inside the classroom for covering a wide range of mathematical topics relevant to the new curriculum
- inside the classroom for a community able to discuss mathematics and mathematical ideas critically within a climate of mutual respect
- for technology to be integrated into the pedagogic context, including ICT, graphic calculators, use of the internet

- for specialist, developmental and assessed practice teaching experience (in this context it is experiential)

Pedagogic spaces closed in both contexts include spaces:

- for learning mathematics as an academic discipline in-and-for itself through interaction with an academic mathematics department
- for constituting ME as a discursive field and for developing the teacher's identity as someone interested in learning from the field of research in mathematics education and using this research to theorise their mathematics teaching practices²⁴⁹
- for learning from the wisdom of practice

What can be recognised in this account is that each case is productive of practices that work to produce teachers who (if they are 'good' subjects) are likely to be successful teachers in specific contexts. The successful student teachers of CU are likely to be thoroughly modern, with access to technology and able to work productively within the ideals of the new curriculum. The extent of their mathematical ability cannot be measured in this study. However, they are likely to cope better in well resourced and non-traditional schools in which authority relations are more democratic and social cohesion is maintained through organic solidarity, than in traditional schools where authority is positional and social cohesion is maintained through mechanical solidarity. They are likely to focus on developing understanding of school mathematics and creating classroom climates where there is considerable space for discussion of concepts and ideas. They may find it difficult to provide sufficient space for learners to practice mathematical processes and methods. It is not clear whether they would be able to cope in the context of a typical under-resourced South African school where the ethos may be towards more traditional mathematics teaching and learning.

On the other hand RU's good subjects are likely to be more traditional in their teaching approach, focused on providing access to mathematical methods and knowledge that would enable their learners to escape from poverty and degradation. They would be determined to provide learners with good explanations and opportunities to learn and practice mathematics

²⁴⁹ Only one of the good subjects across the two institutions projected an identity that might be recognised as attempting to reflect on theory and research, i.e., Karyn at CU. This is recognised in her self projection in which she sees her lack in this area. However, it would not be correct to connect this to any specific aspect of the CU curriculum or context – rather she developed this orientation 'in spite of' of the pedagogic context. It is more connected to her own ambition and to her interest as related to other studies, particularly her engagement in simultaneous studies in philosophy and psychology in her B.A, than to any learning directly related to ME studies.

to become fluent and successful in its use and to motivate them to learn mathematics and submit themselves to the discipline through continually reminding them of the opportunities that mathematics will open. They would be likely to cope in rural and township contexts characterised by deprivation and degradation and traditional authority relations. It is not at all clear whether or not they would cope well in other non-traditional contexts.

6 Conclusion

In this chapter, I have presented a cross-case analysis in which aspects of each case have been contrasted against one another, a field of differences and a field of absences have been presented, and used to illuminate pedagogic spaces that have been opened and closed within each context. I have shown that each institution in this study was working within a context that enabled the opening of different kinds of spaces for teacher learning – at CU the spaces *inside* the lecture theatre and access to technology for teaching and learning mathematics, and at RU, spaces *outside* of the lecture theatre and access to community resources for teaching and learning mathematics.

Chapter 13

Conclusion

1 Introduction

I began this project with a problem that had arisen out of attempts to negotiate a curriculum for initial teacher education within my local context. This context was marked by a general climate of educational transformation in the country, and in teacher education, brought about by the introduction of numerous education reform policies, including the introduction of the NQF, new Higher Education policy, a new school curriculum, a new regulatory framework for teacher education, and a restructured teacher education landscape. I was frustrated that the curriculum decisions within the institution, after incorporating the College of Education, seemed to be based more on ideological positions connected to past histories, than on any specific epistemological or empirical grounds that could be supported by research in the field. I was motivated to explore the mathematics teacher education landscape in South Africa to try and understand the bases of discourses circulating in the field informing the design of mathematics teacher education curricula. I hoped, as stated in my original proposal, “to ‘clear the undergrowth’ and to establish what discourses are at work in the organisation of mathematics teacher education curricula and how they are interpreted and implemented in selected higher education institutions” (Parker, 2001, p. 2). At the time I asked questions related to the selection of knowledge(s) and practice(s) in initial MTE curricula, suggesting that the quality of our teacher education programmes would be determined by these selections and how we made them available to prospective teachers.

Now, as I come to the end of this journey and write the final chapter of the thesis, I look back at where I have been to get to this point. I recognise that the problems we were grappling with in making decisions over our initial teacher education curriculum in 2001 are reflected in the teacher education field both internationally and locally. The work of designing and implementing initial teacher education curricula is complex and deeply situated within individual institutions and social practices. I recognise that any particular approach to mathematics teacher education, reflected in the selection and organisation of contents and pedagogic mode for its realisation, opens certain spaces at the very time that it closes others, and that these spaces can be both productive and constraining. That this work is situated does

not mean that we cannot gain insights for the field of mathematics teacher education more widely, or that there are no principles or propositions that may be drawn from case studies of particular practices that could be used to guide some of our curriculum decisions within the field as a whole. However, it does point to the conclusion that there can be no universal ‘solution’ to the ‘problem’ of initial teacher education.

