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Teaching genetics to pre-service teachers: a teacher educator's approach to transformative practice through self-study

Nyamupangedengu, Eunice

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Teaching genetics to pre-service teachers: A teacher educator's approach to transformative practice through self-study

Eunice Nyamupangedengu

A thesis submitted to the Wits School of Education, Faculty of Humanities, University of the Witwatersrand in fulfilment of the requirements for the degree of Doctor of Philosophy

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ABSTRACT

This thesis reports on a self-study in which I generated knowledge about teaching through investigating my own teaching of genetics, a content course to pre-service teachers studying at university. The aim of the study was to investigate how to teach genetics for understanding of content and for teaching in pre-service teacher preparation. The participants were myself and the students registered for Life Sciences III in 2013 at Wits University in South Africa. Being a self-study, I was both the researcher and the researched. I used multiple methods of data collection. The data included the documentation of my planning for teaching the genetics course, journal entries of my thoughts and reflections, notes from discussions with colleagues and from discussions with critical friends, video-recordings of my lecture proceedings and finally, interviews with students. In order to address validity issues concerned with the use of the self-study methodology, I engaged critical friends who mediated my thinking and my interpretations of the data throughout the study. In addition, I subjected my observations and interpretations of the data to other researchers and peers in the relevant research community for critique at various platforms. The data analysis was both deductive and inductive. The deductive analysis methodology was informed by the PCK framework that I adapted from Davidowitz and Rollnick (2011).

In this study, I confirm that in order to effectively teach genetics (or any course) to pre-service teachers, it is important that teacher educators plan their teaching well. The study shows that in order to plan effectively, teacher educators must possess the four domains of a teacher's knowledge, namely; knowledge of context, knowledge of students, pedagogical knowledge and knowledge of content. The study extends the existing knowledge of the four domains of a teacher's knowledge by contextualizing it to teacher education. This is achieved by demonstrating that in order to effectively teach pre-service teachers; teacher educators must in addition to possessing the knowledge of their context, knowledge of their students, pedagogical knowledge and knowledge of content, they should also have the knowledge of their students' (the pre-service teachers) future contexts, knowledge of their students' future students (that is school learners), knowledge of pedagogical techniques for teaching their students'

students and knowledge of content for teaching in schools. The findings of the study confirm the need for induction of beginning teacher educators (BTEs) and for professional development programmes in higher education institutions. Furthermore, the study shows that research literature and professional peers are rich knowledge resources on teaching and metacognition is shown to be an effective way of developing novel teaching ideas.

The use of the concept of trigger incidents in the data collection and analysis, confirmed the importance of 'noticing' as teacher educators and of responding appropriately to what we notice. In addition, the trigger incidents revealed that when we display as teacher educators an attitude of caring towards our students, the caring attitude has the potential to develop in students a positive attitude towards their work which motivates them to participate fully in the whole teaching and learning process.

The discussions with critical friends led me to realise that I used constructivism in my teaching and this confirms the literature in which it is generally agreed that when an experience is shared with valued other, greater opportunities are provided for reframing of situations and of confronting one's assumptions about practice.

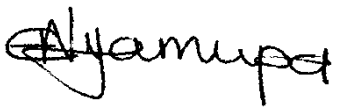
In this study, I demonstrate that when teaching a content course to pre-service teachers, it is possible and important to combine teaching for understanding of content and for teaching. I further demonstrate and confirm that one effective method of combining teaching for understanding of content and for teaching is by modelling good teaching. The study confirms the effectiveness of the methodology of self-study in the professional development of self and of interviewing one's students as a method for gathering data about one's teaching. Overall, I demonstrated in this thesis that self-study is a research approach that can be used to develop effective teaching through transforming into effective practical applications, the knowledge on teaching that lie abundantly and continues to accumulate in the literature.

Key words

Genetics, Pre-service teachers, self-study, critical friends, beginning teacher educators, pedagogical content knowledge, pedagogical knowledge, induction, metacognition, trigger incidents, constructivism.

DECLARATION

I declare that this thesis is my own unaided work. It is being submitted for the degree of Doctor of Philosophy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.



Eunice Nyamupangedengu

23rd day of March in the year 2015

To my husband Cuthbert who is my greatest inspiration

To my son Kudakwashe, and my daughter, Ruvarashe who are my staunch supporters

To my siblings Servias, Margaret, Persistence, Ngonidzashe, Ephyson, Munyaradzi, Mufaro, Admire, Chipo and Varaidzo my cheer leaders.

To my parents, thank you for training me to be a responsible and accountable individual. I look forward to your presence at my graduation.

PRESENTATIONS AND AWARDS EMANATING FROM THIS RESEARCH

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TABLE OF CONTENTS

ABSTRACT ..... **ii**

DECLARATION ..... **iv**

PRESENTATIONS AND AWARDS EMANATING FROM THIS RESEARCH ..... **vi**

ACKNOWLEDGEMENTS ..... **vii**

TABLE OF CONTENTS ..... **viii**

LIST OF FIGURES ..... **xv**

LIST OF TABLES ..... **xviii**

LIST OF ABBREVIATIONS ..... **xix**

Preface ..... **XX**

Chapter 1: Positioning my study in my lived experiences through a self-study **1**

1.1 Overview 1
1.2 Teacher education contexts 2
1.2.1 The teacher education models 2
1.2.2 The WSoE teacher education programme 3
1.2.3 The location of the genetics course in the Wits School of Education programme 4
1.3 My topic-focussed autobiography 5
1.3.1 The story of my career 5
1.3.2 My high school experiences 5
1.3.3 My first year experiences as a teacher educator 6
1.3.4 Turning points in my career as a teacher educator which became the motivation for this study 9

1.4 My professional motivation for the study 12
1.5 My personal motivation for the study 12
1.6 Self-Study of Teacher Education Practices (S-STEP) research 13
1.7 The purpose of the study 13
1.8 My research questions 14
1.9 The methodology of self-study 15
1.10 Theoretical perspectives that informed the study 16
1.11 The story of my life 17
1.12 The ma'am context 26
1.13 Chapter outline 27

Chapter 2: Bodies of literature that form the theoretical matrix for my study 28

2.1 Introduction 28
2.2 Teaching in pre-service teacher preparation 29
Good teaching in higher education 31
2.3 Content knowledge 34
2.3.1 Subject matter content knowledge 34
2.3.2 Curricular knowledge 35
2.3.3 Pedagogical Content Knowledge (PCK) 36
2.3.4 Content knowledge for teaching 37
2.3.5 Content knowledge and the teaching of genetics 38
2.4 Pedagogical knowledge (PK) 38
2.5 What literature says about the teaching and learning of genetics 39
2.6 Teaching content for understanding and for teaching in pre-service teacher preparation 48
2.6.1 Metacognition 48
2.6.2 Modelling good teaching as a way of teaching for teaching and for understanding content 49
2.6.3 Constructivism 49
2.7 Teacher educator professional identity 51
2.8 Learning experiences 52
2.9 Pedagogical content knowledge (PCK) 54
2.9.1 The PCK model by Rollnick et al. (2008) 56
2.9.2 The notion of pedagogical reasoning and action 60

2.10 The conceptual framework for my study 66
Explanation of the conceptual framework 66
2.11 Terminology in the practice of teaching 70
2.12 Conclusion 71

Chapter 3: My research design and methodology 73

3.1 Introduction 73
3.2 Approaches to the methodology of self-study 73
3.2.1 Action research 73
3.2.2 Reflective practice 75
3.2.3 Teacher inquiry 75
3.3 Narrative inquiry/Teachers' narratives 75
3.4 How I conceptualized my research 76
3.5 Participants 77
3.6 Why genetics 78
3.7 Critical friends (CFs) and collaboration 78
3.8 Forms of the collected data 78
3.8.1 Journaling 79
3.8.2 Discussions with colleagues 79
3.8.3 Discussion with critical friends 80
3.8.4 Collaboration 80
3.8.5 Video-recordings of lectures 80
3.8.6 Interviews with students 81
3.8.7: A summary of the data collection methods used in this study 81
3.9 Implementation of the study and data collection 82
3.9.1 Journaling 82
3.9.2 Discussions with colleagues 85
3.9.3 Interaction with critical friends 85
3.9.4 Video-recording of lectures 86
3.9.5 The interviews 87
3.10 Validity and reliability 91
Validity 91
3.11 Generalizability of my research 96
3.12 Data analysis 96

3.12.1 The narrative texts 97
3.12.2 The analysis of lecture transcripts 98
3.13 Ethical issues 102
3.14 Conclusion 104

Chapter 4: Planning my teaching: A basis for professional development 106

4.1 Introduction 106
4.2 Knowledge of context 107
4.2.1 My context 107
4.2.2 My students' context 108
4.3 Knowledge of students 109
4.4 Knowledge of content 111
4.4.1 Background to the course breakdown 113
4.4.2 The course breakdown process 114
4.4.3 An explanation of the choice and sequencing of the genetics topics 118
4.4.4 Feedback from colleagues on my genetics course breakdown 123
4.5 Designing the genetics course outline: Significance and lessons learnt 126
4.6 Pedagogical knowledge (PK) 129
4.6.1 Guidelines for my planning to teach 130
4.6.2 My plan for encouraging students to come to lectures on time 131
4.6.3 Preparing my introductory lecture to the course 132
4.6.4 Planning the teaching of the topic genetics at molecular level 133
4.6.5 Planning the teaching of the topic meiosis 137
4.6.6 Planning for teaching inheritance or Mendelian genetics 141
4.6.7 Planning for tutorials and practicals 144
4.7 Discussion: Planning to teach a course in pre-service teacher preparation, a basis for professional development 146
4.8 Conclusion 148