The thesis therefore supports a middle path, suggesting that it would be impossible to define the *right* selection of knowledge discourses and practices that *ought* to be selected into any specific MTE programme. Pedagogic discourses for MTE are developed in specific contexts, and are productive of and constituted by the *relationships* which are made possible by the different resources (both material and epistemic, physical and human) which are available within the context. It also suggests that attempts to reproduce a *best* practice (or that there is even something that could be defined as a best practice that is dislocated from context) in MTE may be misguided. Attempts to regulate teacher education through the production of policies on norms and standards to be implemented across a system, while they may be driven by a perceived social need to get some uniformity in quality and ensure the relevance of curricula for the production of the ‘right’ kind of teacher, are unlikely to have desired effects if they are not integrated into the ideological fabric internal to the context. Teacher education is delivered at the institutional level, and the constitution of pedagogic discourses for specialising teachers are localised within the institution, determined by the specificity of the context and the operation of the distributive rule within that context, in relation to both the student teachers and their lecturers. A level of commonality in programmes and quality across the system will not happen with the publication of regulatory policy, it is more likely to occur if education academics and others involved in the design and implementation of teacher education curricula are reflexive in their practice, begin to do and use research as a basis for their practices, and to share this across contexts.

In this conclusion I will provide an overview of the journey travelled to produce this thesis and highlight some of the conclusions, insights and surprises reached along the way. This will be followed by a discussion of some of the methodological insights gained in undertaking a research project of this scale, including a reflection on the scope of the project and the productive relationship between this research project and the QUANTUM project in which I have been simultaneously involved. Finally I will discuss some of the limitations of the research and raise questions for further research in the field.

2 An overview of the journey

At the beginning of the thesis I showed that reforms in teacher education and the restructuring of the institutional landscape of teacher education in South Africa during the 1990s were not simply a local phenomenon connected to the fall of apartheid and the introduction of the new democratic state, but were part of a wider pattern of reform in teacher education seen across the globe. In countries across the world, the perceived failure of schools and education in general to produce the kind of citizens required by the (global) economy and polity was connected to the failure of teacher education to produce the right kind of teachers for this changing social context. Three specific international movements were identified: moves towards teacher education being recognised as a profession and the increasing focus on professionalism in the work of teachers; movements towards locating all teacher education in the HE sector and increasingly within university education faculties or schools (teaching was to become a graduate profession); and, a trend towards the production of policies designed to regulate teacher education to ensure its accountability and relevance to the state, the economy and polity.

I argued, in agreement with Harley and Parker (2007), that the need for regulation was brought about by changing forms of social solidarity. With contemporary globalisation of capitalism and the concomitant increase in diversity within and between societies seen specifically in the differentiation of labour, mechanical solidarity could no longer be counted upon, and in particular positional authority could not be taken for granted. The loss of trust in teacher education institutions resulted in the need for social contracts (through policies and the law), and this is seen across the world in the various attempts to regulate teacher education. Regulation of teacher education was specifically linked to the production of standards to ensure relevance (the ‘right’ contents and teacher competences are selected for specialising teachers) and accountability (through mechanisms for quality assurance to ensure the public that their investment in teacher education is worthwhile). I showed that while these general movements could be recognised across the globe, the policies and the practices in place varied considerably from country to country and produced different possibilities for teacher educators and academics involved in teacher education practice. This suggested that the social (and therefore underlying ideological) bases for the development of teacher education programmes and curricula would vary from country to country.

Theoretically, I argued, the social base for teacher education could make a difference to the specialisation of identity and the development of productive identities in and for our specific

South African context, fraught as it is though a history of stark differentiation and differences. In SA education policy in general, and teacher education policy in particular, was designed to change this legacy – to reform the education system and take South Africa into a new democratic future, a future in which there would be a more equitable distribution of educational opportunities and access to high skills that would ensure the country's development and global competitiveness. This general orientation to the future, what ought to be, clouded policy and tended to obscure what is.

In Chapter 3 I showed that the structural changes in the teacher education landscape in South Africa resulted in a relocation of teacher education from the field of reproduction into the field of production. I argued that within this repositioned context, the regulation of teacher education was open to interpretation. Therefore while policy might appear to be prescriptive, it was relatively open: spaces were available for teacher educators located in the UPRF to profoundly influence the selections and therefore the specialisation of teachers within this context. The regulatory environment specifically encouraged research to be inserted as a central generator for decision making in the design and implementation of curricula for teacher education. The relocation into higher education and the responsibility of HEIs to develop and generate their own curricula opened the space for socialising teachers into subject loyalties based on a disciplinary bias, rather than in 'generic' knowledge forms that were not necessarily intelligible. However I also recognised that the language of competence embedded within the policy documents and the particular general regulatory discourse framed by the constitution and the commitment to stakeholder democracy may obscure this openness, particularly in institutions that were dominated by authoritarian structures from the past and under economic pressure in the present. There were also other challenges of economic positioning, the low status of education within the university and access issues that could push institutions in the opposite direction – filling their programmes with 'generic' knowledge and practice-based experiential contents. Nevertheless I argued that to overcome the legacies of the past it was important for teacher educators and academics, positioned as they were as both producers of knowledge and recontextualisers for teacher education, to recognise their pedagogic space, and to insert pedagogic discourses that were based in principled knowledge (disciplines, discursive fields and codified practical wisdom) rather than in 'mythological truth' generated through popular/ general voice discourses. While these spaces were theoretically open, whether or not they were recognised (or misrecognised) and the relative power was exercised (or not) would only be seen by considering individual cases in the field of practice.