Chapter five: My reflections on incidents that occurred during my teaching 149

5.1 Introduction 149
5.2 The notion of shared language about teaching 149
5.3 Trigger incidents during my teaching of the genetics course 150

5.2.1 The first trigger incident: The unexpected responses from students which showed the influence of prior content knowledge on students' learning .. 151
5.2.2 The second trigger incident: Students' non-participation in discussions during lectures 154
5.2.3 The third trigger incident: Students' 'refusal' to participate in whole class feedback sessions 157
5.2.4 The fourth trigger incident: Failure to understand a student's question.... 160
5.2.5 The fifth trigger incident: A student walks out during a presentation by a guest lecturer 165
5.2.6 The sixth trigger incident: Student's thinking that I don't need to read anymore in preparation for my lectures because I know the content that I teach 166
5.2.7 The seventh trigger incident: Students who refused to participate in whole class feedback sessions participated in a role-playing activity without showing any anxiety. 168
5.4 Discussion 170
5.5 Conclusion 175

Chapter six: What did I say and do? Analysis of my teaching and presentation of findings..... 176

6.1 Introduction 176
6.2 How I analyzed my teaching 176
My initial coding scheme 176
6.3 Background to the presentation of findings from the analysis of my teaching 181
6.4 Presentation of findings 183
6.4.1 Knowledge of context 183
6.4.2 Knowledge of students 190
6.4.3 Pedagogical knowledge 194
6.4.4 Knowledge of content 207
6.4.5 Manifestations of PCK 209
6.5 A summary of my teaching practices as revealed from the analysis of my teaching 216

Chapter seven: What did they do, see and feel? Analysis of interview transcripts and presentation of findings 218

7.1 Introduction 218
7.2 Results of time triangulation 218
7.3 Developing the coding scheme 220
7.3.1 Descriptions of the four categories of students' experiences 225
7.3.2 A further look at the codes 229
7.3.3 The final coding scheme for analysing students' experiences of my teaching 231
7.4 Presentation of my findings 234
7.4.1 Background to the findings that I am going to present: A preamble 234
7.4.2 Students' descriptions of my teaching practices 238
7.4.3 Students' responses to my teaching practices 257
7.4.4 Students' multiple identities and the tension they create 266
7.4.5 Students' descriptions of the knowledge they gained 268
7.5 Summary and discussion 275

Chapter eight: Conclusions and recommendations 284

8.1 Introduction 284
8.2 My conceptual framework 284
8.2.1 My initial conceptual framework 284
8.2.2 My revised conceptual framework 286
8.3: The knowledge that a teacher educator should have in order to effectively teach a content course to pre-service teachers 289
8.3.1 Knowledge for teaching genetics, a content course to pre-service teachers 290
8.3.2 Insights into my other roles and responsibilities as a teacher educator ... 295
8.3.3 Insights about induction of BTEs and PD in HEIs 295
8.4 How my practice as a teacher educator transformed as I examined and reflected on my teaching of genetics to pre-service teachers 300
8.4.1 The power of noticing and a caring attitude towards students 300
8.4.2 Constructivism as an overall approach to my teaching 302
8.5 Students' experiences of my teaching and lessons learnt 302

8.5.1 Students' experiences of my teaching 302
8.5.2 How the knowledge about students' experiences can be used to improve our teaching of content courses 305
8.6 Methodological findings 308
8.6.1 Video-recordings 308
8.6.2 Interviewing students 308
8.7 Reflections on the methodology of self-study 309
8.7.1 Getting hands dirty 309
8.7.2 The challenges of doing a self-study 310
Epilogue: The 'joys' of my PhD journey 311
Reference list 313

Appendices 327

Appendix A: List of critical friends 327
Appendix B: Information on interviewees 328
Appendix C: My final course outline 328
Appendix D: The Reebop Activity 329
Appendix E: Examples of "Today's questions" 332
Appendix F: An excerpt of a quiz show 333
Appendix G: Codes created from the analysis of interview transcripts 334
Appendix H: Ethics clearance letter 335
Appendix J: Request for permission to do my study at WSoE 336
Appendix K – Ethics documents 338

LIST OF FIGURES

Figure 1: In my office at my workplace 18

Figure 2: Winnowing with my sister in law 19

Figure 3: Washing dishes outside our rural home kitchen 19

Figure 4: My rural homestead 20

Figure 5: Diagram showing the relationship between plants and animals 35

Figure 6: Tailored model for PCK (Rollnick et al, 2008) 57

Figure 7: Modified model for PCK (Davidowitz & Rollnick, 2011) 59

Figure 8: Shulman's model of pedagogical reasoning as adapted by Bishop & Denley (2007) 61

Figure 9: Diagrammatic representation of the amalgamated model of PCK of Davidowitz and Rollnick (2011) and of pedagogical reasoning as adapted by Bishop & Denley (2007) 64

Figure 10: Conceptual framework for the study 68

Figure 11: Visual aids showing how DNA organises itself into chromatin material then chromosome 84

Figure 12: Using pool noodles to explain the events of prophase 1 84

Figure 13: Genetics topics in my 2007 genetics course outline 113

Figure 14: The genetics concept map 116

Figure 15: The proposed list of genetics topics for the new genetics course outline .. 118

Figure 16: Picture used to introduce genetics (Source unknown) 133

Figure 17: Levels of DNA packaging 135

Figure 18: String analogy 136

Figure 19: Pieces of coloured string tied together 136

Figure 20: Model of DNA 137

Figure 21: Visual objects to show how DNA organizes into chromatin then a chromosome 137

Figure 22: Model of the events of prophase 1 140

Figure 23: Nyimo nuts 143

Figure 24: Misodzi (tears) seeds 143

Figure 25: The bigger picture of genetics 151

Figure 26: Explanation of blood groups 160

Figure 27: Diagrams showing the structure of a cell membrane 162

Figure 28: Examples of poster charts 186

Figure 29: Making an illustration of a cell just before prophase 1 on the chalkboard 187

Figure 30: Illustrating position of a gene on homologous chromosomes 193

Figure 31: Coloured string representing genes on DNA 195

Figure 32: Students holding up cards to indicate the answers 200

Figure 33: Students holding up cards to show their choice 200

Figure 34: Students' models of the stages of meiosis 206

Figure 35: Using string and other materials to explain the relationships between DNA, chromatin and chromosome..... 207

Figure 36: The four categories of students' descriptions of their experiences 225

Figure 37: The category students' description of my teaching practices and its sub-categories..... 226

Figure 38: The category students' description of my teaching practices and its sub-categories..... 227

Figure 39: The identity category and its sub-categories. 228

Figure 40: Categories of knowledge that was gained by students..... 229

Figure 41: Teaching contexts that were evaluated by the students 231

Figure 42: My final coding scheme for analysing students' experiences of my teaching 233

Figure 43: My initial conceptual framework for the study..... 285

Figure 44: The revised conceptual framework for the teaching and learning of pre-service teachers..... 287

Figure 45: How students' experiences are generated 304

LIST OF TABLES

Table 1: A summary of the Wits School of Education's BEd programme 4

Table 2: Knowledge components of PCK as conceptualized by various scholars 55

Table 3: A summary of the methods that I used for data collection 81

Table 4: Catalogue for the public validation process 94

Table 5: My initial coding scheme for analysing my teaching 100

Table 6: My initial coding scheme 177

Table 7: An example of my coding 178

Table 8: My final coding scheme for analysing my teaching 181

Table 9: The episodes found in lecture transcript one 209

Table 10: Students' responses to the first two interview questions 219

Table 11: My coding scheme developed in chapter six for analyzing my teaching 221

Table 12: Coding of interview transcript one 222

Table 13: Knowledge domains required by teacher educators for teaching pre-service teachers 290

Table 14: Framework for induction of BTE and for the PD of new lecturers* 299

Table 15: Suggestions for promoting positive teaching and learning experiences in our students 306

LIST OF ABBREVIATIONS

B Ed	: Bachelor of Education
BSc	: Bachelor of Science
BTE	: Beginning Teacher Educator
CC	: Concurrent model
CS	: Consecutive model
CF	: Critical friend
CCK	: Common Content Knowledge
CK	: Content Knowledge
HEI	: Higher Education institutions
KCS	: Knowledge of Content and of Students
KCT	: Knowledge of Content and Teaching
PCK	: Pedagogical Content Knowledge
PD	: Professional Development
PK	: Pedagogical Knowledge
TL	: Teaching and learning
TI	: Trigger incident
WSoE	: Wits University School of Education

Preface

Self-study provides a means for examining the messages we give as compared to the messages we intend to give, paired with a critical examination of the self that is the medium of those messages. In pursuing self-study, even familiar and comfortable practices become suspect. We cease to be naïve about our practice and increasingly recognize our individual and collective roles in the success or failure of teacher education. External factors (e.g. the students, the curriculum, the administration, colleagues, government mandates, socio-cultural contexts) can no longer excuse us from being responsible for our impact, and thus we are called to change (Tidwell, Heston and Fitzgerald, 2009, p. XX).

Chapter 1: Positioning my study in my lived experiences through a self-study

__Everything happens for a reason.__

And sometimes things happen to you that may seem horrible, painful, and unfair at first, but in reflection you find that without overcoming those obstacles you would have never realized your potential, strength, willpower, or heart.

Author unknown

1.1 Overview

In this introductory chapter, I first describe the teacher education context (including the teacher education context at Wits School of Education) before narrating my experiences of becoming a teacher educator as the knowledge of this context will help the reader to understand my experiences. I then describe my experiences in the form of two narrative accounts. The first account is a practice-focused autobiographical account of myself as a high school teacher and a novice teacher educator. The second account is the story of my life as a child and a learner who grew up in a rural area and learnt at rural schools. I have included my autobiography because this thesis is a self-study and as explained by Pinnegar and Hamilton (2009), self-study draws on one's life experiences including one's history and culture, one's actions, one's ideas, the texts one has read, the experiences one has had and the people one has known. I have written my autobiography in the form of a narrative because narration is a way of reflecting on and making sense of our own life experiences and teaching acts. According to Coia and Taylor (2009, p. 5) doing an autobiography is useful as it enables one to reflect "on the past from the perspective of the present where one achieves understanding that will hopefully lead to a better future". Autobiography helps one to uncover one's values, beliefs and motivations and to understand how our past impacts our present (Coia & Taylor, 2009). In addition to the description of teacher education contexts and my autobiography, I also describe in this introductory chapter, the motivations and the purpose of my study and the methodology of self-study. I also present my research questions and end the chapter by outlining the structure of the thesis

1.2 Teacher education contexts

1.2.1 The teacher education models

Teacher education and pre-service teacher preparation are used as synonyms in many contexts (Loughran, 2006). I will therefore also use these terms interchangeably in this study. Through discussions that I had with colleagues from various institutions within South Africa and from other countries, I got to know that pre-service teacher preparation programmes vary from institution to institution within South Africa and from country to country in the world. However, from the discussions, I distinguished two main models of teacher education preparation that are used for pre-service teacher preparation programmes which are described as the concurrent model and the consecutive model (Key Data on Education, 2009). Both models comprise of what is called the general component where students study one or more teaching (academic or content)[1] subjects and the professional component where students study the theory and practical skills needed for teaching. The professional component also includes school placements where students practice teaching for a given period under the supervision of practicing teachers at the schools and university lecturers. In the concurrent model (I will refer to it as the CC model) students concurrently study both the general component and the professional component and in the consecutive model (CS model), students of teaching first obtain the general component (an undergraduate bachelor's degree or even a postgraduate degree) in one or more content subjects after which they then take up further studies for the professional component. The CC model is structured in various ways at different institutions. For example, at some institutions the students study the content subjects in one faculty then move over to the education faculty for the professional component. I will call this structure concurrent model 1 (CC1). At other institutions, students concurrently study both the content subjects and how to teach those subjects in the same faculty or school of teacher education and then qualify as teachers for those subjects at the end of their studies. I will call this structure concurrent model 2 (CC2). The Wits University School of Education (WSoE) which is the setting for this study uses the CC2. In CC2, the role of a teacher educator is not just to teach about teaching (teaching the professional component) but also to teach content subjects (teaching the general component).

[1] In the rest of the thesis, I will use the phrase content subjects to refer to teaching subjects.

1.2.2 The WSoE teacher education programme

The WSoE teacher education programme is organised into what are called streams around which courses are built. Four streams make up the programme. The first stream is the academic stream which covers the teaching of content subjects such as mathematics, science, geography and English. The second stream has what are called core subjects such as philosophy, psychology and sociology of education. The third stream is made up of the methodology courses. Methodology courses are those in which pre-service teachers are taught how to teach a specific content subject. Examples of such courses are **Secondary Methodology Life Sciences**, a course in which they are taught how to teach Life Sciences or **Secondary Methodology Physical Sciences,** a course in which pre-service teachers are taught how to teach Physical Sciences. The methodology stream therefore, includes subject-specific methodology courses. While all students (whether they are training to teach Foundation phase, Intermediate or Senior phases or Further Education and Training (FET) band)[2] are taught the same content subjects, there are separate methodology courses for secondary school teaching and for primary school teaching. The last stream in the WSoE teacher education programme is the Teaching Experience stream whereby students are placed in schools for two three week sessions per year to practice teaching.

The academic stream aims to give students the requisite content knowledge and conceptual understanding. The academic stream consists of two 'learning areas'[3] both studied for two years and then extended by the study of two content subjects, one taken for a further two years as an academic major and the other studied for a further one year as a sub-major. Table 1 below shows a summary of one stream which is the academic subjects stream, within the university's Bachelor of Education (BEd) programme. In the Table, Natural Science is given as an example of a learning area in the academic subjects stream and the Life Sciences (Biology) subject as an example of a subject which can be studied further as an academic major or sub major. I have chosen to illustrate the structure of our university's B Ed programme using the Life Sciences subject because genetics is found within this subject and it is the teaching of genetics which is the focus of this study.

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[2] In South Africa, the education of learners is divided into phases from grade R to grade 12. Foundation phase covers grades R to grade 3, intermediate phase grades 4 to 6, senior phase grades 7 to 9 and the FET band covers grades 10 to 12.

[3] A learning area covers a number of related subjects e.g. Natural sciences is a learning area that covers Life Sciences, Physics, Chemistry and Earth Sciences. Social Sciences is a learning area that covers History and Geography

Table 1: A summary of the Wits School of Education's BEd programme

Streams	Year 1	Year 2	Year 3	Year 4
Teaching subjects	Natural Science I (NS) (Learning area)	Natural Science II	Life Sciences III (LSIII)	Life Sciences IV (LSIV)
		Second teaching subject I (in a different learning area e.g. Mathematics	Second teaching subject II	Second teaching subject III
Core subjects	Education I	Education II	Education III	Education IV
Methodology subjects	Secondary methodology NSI	Secondary methodology NSII	Secondary methodology LSIII	Secondary methodology LSIV
Teaching Experience (TE)	TE I	TE II	TE III	TE IV

Although the B Ed programme delineates the teaching of methodology courses in relation to academic majors, the content and the methodology courses are taught separately and may or may not be taught by the same person at each level. As such, what is done in the methodology courses may not necessarily be linked to the content that is covered in the academic course. For example students being taught genetics in the academic course may not be taught how to teach genetics that is skills and competences associated with the teaching of genetics.

1.2.3 The location of the genetics course in the Wits School of Education programme

The teaching of the genetics course was the focus of this study. The genetics course is a third year Life Sciences course. Genetics is offered to third year students who are taking Life Sciences as their major and fourth year students who are taking Life Sciences as their sub major. The genetics course is a six week course which is allocated seven 50 minute periods per week. Of these seven periods, three periods are for lectures (one double and one single), one period is used for a tutorial and the last three periods are a practical session. Teaching occurs in the lecture periods. In the tutorial periods students answer questions based on the content that is covered in the lectures. They can also engage in other activities such as role playing and presentations. In the practical session, students engage in practical activities like microscopy or modelling biology phenomena.

Below I narrate my experiences of becoming a teacher educator at Wits School of Education the context of which I have described above.

1.3 My topic-focussed autobiography

In this section, I give a practice-focused autobiographical account of myself as a high school teacher and a novice teacher educator. I describe briefly my practice as a high school biology teacher as that experience influenced the way I taught when I became a teacher educator. I then describe in detail my experiences as a novice teacher educator who was responsible for teaching genetics to pre-service teachers at university. I narrate this story of my experiences so that I can bring out how an examination of and a reflection on these experiences ushered in a new understanding of my roles and responsibilities as a teacher educator and then motivated me to carry out a self-study which culminated into this PhD thesis. As is common in self-study (see section 1.11), I presented my autobiography to a critical friend (CF). The responses from my CF which sharpened my reflection are included in my autobiographical account.

1.3.1 The story of my career

I am a teacher educator at a Higher Education Institution (HEI) in South Africa. I joined the institution seven years ago (2007), straight from a high school classroom. I had been a high school biology teacher for 14 years in a neighbouring country Zimbabwe. When I got employed as a teacher educator, I was already enrolled for an MSc (Science Education) degree and I was hired on the basis of being a successful high school teacher and a successful post graduate student. I was hired to teach a content course (genetics) to pre-service teachers. I did not expect to encounter any challenges in moving from high school to teacher education as I was riding on my successful experiences as a high school subject specialist. I anticipated that I could easily teach the content of genetics. After all, the subject matter the student teachers needed to know was what I had been teaching for 14 years. When I started at the HEI, I did not go through any induction or formal preparation for teaching pre-service teachers. I went straight into the lecture room. Therefore, at the beginning of my career as a teacher educator, I had my own assumptions of what good teaching of biology to pre-service teachers entails.