Before considering the case studies I needed to understand the policy context more deeply and the external factors that would impinge on the production of curricula in the PRF. In particular I argued that mathematics teacher educators had a responsibility to be responsive to the national context and to produce teachers who could work productively within the system, who could interpret the national school curriculum and could enable opportunities for learners to gain access to powerful forms of mathematical knowledge. Therefore it was important to understand the bias and focus of official mathematical knowledge and pedagogic identities projected from policy. To produce an account of this I needed to consider the policies of the ORF with respect to teacher education generally (NSE) and to mathematics teacher education and mathematics teaching more specifically (through an analysis of the NCSM).

In Chapter 4 the focus therefore moved to a consideration of the NSE and NCSM policies in order to produce an account of the expectations of policy with respect to the general and specific pedagogic discourses for teaching and for mathematics teaching in particular. I showed that while on the one hand the general regulative discourse of the curriculum seemed to present a competence-based pedagogic model, aspects of the specific discourse of official school mathematics represented a performance-based model and thus the curriculum represented a hybrid, which while retaining some features of the past required some fundamental changes in orientations to mathematical knowledge and pedagogic practice. The in-depth analysis of the assessment standards showed five different orientations to knowledge which taken together produced a view of school mathematics that would fit with dominant mathematics education discourses circulating in the field. These projections of subjects, knowledge and persons (teachers and learners), were framed within content that appeared to be in line with broader trends across the world – in terms of the wider roles to be played by teachers, new orientations to knowledge and pedagogy, and the specifications of the curriculum which were framed not only within the specific values of the new SA state, but also inline with many international movements in teacher education (as recognised in the various UNESCO publications discussed in Chapter 2) and the field of mathematics education and teacher education research more broadly.

In this work I accepted that regulation was part of an attempt to bring institutions to a common understanding of what quality in the system means and what relevant teacher education for the vision of the new South Africa would be about. Whether or not this was the ‘right’ thing for South Africa was not considered. There are arguments that could be made to

suggest that we should focus more on ‘what is’ rather than ‘what ought to be’ – however the pedagogic device operating on a global level suggests that this would lead to isolation that may be impossible to sustain if SA wants to be part of the global economy. It is difficult to resist these international movements towards reform. However, I argued that attempts to regulate quality through producing generic policy descriptions of competences would be unlikely to change practices and that changing the consciousness of mathematics teachers through a teacher education curriculum would be a pedagogic problem in the context of MTE practice and not a regulatory one. The ORF projected pedagogic identities which were clearly very different from existing realities and identities of teachers practicing in the system, and of novice teachers who had been educated through the existing system. The pedagogic problem would be directly related to the ‘what and how’ of the teacher education curriculum and the practices within pedagogic contexts at the level of individual institutions. Whether or not these would enable the type of changed identities required by the policies of the ORF could only be explored through empirical research in sites of MTE practice.

The project now required that I look at the field to see how teacher education institutions within the PRF had responded to the new regulations and to see to what extent they had recognised the pedagogic space opened up within the regulatory environment. Had they interpreted policy as prescriptive or generative? Had they used research in the field to guide the design of their curricula, and how had they attempted to select and organise different forms of knowledge and practice within these? I had theorised that there were likely to be major differences across the system not only in terms of how institutions had positioned themselves to official discourses, but also with respect to their selections into the curriculum – particularly in terms of the three discourses and their practices (M, ME and MT) that I theorised would be likely to underpin the specialist aspects of any teacher education curriculum. The survey, reported in Chapter 5, showed this to be the case. It also confirmed that in terms of the regulations most institutions were compliant meeting the regulatory demands of the state. However, the documents they submitted to the authorities in terms of the various regulations, while following the form required did not reveal much of the substance of what was being offered across the HEIs. Three major findings were made visible by the survey. Firstly, while all institutions met the minimum requirements spelt out in the NSE relating to the specialist role, most appeared to read minimum as maximum, and limited the number of credits for the specialist role. The result was a spreading of the minimum credits across all specialisations, sometimes resulting in the probability of very limited development in the area of specialisation, particularly in the case of senior phase

qualifications where there could be three or four learning areas in focus. Secondly, while all institutions clearly privileged mathematics over mathematics education in terms of time given to these contents in their curricula, they seemed to locate all aspects of their secondary MTE programmes in their education faculties and schools, thereby excluding the possibility of developing productive economic and pedagogic relationships with disciplinary experts in other academic departments in the university. Thus teachers were being denied access to knowledge of their teaching subjects from the disciplinary perspectives of mathematicians. Thirdly, the place of knowledge from-and-in practice was obscured. Many institutions did not seem to award credits for practice teaching, and the general trend seemed to be towards teaching practice as experiential. Where it was assessed, this was most often by generalists rather than specialists.

The survey of the system showed that the majority of HEIs, repositioned as they were, had responded positively to the regulatory environment and had complied with new policy. Their positioning with respect to the ORF however was varied. Some institutions took a holistic view and inserted their own professional and historical positions as teacher educators into their designs while still meeting the requirements of the policy regulations. These institutions were recognised as positioning themselves in compliant, yet unofficial, positions with respect to the policies from the ORF and the authority of the ORF. There were also those HEIs who positioned themselves 'in line' with the new regulations and used the roles and competences in the NSE as an organising device for selections into their programmes. These institutions were identified as taking 'official' positions. Within these there was also a recognition of differences, with some institutions using the individual competences listed in the policy as the basis for their design and so assigning specific credit points to fragmented competences, and others using the 'roles' as wholes and so coming up with more holistic designs. These official positions were therefore identified in terms of holistic and atomistic official positions.

The wide range of programmes that had been recognised (at least on paper), confirmed that there were a variety of different interpretations of NSE policy and that in spite of the regulations, differentiation across the system was likely to occur in practice. The regulatory processes were applied in a manner where the form of the paper exercise was the criteria for compliance rather than the substance of the curriculum contents or quality of the programme that this might represent. In order to get a more nuanced understanding of the field it was necessary to carry out in-depth case studies. The survey provided sufficient detail to enable the selection of two cases that I hoped would throw up contrasts that would illuminate the

field in productive ways. Two institutions which I called City University (CU) and Rural University (RU), met all the conditions for selection.

The focus of the project now moved to understand how pedagogic communication and teacher identities were being constituted in these contrasting contexts: how was the pedagogic device operating to distribute specialised forms of consciousness and conscience across these extremes in the system? Using theoretical resources derived mainly from Bernstein's theoretical work, but supplemented by Hegel (as recontextualised by Davis), I was able to give an in-depth analysis and interpretation of how curriculum, pedagogy and assessment was constituted within each of the two institutions and to provide insight into how these worked to specialise the consciousness and conscience of student teachers in each institution. This was the focus of Chapters 6 to 8. Next I considered teacher identities that had been produced within these contexts, through an extended methodological framework and language of description drawing on Lacan, Davis and Zizek. This was the focus of Chapters 9 to 11. Finally in Chapter 12, the two cases were contrasted with one another to illuminate aspects that would assist with understanding the differential specialisation of consciousness across the contexts and would raise issues for the field of mathematics teacher education as a whole.

The overall analysis revealed that knowledge and practices were differentially distributed across these two contrasting contexts. The distributive rule was operating in significantly different ways in the urban and the rural context. The urban institution was operating within an ideological field that was part of a social fabric operating with forms of organic solidarity connected into a globalised and networked world. While at the institutional level, selections of contents and pedagogic decisions over the MTE curriculum were being made based on localised interpretations of the student teachers coming into the institution and their likely school backgrounds (relatively weak in mathematics and with a view of mathematics dominated by instrumental understanding and procedures), the choices were underpinned by an interpretation of official discourses based on the NCSM and certain selections from the field of mathematics education and mathematics teacher education that privileged a form of pedagogic constructivism. The form of competence pedagogy at work within the context rejected what were perceived as traditional ways of teaching mathematics and privileged a practice that focussed on understanding, discussion, and personal relationships with mathematical knowledge. Within this context mathematics education and mathematics teaching were constituted as practical accomplishments, which supported pedagogic identities based on imaginary identification rather than identities based on symbolic identification with

discursive bodies of codified knowledge. However, at the same time learning to teach in-practice was constituted as a specialised aspect of the curriculum, mentored by specialist teachers and assessed by specialist university tutors.

In contrast, at Rural University, the ideological field was stitched together within a social context operating with more traditional authority relations, but also within a regulatory environment that was underpinned by an ethic of care and recognition of the need to build self confidence and self belief in its student teachers. While ‘lack of coverage’ of school mathematics contents was an issue for the selected student teachers, they were nevertheless able to develop strong mathematics identities through the spaces created within the context to learn and practice mathematics. They were empowered by self confidence and self belief in relation to their ability to be life long learners, adept at using local resources and to cope with the realities of rural under-resourced classrooms. In this context practice teaching was constituted as largely experiential, a time to be spent in schools.

The cross-case analysis showed that the two cases were at extremes in the system and that the gaps found in the one could be related to the strength of the other. While at CU the spaces *inside* the lecture theatre for productive pedagogic engagement and the development of mathematics teacher identities were opened, and access to technology for teaching and learning mathematics were integrated into the students teachers’ mathematics learning experiences, at RU, spaces *outside* of the lecture theatre for productive mathematical engagement and learning were opened, and access to community resources for teaching and learning mathematics was possible.

The cross case analysis also revealed that there were two areas where both cases were clearly lacking: firstly the absence of a study of mathematics education in-and-for itself and therefore a lack of focus on an identity as someone interested in learning from the field of mathematics education and mathematics teaching research to inform teaching practice and develop reflexive competence; and secondly, the lack of any relationship between academic mathematics departments and the mathematics education academics at each institution, and hence the total exclusion of these academic mathematicians or tutors and of their disciplinary bias in teaching mathematics teachers.

3 Some surprises and insights

In the previous section I gave an overview of the journey and summarised some of the findings of the project. In this section I highlight a few of the conclusions.

3.1 The positioning of institutions with respect to the ORF

What came out clearly at the end of the case studies, and was a surprise, was that what initially seemed to be an official positioning of an institution with respect to the ORF turned out to be unofficial, and what appeared to be an unofficial position turned out to be more official! In hindsight and on reflection I can see that I ought to have expected that this might be the case. However, I did not expect it and when it was revealed it came as a surprise.