1.3.2 My high school experiences

As a high school teacher, I had been responsible for teaching Ordinary (O) Level and Advanced (A) Level biology. O-Level curriculum covers the first four years of high school. A-Level is a two year programme that is done after completing and passing O-Level. A-Level students choose three subjects only which they do in two years so the content to be covered

is quite extensive. In the A-Level biology syllabus, many topics of biology are taught. Genetics topics are scattered throughout the syllabus and are taught at different times during the two year programme. I used to teach according to how the topics were arranged in the syllabus. The genetics topics were therefore not taught as one unit but rather as discrete topics taught at different times. The A-Level biology syllabus was also a well-detailed document in which for each topic to be covered, objectives were outlined. The objectives made it clear on what learners were expected to be able to do by the end of each topic in preparation for the final examinations. The focus of my teaching was therefore to meet those objectives. The competence of a teacher and hence of a school was measured in terms of not only how many students passed the national examinations but also how many students achieved distinctions. That being the case, my focus and that of many teachers was to teach for examinations. Throughout my career as a high school teacher, I used to teach for students to pass examinations. I was an authority as far as the teaching of my subject was concerned. I knew the objectives of the curriculum. I knew how to prepare my learners for examinations and my students used to pass their examinations very well. In this respect, I was regarded as a very competent teacher and I viewed myself as an accomplished high school biology teacher. As a result of this background, I didn't hesitate to accept to teach the genetics course to pre-service teachers.

1.3.3 My first year experiences as a teacher educator

When I became a teacher educator, I was employed to teach a content course; genetics to third year university biology students. The course was part of a full year Life Sciences course and was only six weeks long. When I started at the institution, I was given a list of topics making up the genetics course. I had to design a course outline from the given list of topics. There was no previous course outline to work from. (*Although at that time I felt that it was irresponsible for the Division of Science not to have copies of the previous course outlines to give to new members of staff, when I look back now, I see it as an opportunity that presented itself to help me to engage head on with the demands of my responsibilities as a teacher educator*). Faced with this situation, I resorted to the only resource that I had; my own high school teaching experience, to organize the topics into weekly lecture units. I spent many hours reading biology textbooks to update my subject matter knowledge and prepare for my lectures. (*It did not occur to me then that research literature could be a source of more appropriate information about the teaching and learning of genetics*). **California** (***Critical Friend): Did you look at previous exam papers and if so what guidance did you glean from these?*** I did look at past exam papers with the aim of determining at what level I

needed to pitch the content of my course. After browsing through a number of past exam papers, I felt that my high school experience and knowledge of genetics was more than adequate for the teaching of the genetics course and my confidence grew. ***California: Did you check what genetics was included in year 1, and if so, how did that guide you? If you did not check any of these, why not?*** I did not check these things because my thinking at that time was that my responsibility was to teach the topics that I had been given. My focus was therefore to prepare a 'good' course outline based on the topics that I had been given then teach according to that course outline. What guided me in preparing the course outline was my high school experience of teaching these topics. The preparation included figuring out how to teach the concepts to my students. My resource for the choice of activities was high school experience. For example, for meiosis, the support materials I chose were exactly the same as those I used in high school: photomicrographs and microscope slides of the different stages of meiosis.

The teaching of the course 'proceeded well' in my first year (2007) of teaching pre-service teachers. I had put together a kit of activities from my high school experience which I thought were very effective. As a high school teacher, I believed that a good teacher was one who gave good explanations of concepts and linked theory to practical applications in her teaching to help learners to understand the concepts. The teaching approaches that I chose supported that belief in a number of ways. For example, within a single lecture, the teaching of content would be alternated with appropriate practical activities by the students. I was able to give individual attention to those who needed it. In my opinion, all these teaching approaches were examples of 'good' teaching. I would also dedicate a lot of time to genetics problem solving exposing my students to a variety of genetics problems. The sessions on solving genetics problems were like drill sessions where I would introduce a concept such as co-dominance. Then students would work on a number of problems on co-dominance before moving on to the next concept. Students would therefore be exposed to the same kind of problems and would use same procedures over and over again. The size of the group then was small (19) and I was responsible for both the teaching and the running of the practicals. This is not always possible at HEIs where student numbers are typically big and only contained in large lecture theatres. In this case however, because the group was small, I used the laboratory for both lectures and practical activities and I could easily combine teaching with individual or group activities. I used a high school classroom set-up for my teaching. At the end of the course, both the formal and informal feedback that I received showed that the students had learnt a lot about genetics and had enjoyed the course very much. (*It matters to me what my students think about my teaching and what their*

experiences of my course are. The positive feedback that I got therefore meant a lot to me). One student at the end of the course came to me and said this:

Ma'am, now I really understand what genetics is all about.

And from the university administered formal lecturer evaluations

- *Mrs Nyamupa teaches well. She makes concepts clearly understood and explains well, until it is understood*
- *She takes her time in explaining her work. She works with students until they understand*

California**: **These are really good evaluations. So what was problematic with your teaching? The good evaluations from the students were the problem! The evaluations showed that students were happy and satisfied with my teaching and I also got satisfied with the way I had taught them.

California: Were there no negative comments in the students' evaluation? There were some comments which were more of suggestions for improving some aspects of my teaching rather than negative comments. The suggestions are listed below:

- *If the lecturer could attend all of us when we need help. I think the lecturer takes interest on those who knows (sic) the work. For some of us who don't she ignores us.*
- *If she could start from the basics then gradually moving to the abstract and more complex structures of the lesson.*

California: Up to here you did not seem to change identity. You saw your role still as a school teacher supporting learners' understanding of subject content. Any PCK that you used was not content-specific. Even the sequence that you used was adopted.

California's comments sum up what was happening in my teaching in the first year of my career as a teacher educator before some events happened in my line of work that helped me to become aware of my new identity and motivated me to re-think my responsibilities as a teacher educator. These events are described in the next section as turning points.

1.3.4 Turning points in my career as a teacher educator which became the motivation for this study

A turning point is defined by Bullock (2011, p. 105) as 'a rich description of a problematic issue that invites careful analysis and helps one to understand pedagogical practice in a systematic way'. When I reflect back on my journey as a teacher educator, I see a number of turning points. I highlight these turning points below as they were the motivation for this study.

Turning point number one

In 2008 I used the course outline and activities that I had used in 2007 for teaching the genetics course to pre-service teachers. The group that registered for the genetics course was however, now much bigger than the 2007 group (41). I had to use a lecture theatre for my lectures and found myself doing most of the talking during the lectures. I could not think of any activities that would be appropriate for use in a big lecture room contrary to what I had been used to when the student group was small and lectures conducted in the laboratory. Doing group work or individual activities during lectures whereby I could move around helping my students was no longer possible. Students now had to wait for the day of the practical to do most of the practical activities. I was also now working with a demonstrator[4] during practicals. This was the first turning point in my career as a teacher educator. I found myself limited in terms of my capabilities to teach the content of genetics through the common high school approaches that I knew. My high school approaches were no longer appropriate for this teaching situation and I was not able to adequately address or resolve this problem at that time.

Turning point number two

In semester 1 of 2009, I was invited as a facilitator at a workshop on the teaching and learning of genetics to a group of Life Sciences subject advisors[5]. I was invited in my capacity as a biology lecturer responsible for teaching genetics at a Higher Education Institution (HEI) in South Africa. I was to facilitate the teaching and learning of genetic inheritance at the workshop. Although this invitation was a big honour, it was also a big

[4] A demonstrator is a teaching assistant who is hired to help and monitor students' activities during practical sessions

[5] A subject advisor is an educator who is a specialist in a particular subject, in this case Life Sciences, who then oversees the teaching of that subject in a school district.

challenge as I did not know how to teach about teaching. I had come from a high school classroom straight into a teacher education lecture room. Now I had to workshop the high school teachers on the scholarly apprenticeships of teaching genetics, but in my lectures I was still doing pretty much the same type of teaching and activities I had done in high school. This was the second turning point in my career. The Department of Education had not invited me to teach content to its subject advisors in those few hours. The department was asking me to do something more. They had invited me in my capacity as a teacher educator and I needed to understand this new role. My Pedagogical Content Knowledge (PCK) for teaching pre-service teachers was being challenged because I had the content but did not know how to teach the content together with the pedagogy.

Turning point number three

I accepted the invitation to facilitate at the genetics workshop and with some collaboration with a colleague, prepared thoroughly for the workshop. In the workshop, I presented to teachers an inventory of problems associated with the teaching and learning of genetics that I had identified from literature. After a presentation of problems associated with the teaching and learning of genetics, the rest of the workshop was a series of exercises, explanations and activities that the teachers could do to overcome the problems of teaching and learning genetics that we had discussed. According to feedback evaluations, the workshop was 'successful'.

When I reflected on my facilitation at the genetics workshop, I realised that:

- My facilitation covered both content and pedagogy but in my genetics course at the university I was covering content only. While teaching content only is not a bad thing, in the structure of the B Ed programme at Wits University (CC2), methodology courses are taught separately to the content courses and as such, what is done in the methodology courses may not necessarily be linked to the content that is covered in the academic subject.
- My facilitation focussed on what research literature says about the teaching and learning of genetics; the misconceptions and difficulties associated with the teaching and learning of genetics and the activities that teachers can do to deal with some of the misconceptions and to overcome some of the difficulties, but in the genetics course that I was teaching, I was only focussing on content coverage i.e. describing and explaining facts, principles, processes, structures of genetics and their functions.

These observations made me realise that my focus as I prepared and facilitated at the genetics workshop was different to my focus when teaching genetics to pre-service teachers. In the genetics course, in my teaching of pre-service teachers, I was focussing on content only and nothing about pedagogy; in this instance pedagogy for successful teaching and learning of concepts in genetics. My teaching was content driven.

California: Why content driven? My teaching was content driven because the course was a content course and therefore my belief was that in a content course you teach content. As explained above, it is not a bad thing to teach content only, when considering the structure of the B Ed programme at my institution. However, the students may never get a chance to be exposed to pedagogical issues surrounding the teaching and learning of particular content for example genetics in this case.

When I prepared and facilitated at the teachers' workshop, I didn't read biology textbooks in preparation for genetics teaching and learning. I read lots of journal articles on the teaching and learning of genetics. I found myself wanting to know what research says about the teaching and learning of genetics so that I could present this knowledge to the in-service teachers. I was now searching for new knowledge and skills that I needed as a teacher educator. It dawned on me then that I was no longer a teacher teaching high school learners, I was now a teacher educator teaching prospective teachers and I needed to develop new knowledge and new skills. In other words, I needed to develop PCK for teaching pre-service courses. This became the third turning point in my career. My perspective on what it means to be a teacher educator was being challenged. It was from this workshop that my confidence as a teacher educator was stifled. I started to question my own assumptions of what good teaching is when it comes to teaching a content course to pre-service teachers. This questioning of my practice culminated in this PhD self-study two years later.

Turning point number four

After facilitating at the teachers' workshop as described above, I got into a dilemma. My experiences at the workshop showed me that it was not enough to just teach genetics content to my students. While teaching the content, it was necessary to focus students on how they can teach that content. However, I was not sure if information such as learners' misconceptions and the difficulties associated with the teaching and learning of genetics could be taught as part of a content course. This observation, like my observations during the teachers' workshop, prompted me to again rethink my teaching of the genetics course. I

began to think that maybe there was a 'better' and more appropriate way of teaching pre-service teachers that I was not aware of that my colleagues could be using. I assumed that my colleagues could enlighten me on how I should teach a content course. However, when I consulted my colleagues, I realised that they all had different ideas and therefore no one could specifically advise me on how to teach a content course.

1.4 My professional motivation for the study

As commented on by my CF earlier, my move from high school teaching to becoming a teacher educator did not change my identity in terms of my teaching. Yes, I was now called a teacher educator but my focus was still teaching content in the same way that I was teaching at high school. Yet becoming a teacher educator requires a generation of what Russell (1997, p. 44) called *'a second level of thought about teaching, one that focuses not on content but on how we teach'* The question however is how does a new teacher educator get to know about this important requirement and how does one develop it? HEIs, do not have any or effective induction or preparation structures for their new teacher educators (Berry & van Driel, 2013; Chetty & Lubben, 2010; Murray, 2005a) although many of them begin their careers as secondary or elementary school teachers then move to HEIs (Dinkelman, Margolis, & Sikkenga, 2006). Research shows that most of these teacher educators have to learn through what I would call 'on the job practice' how to teach teachers. This idea of learning to teach through practice became the motivation for this PhD study; to investigate how I should teach pre-service teachers through practice using the methodology of self-study.

1.5 My personal motivation for the study

One important aspect of my life is that I am very passionate about teaching and one of my biggest desires in my teaching career at the moment is to be the best genetics teacher educator ever. When I decided that I was ready to do a PhD, it was in 2011, two years after I had facilitated at a teachers' workshop described earlier. I wrote a one page proposal and gave it to my supervisor. In that one page, I had described my experiences of teaching genetics to pre-service teachers before the teachers' workshop and after the workshop (I narrated these experiences in the earlier sections). After reading the short proposal, my supervisor said to me *"It's a good proposal. I can see that you are very passionate about your teaching of genetics. Why don't you do a self-study? I don't know much about self-study but I encourage you to find out more about it and decide"* He then handed me a primer on self-study by Samaras and Freese (2006). This is how I got to know about self-study. The

knowledge about self-study research that I gained from reading the primer motivated me as I saw it as a way that would help me to understand and to improve my teaching. The turning points that I had experienced in my teaching of genetics (narrated above) had stifled my confidence as a teacher educator and had created in me uncertainty about the appropriateness and effectiveness of my teaching. Therefore, a Self-study of Teacher Education Practices (S-STEP) known simply as self-study was exactly what I needed at that point in my career as a teacher educator. A self-study was going to provide what Samaras (2011) described as a safe environment that would allow me to research these uncertainties about my teaching practice that I was facing and to learn from them. Through a self-study, my hope was that I would understand my teaching then use the knowledge gained to improve it.

1.6 Self-Study of Teacher Education Practices (S-STEP) research

Self-study is a study of the self by the self. It is about researching practice by teachers/teacher educators interested in better understanding and developing their knowledge of practice (Berry, 2008). It involves one's personal teaching stories that arise out of one's 'own challenges, frustrations and dilemmas' (Samaras & Freese, 2006). Self-studies in teacher education help teacher educators to learn about themselves and to improve their practice. Tom Russell in Russell (2005) described how he used self-study to study and improve his practice. Amanda Berry used self-study to investigate how collaborative research can build teacher educators' knowledge (Berry & Scheele, 2007) and through a self-study a pre-service teacher was able to come to a better understanding of what it means to be a teacher (Samaras & Freese, 2006). While self-study is said to be a study of the self by the self, the research is not about the self. Self-study research is about what one can do for students and for education. The ultimate goal in self-study is therefore to positively impact one's students' learning (LaBoskey, 2004).

1.7 The purpose of the study

My study was a self-study in which I was investigating my practice as a teacher educator responsible for teaching genetics to pre-service teachers. The purpose of the study was to study my teaching with the aim of improving how I teach a content course to pre-service teachers. I wanted to learn and to understand how I could prepare teachers who would have the requisite depth of knowledge and understanding of genetics and who would also be able to effectively teach genetics.

1.8 My research questions

As outlined above, the purpose of my study was to investigate my own teaching when **teaching genetics**, a **content** course to **pre-service teachers**. I adapted questions from McNiff (2002) to guide the formulation of my research questions.

1. **What was my concern?** My concern was how to teach pre-service teachers genetics for both understanding of content and for teaching.
2. **Why was I concerned?** I had become dissatisfied with the way I was teaching as I had come to realise that the way I was teaching pre-service teachers was not going to adequately prepare them to teach genetics.
3. **What did I think I could do about my concern?** Firstly, I thought I needed to consolidate my knowledge of genetics content and of genetics teaching and learning by reading the literature on genetics teaching and learning. Secondly, I thought it was important to familiarise myself with the literature on the teaching of pre-service teachers, discuss possible improvement in terms of how to teach a content course for both understanding and for teaching with colleagues then implement all suggestions not with the aim of staging 'good teaching' to pre-service teachers but rather to gather evidence of classroom practice that could inform my own and others' future teaching of a content course to pre-service teachers.
4. **How was I going to show whether I was influencing the situation for good?** By finding out students' experiences of my teaching through interviews and lecturer evaluations.
5. **How was I going to judge whether any conclusions I was going to come to were reasonably fair and accurate?** By involving critical friends and the research community at large to critique my work from designing phase to data collection, analysis and discussion and at intervals presenting my work to the scholarly community for deliberation, further testing and judgement

The responses to the questions above guided the formulation of my research questions and subsequently my research design and methodology. My research questions were:

1. What knowledge should I have as a teacher educator in order to effectively teach genetics, a content course, to pre-service teachers?
2. How is my practice as a teacher educator transformed as I examine and reflect on my teaching of genetics to pre-service teachers?
3. What are students' experiences of my teaching practices?

4. What do I learn from students' experiences and how can I use that knowledge to improve the teaching of pre-service teachers?

1.9 The methodology of self-study

In this section, I describe the characteristics of self-study methodology to familiarize the reader with this methodology. Self-study is a methodology for studying professional practice (Loughran, 2007b). It (self-study methodology) is not a way of knowing but rather "a stance that a researcher takes towards understanding or explaining the physical or social world" (LaBoskey, 2004b, p. 1173). Five principal characteristics typify self-study methodology. The five characteristics are that; the work is *self-initiated and focused*, the work is *improvement aimed*, *interactive*, uses *multiple, primarily qualitative methods* and *validity is exemplar based* ***(***LaBoskey***,*** 2004***)***. I will explain these characteristics below.

Self-initiated and *focused* means that the teachers or the teacher educators are the researchers and the researched (Samaras, 2011). The work is *improvement aimed* means that the work of the teacher educators is aimed at improvement not only of themselves but also of their students, their students' students and their institutions and social contexts (LaBoskey, 2004). Since in self-study, the researcher and the researched are one and the same, the study is *interactive* at one or more stages of the process. The interactive nature of self-study describes the monitoring process whereby critical friends, colleagues and students get involved in the self-study project (Samaras & Freese, 2006). Critical friends with their alternative views improve the process and colleagues ask for clarifications and can offer alternatives (Samaras & Freese, 2006). The interactive nature of self-study also entails interaction with the literature (LaBoskey, 2004). According to LaBoskey (2004, p. 821), the interactive process "guards against the inevitable limitations of individual interpretation so affected by personal history". Self-study methodology uses *multiple, primarily qualitative methods* for gathering data. The use of multiple methods provides opportunities for the self-study researcher and for others to gain different angles or viewpoints on the educational processes being investigated thereby providing a more comprehensive view of the process. V*alidity is exemplar based* means that validation is achieved through "the construction, testing, sharing and re-testing of exemplars of teaching practice" (LaBoskey, 2004, p. 859). Exemplars of practice are concrete documents and examples of practice that are presented as exhibits to allow members of a relevant research community to judge for themselves the trustwothiness and validity of the observations and interpretations.