In terms of the stated positions in the documents provided to the state, and in terms of the overall design of the curricula it, RU was recognised as taking an *official position* with respect to the ORF of the state, accepting its authority and following the NSE policy quite literally. They were clearly *consciously* attempting to work with policy and institutionalise the bias and focus of the state. However, within their under-resourced context, most starkly illustrated by the two maths education staff (who it must be reiterated were both highly qualified for these positions) having to cope with large numbers of students without additional support, we see that while aspects of the official discourse, particularly the notion that teachers must be researchers and scholars, comes through very strongly, the distributive rule working within the context produces a different content from that presumed by the ORF. So while the institution ‘looked’ modern and ‘with policy’, the delivery of the curriculum and the specific access that was made possible within the institution supported M and MT identities that were fairly ‘traditional’ in the SA context and that were more determined by past ‘good’ practices than future expectations. ME identities within this context were based mostly within localised horizontal discourses based on consensus and were unlikely to provide the basis for students to develop the kind of reflexive practice expected by policy. However, the identities produced and the focus of the programme was, it has been argued, productive of strong teacher identities likely to be able to cope well within the largely rural and under-resourced realities within which they would teach, although with limited knowledge resources. The good subjects’ identities had been changed. These changes are not in line with the contemporary distributive rule of global capitalism and with discourses in the ORF which demand forms of competence pedagogy, new forms of mathematical knowledge and teachers to become extended professionals. Rather they represent new images of mathematics teaching and doing

mathematics that do not fit with the school mathematics learning experiences of students from deprived degraded rural contexts (of rote learning, teaching through specific examples taken directly out of text books, and teachers who ‘did not have their facts straight’).

On the other hand while CU, from its formal documents appeared to take a compliant but unofficial position, was after the analysis seen to be well aligned with official policy – it was ‘modern’ and networked into contemporary society, producing teacher identities that were substantially changed but very much in line with official projections. However whether and how these teachers would cope with the realities of the system – particularly if they were placed in ‘traditional schools’ or in poorly resourced rural/ township contexts would require further research. It may be that they would be challenged by the reality of these contexts. These teachers while gaining substantial access to mathematical contents that were in line with the NCSM and also with the NCS – would be likely to cope well in well resourced schools that function well within less formal and non-authoritarian structures.

That these institutions produced different identities is perhaps not surprising given the stark differences in contexts. However, what the case studies illuminated was that the identities they produced were not congruent with their conscious positioning. CU, connected as it is into networked society and having a strong history of teacher education and a growing research base (particularly in its post-graduate sections) assumed its independence and positioned itself as relatively autonomous – however it was very much ‘in-line’ with official discourses (which it is also confirmed are very much in line with international trends in terms of the global reform movements). In this sense it could be seen as responsive to the ORF and its curriculum might be identified as largely ‘relevant’ to the goals of the democratic state. What is surprising is that the institution was not aware of its alignment with the ORF – at least at the level of lecturers involved in designing and selecting the contents of the mathematics teacher education curriculum. They were making selections framed by needs of the system as projected through policy, but doing this at a fairly unconscious level – that is not reflexively.

On the other hand RU, while consciously positioning itself in line with the ORF, was not working with these new identities but rather was responsive to the ontological space that it inhabited – rural, under-resourced, marked by deprivation and degradation – and producing identities that would be more in line with the ‘old’ curriculum and traditional ‘good’ teacher practices. It was also unconscious of these effects.

3.2 Context and access to resources count

Referring back to the issue of regulation and quality assurance, we see that the differentiation identified in Chapter 2 with respect to approaches to teacher education across different county contexts goes right down to the local level – *everything* is contextualised. The distributive rule works differentially across different contexts (as Bernstein understood) at both the epistemic and ontological levels. Lecturers have differently specialised consciousnesses and knowledge resources at their disposal, and this together with the realities that they are faced with in relation to the physical and material resources available within the context on a day to day basis, influences what is possible in the pedagogic context: at the level of curriculum design through the intended selection of contents and coordination of these across time and the relations between them (distribution of forms of knowledge and practice and their classification in the curriculum), the recontextualisation of these selections in practice (pedagogization of knowledge and pedagogic discourses operating within the context) and the way these are made available to pedagogic subjects (pedagogic mode and evaluation).

It is a truism that everyone always has to make selections, and will necessarily leave something out when selections are made. What the case studies have confirmed is that the privileged selections are not necessarily controlled through *conscious* processes and that the agents involved in making selections are constrained by contextual realities (time, human resources available, physical conditions, other material resources) as well as their own access to knowledge resources and understandings of pedagogic practice. Even when conscious decisions are made, the way the overall design is put together and the inclusion/ exclusion of specific agents²⁵⁰ in making decisions over selection will make a difference to what is produced. This is because pedagogic discourse always operates through ideological screens embedded within the instructional and regulative discourse, and at the level of regulation these are embedded within the social fabric in ways that are not always consciously accessible to the agents involved.

To go back to my original desire in carrying out this research mentioned in the introduction of this chapter, the research project has enabled me to see more clearly that if an institution was to attempt to make choices that are ‘epistemologically sound’ and ‘based on research’ agents need to be reflexively aware of their choices. That is, understand the theoretical (symbolic)

²⁵⁰ For example, all decisions being made within the education faculty by people suspicious of academics in the general university, and a fundamental belief that ‘they’ (e.g. academic mathematicians) do not understand what it means to educate a mathematics teacher and would necessarily make the incorrect choices (give them high level irrelevant mathematics content) and would provide poor models of mathematics teaching.

and practical basis on which selections into the curricula are made, and to rationally make decisions over the balance of different types of knowledge and practices that they see as necessary to include. That choices would involve dilemmas is inevitable since there are always limited resources and in particular, the programme must take place over a specific and limited time. This reflexivity would be necessary at two levels: the overall design of the curriculum and the selections into the individual components (courses/ modules) that constitute it.