According to LaBoskey and Hamilton (2010), when doing a self-study, you first make observations of yourself then systematically collect data to represent your observations and to capture further observations. You then study research from other methodologies for insights into your current practice. You reflect on own background for insights of your contribution to the current setting then utilize your study to represent for others what you have come to understand in your own practice and ultimately to perfect and improve the quality of your own practice. There are four important features to the methodology of self-study (LaBoskey, 2004). These features are that firstly, there should be evidence of reframing and transformation of practice; secondly, there should be evidence of interaction with colleagues, students, educational literature and the researcher's previous work, thirdly, there should be competent use of multiple methods and lastly the work must be made available to the professional community. Interaction with colleagues, students and one's previous work is important as it allows interrogation of one's developing understandings. According to LaBoskey (2004), the use of multiple methods of data collection provides opportunities that allow for different and more comprehensive perspectives on the educational process being investigated.

1.10 Theoretical perspectives that informed the study

In the absence of readily available theories that explain how one learns to become a teacher educator through practice, my point of departure was an assumption that the major role of a teacher educator is to teach content and pedagogy to pre-service teachers. This assumption was supported by the literature. According to Loughran (2006), in teaching and learning in teacher education, focus should be on both **content** to be taught and learning to be experienced. The learning to be experienced is not just about content only but about the **methods** that are used to teach that content. Loughran argues that in a teaching and learning environment, pre-service teachers should be able to learn that which they are being taught and at the same time be able to question, examine and learn about the way in which the content is actually being taught. What this means is that a teacher educator should be able to provide the kind of teaching that will allow pre-service teachers to learn content and at the same time learn about the teaching of that content. Although Loughran was talking about content in the **context** of teaching about teaching, I see this as also applying to teaching and learning when the **context** is teaching a content course like genetics as long as that content is being taught to pre-service teachers. Garbett (2012) had a similar idea to that of Loughran (2006). Her idea was that teacher education has a dual purpose and the role of teacher educators is to marry that purpose.

> **Student teachers** learn content knowledge and at the same time, must learn about teaching that content to others. The teacher educator's role is to marry these dual purposes in such a way that student teachers develop the skills, confidence and competence to teach learners with different needs and abilities (Garbett, 2012, p. 38).

The key components in the ideas above (indicated in bold) about teaching pre-service teachers are context, students, pedagogy and content. Therefore, I decided to draw on the PCK framework by Shulman (1987) specifically the model by Rollnick, Bennett, Rhemtula, Dharsey, and Ndlovu (2008) (see section 2.10.1) to guide my study.

1.11 The story of my life

This is the second account of my autobiography. I describe this part of my autobiography because it has greatly influenced who I am as an individual and how I conduct myself as a professional (a teacher educator). I was born in Zimbabwe in the town of Masvingo. I am a second child in a family of seven, two boys and five girls. My father was a primary school teacher then headmaster and my mother was a nurse. I grew up in the rural areas of Masvingo. When I was growing up, we used to stay at those schools at which my father worked as a teacher because in rural areas, teachers are provided with accommodation at the school where they are based. During school holidays we would go back to our rural home. I attended three different schools for my primary education and hence experienced three different socio-cultural environments. As a result, I learnt at a very young age how to survive and to integrate into new sociocultural environments. I also got to know at a very young age that people have different cultures which must be respected and that if you make an effort to understand other people's cultures you will be in a better position to help them to understand and to respect your own. For example at one of the schools where my Father was a Headmaster, people in that area followed a certain type of religion called Remba where they only ate meat of an animal slaughtered following specific rituals and conducted by a Muremba person. Therefore, to show that we were welcoming the local people into our house and that we would want to share our food with them, my father always asked a Muremba person to come and slaughter our animals for us such as chickens, goats and cattle.

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The life that we lived at school which was my father's work place was different to the life that we lived at our rural home. At school, our activities were governed by time tables: time for breakfast, time for lunch and for supper and time for doing some school work especially reading. My father would buy many English books for us to read. As children, we would also get some snacks or an extra meal in-between the main meals of breakfast and lunch and between lunch and supper. At our rural home however, our lives were very different mainly because we lived as a big extended family. For example, there were no extra meals in-between the main meals because there would be too many children to feed including brothers and sisters from the extended family. In addition, there was no specific time for breakfast, lunch or supper but a time range determined by the position of the sun. There was also no time for reading. Our rural colleagues would actually consider it as show off if I were not to join them in an activity for the reason of wanting to read. We had to be part of the rural activities including looking after the goats, going to swim in the river or going to look for wild fruits and wild mushrooms in the forest. The two different lives that I lived in my childhood helped me to understand that different sociocultural environments have different norms and expectations that should be adhered to for the smooth running of activities in those environments and for maintenance of relationships. Even now in my adult life, I am still living those two different lives. I work and live in an urban area and my life in this environment is dictated by timetables, computers, books and TV. Figure 1 is a picture of me in my workplace office.

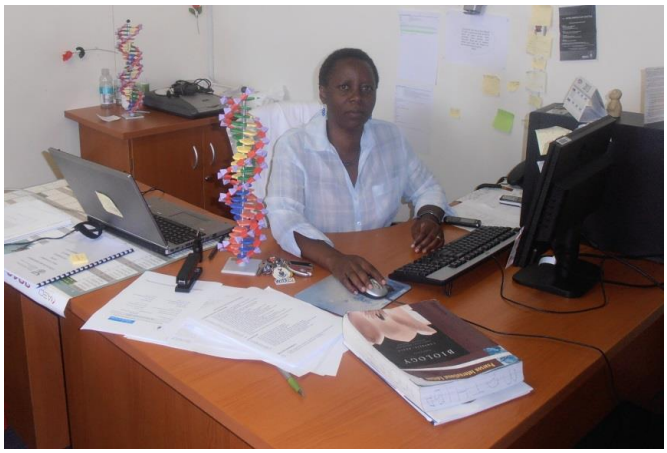

Figure 1: In my office at my workplace

During the holidays, I still go to my rural home and I am able to adjust to the rural way of life. Figures 2 and 3 are pictures of me caught in some typical rural activities.



Figure 2: Winnowing with my sister in law



Figure 3: Washing dishes outside our rural home kitchen

At the end of every year when we are tired of the hustle and bustle of the city, we go to our rural home to find solace. The modern structure in Figure 4A below is our main house with bedrooms. That is where everyone sleeps. The round thatched structure is our kitchen. That is where all the cooking and eating is done. In the evenings we all sit around a fire in the kitchen and talk. Evenings when we all sit around the fire are special family times. There is no TV to distract us from talking to each other, listening to each other and laughing together. Figure 4B is our fields and the surrounding view. This is the other side of my life.



A



B

Figure 4: My rural homestead

In the rural areas where I grew up, everyone spoke Shona. At that time, not all members of the community could speak or understand English so speaking English was never practiced in the community. At home, although my parents could speak English fluently, we hardly communicated in English and at school we also never communicated in English except during lessons.

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I started my grade 1 in 1976. At the end of my grade 1, my father relocated to another school which was nearer to our rural home. My mother was nursing my young sister at the time and therefore was out of work. During the British rule in Zimbabwe there was no paid maternity leave. The law was that a woman would have to resign from her job to go and deliver her baby and would have to re-apply after weaning the child. At the time of my primary schooling, the war of liberation was raging on in my country Zimbabwe then Southern Rhodesia and in 1978 disaster struck. My father, the sole breadwinner was thrown into jail for supporting 'terrorists'. My mother had to take over the responsibility of looking after us although she was not working. We were now permanently based at our rural home walking about 5km to the nearest primary school. Everyone in the family had to work hard in order to have food on the table. Our food came from tilling the land and money from growing and selling vegetables. Our main role as children was to water the vegetables. The garden was big and was situated near a stream about a kilometre from the house. We used buckets and tins to fetch water from the stream to water the vegetables. So after school, whether my mother was at home or not, we knew we had to water the garden. I therefore learnt from a very tender age survival skills, hard work, responsibility, discipline and accountability.

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We survived the war and so did my father. He was released from jail at the end of the war in 1980. He got his job back. My mother also got a nursing job at a mission school which was quite far from home. So we would only see her when she took days off from work. With both my parents working, it became the turning point in my life as my parents decided to send me and my sister to a boarding mission school. When I went to boarding school I was in grade six. Throughout primary school, though English was the official language of instruction, communication was essentially in the Shona language. I passed my grade seven examinations well and proceeded to high school.

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While most of my high school years were spent at a boarding school, school holidays were spent at my rural home. My family was still big. The whole family had to work hard in the fields to produce food that would supplement my parents' income. My father's policy was that during school holidays, it was our responsibility the children to do all the work that needed to be done. The work included looking after the cattle and tilling in the fields. So school 'holiday' was a time of hard work. My mother, being a nurse was away most of the time. The hospital where she worked was far from home. My father would go and stay at his school and would leave us alone at home expecting us to have completed all the work that needed to be done before the end of the school holiday. This situation which we found ourselves in every holiday taught us to plan and to work with targets. The situation also taught us to work very hard under very tough conditions without anyone to supervise us. Sometimes we would be forced to wake up as early as 4:00 am in order to meet our target. Most of the time we would work right through the day in the scorching sun only breaking for tea and lunch. While it was a very painful experience at that time, the experience has become an asset in my adult life. The experience trained me to be a hard worker, to work and work until the work is accomplished, to be able to set my own targets and be able to meet them without supervision. Today, if I am planning a lesson and I feel it's not yet ready, I can easily work into the night until I am satisfied with my preparation.

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At high school I met quite a diverse group of students from all over the country. Even though, we could freely speak our home language, Shona, we were expected to speak English in class. Although I had passed my written English very well in the grade seven examinations, I found it very difficult to speak English fluently. I could write English very well but speaking it was very difficult for me. Some learners who had come from towns and private schools could speak the language very well and would laugh at me and others like me who could not speak fluent English. We were even labelled SRBs which means those with a Strong Rural

Background and this was a stigma. Those who could speak English fluently were called maNose and this was an envied status. Literally, the word means 'through the nose' because the way they were speaking in English sounded like they were speaking through their noses. To cover up for my English fluency deficiency, I withdrew as much as possible from the activities that required me to speak English. Even in class, I hardly participated for fear of humiliation. I just could not express myself orally in English. Although there was no punishment imposed on those who made mistakes when speaking English, I just could not stand being laughed at. The environment was too 'hostile' for me to interact orally in English (Nyamupangedengu, 2014). My rural background and the rural schools that I had attended for my primary education had not equipped me with the linguistic capital (Grenfell & James, 1998) that I needed for full participation in this new environment. The issue of using a second language as the language of instruction was therefore excluding me from interacting with others in class. I however had the competence as far as the written communication was concerned. The ability to write English well motivated me to work hard in my agony of silence. I passed my Ordinary Level (O-level) exams as one of the top scholars at the school and proceeded to do my Advanced Level (A-Level) specializing in science subjects: biology, chemistry and mathematics. I passed my A-level and enrolled for a Bachelor of Science general (BSc) degree at the University of Zimbabwe.

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At the university, the English language problem got worse. Firstly, I failed an English communication skills test which was given to all first year BSc students. As a result of failing this communication skills test, the SRB label remained with me even at the university and lowered my self-esteem and further muted my voice in the classroom. All those who failed this test were expected to attend an English course which was three months long. I vaguely remember what we did but what I remember is that the course did not help me at all to improve my English in any way. The course was not addressing my problem which was a lack of vocabulary that is used in everyday communication and is crucial for one to adequately express himself or herself orally. Secondly, most of our lecturers were English speaking Caucasians. I could hardly understand what they were saying during class. It was very stressful to sit in a two hour lecture and hear and understand nothing. I would copy everything that was written on the board hoping that once I am back at the hostels, I would go through the notes and try and make sense of everything. This was not easy especially for Maths because it was the oral explanation which would give meaning to the numbers that I was copying. What made the situation worse was that the notes I was coping would have lots of gaps as there was no time to copy everything making understanding difficult. I had to

rely heavily on tutorials to catch up. The other problem was that Bachelor of Science students were a large group so lectures were presented in large lecture rooms. There was no way I could get individual attention when I had problems of understanding what the lecturer was saying at the same time, I was afraid of asking questions because of that fear of being laughed at. The thought of asking a question during lectures generated extreme anxiety in me and so I never asked. I have noticed similar experiences in the pre-service teachers that I teach. They do not participate in class discussions or ask questions but at the end of the lecture they come to me with questions that they could have asked during the lectures or their own viewpoints about a discussion that would have taken place during lectures and for most of them the reason is the same “they will laugh at me”. During Teaching Experience, I have seen pre-service teachers being laughed at by learners for using ‘broken’ English. My heart goes to these students because I know how it feels like and how it lowers one’s self-esteem and confidence.

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Despite the above challenges, I managed to pass my first year at university and I got motivated again. I had passed my biology so well that I was given an option to proceed to Honours in biological Sciences programme which I accepted. During lectures I would sit in front near the lecturer and would listen intensely throughout the lecture and with time I began to understand some of my lecturers’ English accents. I however failed my second year zoology practical exam which required us to describe features of the animals from different phyla which were on display. I remember moving up and down the lab looking at the animals on display noticing the differences but not knowing the vocabulary to describe them. In the end I abandoned the exam without finishing it (see Nyamupangedengu, 2014 for details of this incident). It was the theory exams which helped me to pass my second year. I continued to work hard in my third year and graduated with an Honours degree in Biological Sciences.

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As Honours students, we were encouraged to apply for Master’s degrees. So towards the end of my Honours degree programme, I made a decision that I wanted to do a Master’s degree in plant protection. Our country’s economy was anchored in agriculture and by venturing in that direction; one could make a contribution to the growth of the economy. Since our final results would only be available three months later, the whole group decided to apply for teaching posts. At that time, there was an extreme shortage of science teachers and so it was just a matter of availing yourself and you would be assigned to a school immediately. I was the only one in the whole group who chose to be posted to a rural school.

The rest of the group wanted to teach in urban areas. My reason for wanting a rural post was simple. I was afraid of being laughed at by urban learners because of my poor English. At the school where I was posted, I requested that I be allowed to teach forms one to four for a start. I was still experiencing extreme anxiety as far as speaking English was concerned so I wanted to learn to teach in English in a non-threatening environment. I needed to find my voice and I was convinced that the young rural learners would afford me that chance. The learners were well-disciplined and eager to learn. Working with these learners and seeing how they looked up to me for their own success developed in me a passion for teaching that I could not shake off. I fell in love with the teaching profession and forgot about my fears. Instead of going back to university to proceed with a Master's degree, I went back only two years later to study for a professional qualification in teaching (Post Graduate Certificate in Education) and became a qualified high school teacher.

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After my professional qualification I moved to an urban school. I was no longer afraid of teaching at an urban school. My confidence had improved during the three years that I had taught in rural areas. As I had anticipated, teaching in rural schools had provided me with a non-threatening environment in which to learn to teach in English with confidence. What also boosted my confidence was that I understood I had something important to offer to the students which they were also eager to get; knowledge. However, teaching biology in English is quite different from speaking the language in social contexts. So, although I was now a confident teacher in the classroom, I still lacked confidence outside the classroom. So I was a silent member of staff. I had found my voice in the classroom but not in the meetings or in discussions with other teachers.

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After teaching high school biology for 14 years in my country, my husband was offered a job at a tertiary institution in South Africa (SA) and we relocated. The relocation to South Africa took place in 2006. As soon as we got to SA, I applied for a Master's Degree in Science Education at Wits University and was accepted. I began my Studies in 2007. My relocation to South Africa and my studies were the catalysts for overcoming my fear of speaking English. Firstly, I found myself in an environment in which I could only communicate in English. Whilst this made life difficult for me this situation forced me to use English language for everyday communication. I did not have the luxury of code-switching to my home language. I just had to speak English. Secondly, during my MSc classes, I found myself opening up and contributing without any fear of speaking 'broken' English. No one including the lecturer for the course paid attention to anyone's perceived 'poor English' unless it was

so bad that it hindered communication. What was emphasized in this Masters class was the ability to put ideas across and to communicate. The lecturer created a learning environment which was conducive for me as an English second language speaker and it made me forget my fears.

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While I was interacting with other students in the MSc programme and in conversations with other people, I was able to pick up words in English (said in appropriate contexts) that are important for everyday communication. It was through this process that I eventually acquired the everyday English language proficiency that I had struggled to get all my life. By acquiring this proficiency, I have overcome my fear and finally found my voice both inside and outside the classroom. What is interesting to note here is that my fear of speaking English, which silenced me as a learner and as a teacher, was socially produced as the sociocultural environment was hostile to me as an English second language speaker. When I eventually acquired English language proficiency, it was also made possible by a sociocultural environment which was friendly and supportive and hence conducive for one to practice and develop communicative competence in English. My English is still far from perfect but this no longer silences me. I have grown to be able to communicate in English both inside and outside the classroom with confidence.

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Although I have now acquired the English communicative competence that enables me to teach and to communicate with others in English with confidence, the challenges associated with the use of English as the language of instruction and for communication still continue in my work environment. A reflection on my experiences that I have narrated above made me aware that poor English communicative competence can negatively impact the participation in teaching and learning activities and success in tests and examinations of students whose first language is not English where English is the language of instruction. This realization is in agreement with the assertion by Setati (2002) that English communicative competence can be key to academic success where English is the language of instruction. My biggest challenge is that as a teacher educator, I am in a situation where I witness the same negative impact on my students. I am teaching at a university where English is the official language of instruction and for communication. The majority of my students are second or even third or fourth English language speakers. This realization greatly influences the way I prepare and approach my teaching. For example, I try as much as I can to use scaffolding strategies that simplify my explanations of content during lectures. I also always use a PowerPoint presentation for my lectures in which important words are highlighted and

explained. The idea behind the use of a PowerPoint presentation every time is so that when students fail to understand what I am saying, they may at least 'see' what I am conveying to them. From reflecting on my experiences as a learner, I have also come to understand the impact that students' backgrounds be they sociocultural or academic can have on their chances of academic success. It has therefore become one of my goals to always create a classroom environment that gives every one of my students a voice and a chance to succeed despite their socio-cultural backgrounds.