At the level of the overall design of the teacher education curriculum, we have seen in the two cases that decisions over interpretation of the various aspects required in the curriculum, and the logic underlying the amount of time and space allocated to each, are removed from the practices of the individual lecturers involved in its delivery. In the case of CU, while there was some attempt to meet the regulatory environment (by integrating aspects that on analysis are clearly related to the various roles, and in focusing on the specialist role) the overall curriculum design appeared to be driven by the institutions historical roots as a college of education and geared towards its traditional client – a matric student who would not necessarily be academically inclined and would probably come in with a poor school background, not only generally but also in their chosen specialisation. This produced a curriculum that was very ‘full’ and a time timetable for students that depended on large quantities of contact time. On the other hand, at RU, there seemed to be an attempt to be ‘true’ to the requirements of the NSE policy, and so to produce a curriculum that ‘covered’ all the roles more or less equally. It was not that the institution did not have a historical practice that could have continued, rather, it was that the design decisions were being made on the basis of seeing the policy as prescriptive, which in part could be interpreted in terms of the institutions historic position of being under the authority of the ‘homeland’ structure and its tendency to follow traditional authority structures. This meant that ‘generic’ aspects of the curriculum were given a significant space in the curriculum as ‘core’ components, to the detriment of space being allocated to the specialist role and in particular to the practical elements of this role. The way that the policy was interpreted at RU, as prescriptive, meant that the curriculum was skewed towards knowledge for an imagined ‘general’ teacher – for example the general teacher who would be a generic ‘researcher’ to fulfil the role of ‘scholar, researcher, and lifelong learner’ without considering this as being part of the specialist role. The resulting curriculum created very little space for the specialist components of the programme and completely neglected the importance of teaching practice. In both cases, the overall design of the curriculum seems to have been determined by interpretations of the new policy from a

perspective rooted in the everyday traditions of the institution and its existing practices: the one as a college of education, the other as a university that operated within traditional authority relations and followed the prescriptions of the state.

In considering the level of the individual specialist modules in the curriculum, we saw that the choices made at CU in terms of mathematics were made at a conscious level and based within a particular orientation to the field of mathematics education and mathematics, and a rejection of traditional mathematical practices as exemplified in academic mathematics departments, and tempered by tensions around an understanding of the students who would enter the programme and responsiveness to the needs of the new school curriculum. Choices into ME/MT were less consciously selected and organised, but were driven by the same orientation to mathematics and mathematics education. This orientation, recognised as a form of pedagogic constructivism, produced the ideological screens that filtered the dominant pedagogic discourse operating at the level of pedagogic interaction and produced a model of good practice that the ‘good’ pedagogic subjects recognised and attempted to adopt.

At RU, there was no conscious reasoning for the selections into the specialist modules rather it was what ‘seemed’ right at the time. This appears to have been a judgement based on the experiences of the lecturers and their unarticulated orientations to mathematics and mathematics education within the constraints produced by their context: lack of time given to the curriculum design process, a general rush to provide module names and contents, a generally under-resourced environment, enormous pressure brought about by heavy teaching loads and the relative isolation of the institution within a rural context. They ‘simply’ put into the given module slots what they ‘thought’ was needed by their prospective students. The ideological screens in the pedagogic discourses constituted at RU were not as consistent as at CU – with a more traditional view of school mathematics (exemplified in the old curriculum) and mathematics teaching (as expository) continuing to operate, and a competence pedagogy operating in some of the mathematics education modules (particularly those lectured by Dr A), based in a consensus type constructivism. Despite the overall design being organised within the prescriptions of the new official discourses, RU in the final analysis produced student whose commitment to mathematics and mathematics teaching could best be described as traditional.

What this research project has illuminated is that if curriculum decisions are not *consciously* biased by a discursive field (that is symbolic identification) and based in research (and

specifically in this case, mathematics education and mathematics teaching research), then they will nevertheless be biased unconsciously within the ideological fabric of the institution. The lecturers who make the selections will be blinded by their own light (whether it is their commitment to certain aspects of a globally hegemonic mathematics education or teacher education discourses/ to other more localised and horizontal knowledge(s) and motivations). We saw this in relation to selections into mathematics education and mathematics in both case studies. For example, at RU, the sentiment that one would *hate* to prescribe to teachers what is ‘best’ for teaching given that nobody knows (it is always some opinion or another), so the best way to decide is through coming to a consensus; or at CU, the idea that the *only* mathematical knowledge teachers need access to is a form of mathematics for teaching which will enable them to ‘unpack’ compressed forms through developing understanding, which then could result in procedural fluency and other forms of reasoning labelled as ‘traditional’ being washed out. In particular when such discourses are used as a basis for the selections but teachers have no access to their discursive basis - in other words when Mathematics Education gets ‘washed’ out there is a danger that the student teachers will be positioned to either follow what they know best (revert to the practices they experienced while at school) or attempt to put the favoured practices of their lecturers into practice, which could lead to strategic mimicry if they do not have access to the underlying criteria for the practices.

What this illuminates is the importance of the teacher education institution (and its agents) being reflexive in its own practices. Thus the problem of selection of knowledge and practice into a teacher education programme is not simply a problem of the developing the consciousness and conscience of the student teachers with respect to access to different forms of knowledge and practice, it is also about the pedagogic identities of the lecturers and curriculum designers and the access that they have to the fields of M, ME and MT, and education more generally, as well as their understanding of the policy context and what it means to meet the needs of student teachers who must go out and work productively within the education system. To enable such a practice, requires that the agents involved in the design and the delivery of the curriculum need to be reflexive and responsive, and conscious of the need to co-ordinate different types of knowledge and practices in the curriculum. The specific context and resources within the context will always throw up dilemmas for those involved and lead to compromises, and the specialisation and access to knowledge resources of these agents will frame what is possible and impossible within the context.

In both case studies the control of the curriculum for teachers resides completely within the education school or faculty, and the bias of education lectures/ academics within the institution dominates what is possible, both at the level of the overall curriculum design and at the level of specialised mathematics, mathematics education and mathematics teaching modules. Who has access to what knowledge and practices within a specific context will therefore be influenced by the access that lectures have to specialist discourses, official discourses and by their specialisation as mathematics teacher educators. This exclusion of other interests within the university, in particular of mathematicians, has led to curricula which produce a particular conception of M and MT, and paradoxically, tend to exclude the very practices that one might expect education experts to develop strongly, i.e. a discursive base within mathematics education.

The analysis suggests that a key issue for quality teacher education is related to the way in which relationships are set up within the curriculum between different types of specialist knowledge (i.e. M, ME and MT), between the agents who select these aspects in the curriculum and make them available to student teachers within the pedagogic context, between the institution and the schools which provide sites for learning-in-practice, and between the student teachers, their lecturers and the teachers in the practice teaching schools. In the case studies reported here we recognise that in each institution different relationships were operating that were both productive and constraining. Whatever the elements of the specific institutional context, it is inevitable that relationships between the elements will be set up and supported or not supported and will lead to differential specialisation of the pedagogic subjects. These case studies suggest that the relationship set up with mathematics through the specific selections into the curriculum and mode of pedagogic practice operating at the institutional level is important and works to regulate the identity of the student teacher in very profound ways. While this study has enabled descriptions of identities produced within more or less closed curricula enacted within education sections, it has not been able to provide any insights on what the outcome would be if mathematics educators and mathematicians worked together to provide access to different types of knowledge and practices to initial teachers (M, ME and MT). This raises the question: what would be the outcome if productive relationships were set up between mathematicians and mathematics education academics in the development of a curriculum?

3.3 Quality and regulation of mathematics teacher education

The research supports the argument that we cannot expect to get to uniform quality across the system through policy regulation, particularly in a developing context such as South Africa where institutions do not have equal access to resources (human and material) to support the reforms. This research has shown that the pedagogic device and the distributive rule work to distribute access to forms of knowledge differently, and particularly across contexts where there are such stark differences (urban/ wealth/ resources – rural/ poor/ under resourced) this is accentuated. In both cases in this study, the institutions and their lecturers are doing what they genuinely believe is the ‘best’ they can do within their contexts – they are both working very hard to produce the *kind* of teacher that the system requires, however, their interpretations of what is required are determined largely by their own specialisation *and* by the resources they have available. The students at each institution are differently specialised.

The research supports the view that quality and standards cannot be legislated. It suggests that if we want to develop some kind of uniformity in standards and quality across the system it will not be done through policy images, or regulatory demands connected to written documents. It will be through a pedagogic project that will involve the specialisation of the lecturers themselves and the development of a discursive understanding of mathematics teacher education and of the responsiveness required of HEIs within the specific post apartheid South African education context, on which organic solidarity²⁵¹ could be based. Mathematics teacher educators, mathematicians and others who have an interest in producing quality teachers, need to come together, to build relationships, to share research and to use this as a basis for their own practice as teacher educators with a responsibility to teachers, the state and society as a whole.

3.4 Relationships matter

The findings of this research project emphasise that quality teacher education is concerned with *relationships*. Relationships between different components in the teacher education programme (the various forms of knowledge selected into the programme and made available to student teachers); relationships between various agents involved (lecturers and their student teachers); in particular the relationship between developing disciplinary knowledge as a basis

²⁵¹ The HEQC’s review of teacher education programmes may have started a process for developing organic solidarity across the field through which quality, responsiveness and responsibility could be ensured. However, this has not been the focus of this research project and this conjecture would have to be explored as a separate question.

for knowing the subject (in this case mathematics) and its practices (doing mathematics), and developing knowledge for teaching (in this case *MfT*). The findings of the research has emphasised that these relationships matter, and that developing identities are directly related to the relationships that are created at a personal level, both with forms of knowledge and with other subjects (persons interacting in the pedagogic context).

4 Methodological reflections

In the introduction to the thesis I discussed the scope of the research and reflected on the length of the product I was presenting for examination. I indicated that, in retrospect, it was perhaps too wide and too deep for a PhD study, but that since this is what had been done and produced, it needed to be presented. I recognise that the length of the product is a result of both the scope and the methodological approach I took in its production. The research drew on two major orientations: Thompson's (1990) methodology of interpretation and Bernstein's (1996; 2000) languages of description. Here I briefly reflect on this approach.

Thompson's depth hermeneutics methodology resulted in the project working through layers of description, from an account of the pre-interpreted domain (*doxa*), through accounts produced from social-historical analyses and formal discursive analyses using various theoretical and conceptual resources, to a reinterpretation produced through a reflection back over all the layers. This, while being productive in terms of enabling thick and rich descriptions to be produced and therefore ensuring descriptive validity, as well as analytic descriptions and therefore ensuring theoretical validity, contributed to the production of a lengthy thesis. In retrospect the methodology, while ensuring that the cases were explored in the kind of depth that could lead to confidence in descriptions produced, was complex and enormously time consuming. Had a more pragmatic approach been taken, the product may have been more succinct. The length of the thesis presented here is therefore a product of both a scope that was wide and deep as well as a methodology that insisted on layered descriptions.

In addition the approach involved the use of languages of description. The theoretical referents that made up the internal languages of description for the various aspects of the study (the policy analysis; the survey; the case studies of pedagogic communication through the three message systems and accounts of identities produced), enabled a number of models (external languages) to be developed for producing data for interpretation. As explained in Chapter 6 the external languages while providing models could not fully exhaust the empirical field. In addition, as was seen in the analysis of the formal assessments from CU and RU

presented in Chapters 7 and 8, in using the model for the production of data, the model was tested. In the case of the analysis of the formal assessments found at CU and RU, the model while producing data that was useful for interpretation needed to be extended and refined to be more productive for describing formal assessments found in the empirical field of MTE more accurately. This illustrated the productivity of the methodology to enable theoretical development at the very time that it produced an analysis of the empirical field. The movement between the empirical field and the external language of description in this case led to a robust analysis of the assessment items collected at each case study site, and on the basis of the analysis the model can be refined for further work. In the case of the development of an external language of description for exploring teacher identities, the first model produced, while at first appearing to provide a valid way of producing data for interpreting the empirical, was found to be problematic – a stable set of moves could not be found to produce reliable data, as discussed in Chapter 9. In that case the model had to be abandoned and I had to return to the theoretical field once more in order to reconsider a model for producing data that would enable a more reliable description. This illustrates the potential of the methodology firstly to ensure integrity in the description, and secondly to enable the development of theory and of more refined models through the movement between the empirical field and theoretical fields through the development of external languages of description.

One further point I would like to make here relates to the productive relationship between this research and another research project that I was involved in at the same time; the QUANTUM research project that has been mentioned on a number of occasions in this thesis. The Quantum project focused on the constitution of mathematical knowledge for teaching in formal in-service teacher education programmes. While I began conceptualising the project for this PhD research before becoming involved in QUANTUM, and I had already been working with Bernstein's theory, my involvement in the QUANTUM project was very productive for my work here. In particular was interaction with Davis' work on evaluative judgement that we developed in QUANTUM to produce a model for analysing video records of teacher education practice (utilised in the analysis of pedagogic interaction and practice in Chapters 7 and 8). A further aspect was the development of a model for analysing assessments in MTE (extended in developing an external language for analysing CU's and RU's formal assessments in Chapter 6 and used and interrogated even further in Chapters 7 and 8). In addition through this research project I was introduced to the work of Lacan and the notions of symbolic and imaginary identification, which I found to be very productive in the development of the methodology for interpreting the pedagogic identities of the case study

institution's 'good' subjects. This was a direction that moved beyond anything envisaged in the QUANTUM project. The theoretical and empirical work done in the QUANTUM project greatly enriched the work done in this project.

5 Limitations of this research project

This research project provides an overview of MTE in South African HEIs at a particular time in its history. The survey (Chapter 5) while providing broad brush strokes of the system could not provide any details of actual curricula that we could confidently say represented the implementation of MTE programmes across the system. The best it could do was produce descriptions of some written curricula intentions (or perhaps curricula produced for compliance purposes) and highlight some challenges raised by the organisation of knowledge and practice recognised within these. While it was possible, using these formal documents to describe the positioning of the various HEIs with respect to the ORF, these descriptions were all based on the paper designs of the curricula and not on practices in the field. As was seen from the analysis of the case studies, the positions recognised in the analysis of survey data may not match the actual practice. In both cases the positioning consciously written into the formal documentation turned out, in practice, to be incorrect.

The case studies while providing rich and thick descriptions cannot be extrapolated to other contexts – all they do is provide accounts of the pedagogic contexts of the case study institutions, the constitution of pedagogic communication (through the three message systems of curriculum, pedagogic interaction and assessment) within these sites and the construction of pedagogic subjects (knowledge and practices and persons) through this communication. However, having said this, while these are specific cases, the theoretical work done in producing the accounts and the models developed for interrogating the empirical field are productive for further work in the field. The research has also illuminated some key challenges for MTE and has to some extent set out to do what it intended – to clear the ground and get a view of the constitution of MTE across the system. In addition, since these cases represent extremes across the system, the comparative advantage has enabled me to use the accounts to illuminate possibilities and to open up questions for the field more broadly.

6 Concluding comments

This chapter provided an overview of the journey that produced the thesis. The research is clearly partial. It has provided some insights into the complexity of specialising consciousness through a curriculum. It has confirmed that context really does count and that relationships are of crucial importance. It has provided a view across the system which highlights a number of areas for further research, including the crucial area of learning in and from practice, and developing nuanced understandings of practice as more than experience. The study confirmed that in all MTE programmes subject content knowledge (i.e. mathematics) is seen as a key aspect of a teacher's education, however, what is considered to represent the 'right' kind of content knowledge is linked to specific contexts (and therefore remains contested). What is selected and made available is dependent on the specialisation of the agents involved in delivering the programme, the resources they have at their disposal (physical and human) and the relationships they develop with others involved in the process. The lack of productive relationships between academic mathematicians and mathematics educators was highlighted as a characteristic of the field and an area for further research. A consequence of this lack of a relationship and the tendency for mathematics education academics to take responsibility for all aspects of the mathematics teachers' access to different forms of knowledge (M, ME and MT), paradoxically results in access to mathematics education as a field of knowledge in its own right being washed out of the initial MTE curriculum.

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