Upon a critical reflection of my childhood experiences I see a number of critical skills that were developed in me from a very tender age from the way I was brought up which are important for my success as a professional. These skills include the ability to work very hard under no supervision which I see as an attitude of responsibility and accountability. Our mother did not have to remind us to water the garden. We knew we had to do it. Even now as a professional, once I am given a responsibility, whether by my superior or a colleague and I have understood it, I make sure I do it to the best of my ability. An attitude of responsibility is what self-study entails. No one except ourselves are responsible and accountable for what happens in our classrooms and self-study has the potential to enable us as teacher educators to do what we can to bring a positive change in our classrooms and hopefully in teacher education.

1.12 The ma'am context

My students call me Ma'am Nyamupa. This is because in my culture it is disrespectful to call a married woman by her first name especially if it is people who are younger than you. So as soon as you get married, people in the village call you using your totem or surname until you have your first child. When you have your first child, they will call you using your child's name. For example, my first child's name is Kuda so in the village back home I am 'Mai Kuda' meaning Kuda's mom. In Zimbabwe, at the workplace, colleagues never at any given point call you by your first name whether you are married or not unless you are friends. They use your surname. So in Zimbabwe, all students would call me Mrs Nyamupa and all colleagues would call me Mai (Mrs) Nyamupa or just Nyamupa if they are my age or older than me. I am working in a new context with people from diverse cultural backgrounds where people call each other on a first name basis both young and old. I however still feel disrespected, when a young person calls me by my first name. I teach mainly BEd undergraduate students, most of whom are much younger than me. When these students call me by my first name, I feel disrespected. Therefore, I always explain my cultural context

to the students and make it clear that I would prefer to be called Mrs Nyamupa. I do have a few students who prefer to stick to their culture and would call me Eunice. I respect that. The majority of the students however call me Ma'am Nyamupa and I appreciate it very much. So you will find later in this thesis in a number of students' utterances in my findings chapters (chapters five, six and seven) students using the word ma'am. This is the context.

1.13 Chapter outline

In this chapter, which is **chapter one**, I described how my study came into being from my lived experiences as a novice teacher educator. I have outlined the purpose of my study which was to investigate my own teaching of genetics a content course to pre-service teachers, find out students' experiences of that teaching then use the knowledge gained to improve my teaching and to contribute to the knowledge base for teaching genetics to pre-service teachers. In **chapter two**, I discuss a number of bodies of literature that are relevant to my study. The bodies of literature form a theoretical matrix from which I drew in order to effectively do my study. I describe my research methods and design in **chapter three**. In **chapter four** I describe how I planned my teaching of the course which included the development of a new course outline. I documented everything that I did as I was developing the new course outline and discussed the insights that I got from that process. In **chapter five** I present the details of what I called trigger incidents. These are the events that occurred during my teaching of the genetics course which triggered me to pose and reflect on what I was doing in the course. In **chapter six** I analyse my teaching as captured in the video-recordings of my lectures. The purpose of chapter six is to foreground students' experiences which I then present and analyse in **chapter seven**. In **chapter eight** I summarise the findings from my study and make some recommendations.

Chapter 2: Bodies of literature that form the theoretical matrix for my study

2.1 Introduction

In this chapter, I describe the bodies of literature that form the theoretical matrix for my study. The focus of my study was teaching of a content course to pre-service teachers. Therefore, the literature that I review in this chapter is related to teaching. To identify the bodies of literature that I needed to review, I looked at the various parts that make up the title of my thesis: **Teaching genetics to pre-service teachers: A teacher educator's approach to transformative practice through a self-study.** The various parts are: teaching, genetics, pre-service teachers, teacher educator, transformative practice and self-study. To effectively carry out my study, I envisaged that I needed to understand the following: *Teaching in pre-service teacher preparation* because pre-service teacher preparation is the context of my study, *good or effective teaching in pre-service teacher preparation*, *the teaching and learning of genetics*, *teacher educator identity* and *self-study*. I also looked at my research questions to figure out other bodies of literature I would need to look at. The questions that guided my study are:

1. What knowledge should I have as a teacher educator in order to effectively teach genetics, a content course, to pre-service teachers?
2. How is my practice as a teacher educator transformed as I examine and reflect on my teaching of genetics to pre-service teachers?
3. What are students' experiences of my teaching practices?
4. What do I learn from students' experiences and how can I use that knowledge to improve the teaching of pre-service teachers?

From the research questions, I figured out that I also needed to review literature on the *knowledge that a teacher educator needs to have in order to teach pre-service teachers*. As my study progressed, I identified more bodies of literature that were relevant to my study and these were *metacognition*, *modelling teaching*, *conceptions of learning experiences*, *pedagogical content knowledge* (PCK) and *constructivism*. These bodies of literature therefore form part of the theoretical matrix for my study which is discussed in this chapter.

2.2 Teaching in pre-service teacher preparation

Teacher education was described by Loughran (2006) as having two important foci: that of learning about teaching and teaching about teaching. The student of teaching seeks to develop knowledge and skills of teaching and how to competently apply these in practice. The role of the teacher educator is to teach about teaching. The description of the two-fold foci of teacher education by Loughran narrows the purpose of teacher education to teaching about teaching only which corresponds to either the consecutive model or the concurrent model 1 (see section 1.2.1). Even a survey of the S-STEP research literature shows that a great deal of research has been done and is still being done which focuses on teaching about teaching (e.g. Berry, 2008; Bullock, 2011; Loughran, 2006). There is very little research that is done by teacher educators on their own teaching of content subjects like mathematics, science and geography in pre-service preparation programmes. One possible reason for this skewed picture could be that most HEIs in the world use the CS or CC1 model. Research on the teaching of content subjects to pre-service teachers is important for the improvement of practice in HEIs that use model CC2 which as said in chapter one, is the context of this study.

When we look at teaching in teacher education contexts as expounded by Loughran (2006), teacher educators and the students of teaching should practice what Russell (1997) described as the 'content turn' and the 'pedagogical turn'. The content turn focuses on the knowledge of the discipline of teaching such as knowledge of classroom management, higher order questioning, constructivism and cooperative learning (Loughran, 2006). The pedagogical turn is when teacher educators consciously think about how they teach the content and the messages that are conveyed by their teaching (Russell, 1997). All too often, teacher educators and the students of teaching have been seen to focus all their attention on the content turn without paying much attention to the manner that content is taught; the pedagogical turn (Loughran, 2006). When Loughran and Russell wrote about the pedagogical turn and the content turn, they were saying this in the context of teaching about teaching. I however see this assertion as also applying to situations where teacher educators are teaching content subjects like biology and mathematics. This is because the purpose of teacher education is to train teachers and therefore whether you are teaching about teaching or you are teaching content subjects, both the content and how that content is taught are important as both elements influence how the pre-service teachers will teach when they become practicing teachers. In addition, how subjects like biology, mathematics, and geography are taught is important to pre-service teachers, as most of a teacher's time is

spent teaching subjects especially in high schools. Below I describe some insights from research on teaching about teaching which I see as applicable even when a teacher educator is teaching content subjects.

One of the insights that came from research on teaching about teaching is that:

> At any given time in the teaching and learning environment, there is a need to be learning that which is being taught while at the same time questioning, examining and learning about the way in which it is actually being taught: asking questions about the nature of teaching, the influence of the practice on the subsequent learning (or lack thereof); the manner in which the teaching has been constructed and is being portrayed; how the teaching-learning environment has been created and so on (Loughran, 2006, p. 4).

I see this insight as also applying to the CC2 model context because as students of teaching, their learning agenda should always include both learning the subject content and about teaching that content. However, according to Loughran (2006), focusing on both agendas is not easy because it is a very demanding exercise. It is a demanding exercise because for the majority of the students, focusing on content is what they had been taught to do in the 13 years of formal schooling. Furthermore, the teaching that is done in universities sometimes reinforces a focus on content and nothing on pedagogy (Loughran, 2006). It should therefore be the responsibility of the teacher educator to help students to focus on both agendas in order to achieve the purpose of teacher education.

The second insight that was explained by Loughran (2006) is that learning and teaching are linked activities which means that teaching influences learning and learning influences teaching. Therefore, for the students of teaching to influence the kind of teaching that should take place in teacher education settings, they need to pay attention to the content that is taught and how it is taught when learning so that they can ask questions about both the content and the teaching process. On the other hand, teacher educators also need to pay attention to both the content they teach and how they teach it in order to influence the learning of content and how to teach that content by students. This relationship should apply whether one is teaching about teaching or teaching content subjects to pre-service teachers. The challenge however is how to achieve the dual purpose in the context of teaching content subjects. Research is showing that there is now greater awareness of the importance of focusing on both content and how that content is taught in the context of teaching about teaching (e.g. Berry, 2008; Bullock, 2009, 2011). Unfortunately, the same cannot be said about the teaching of content subjects. Research literature shows that when teaching

content subjects, teaching content is all too often the only focus of attention for many teacher educators (e.g. Garbett, 2012; Tidwell & Fitzgerald, 2004) but good teaching when teaching content subjects to pre-service teachers would also require a consideration of the dual purpose of teacher education; teaching content for understanding and for teaching.

Good teaching in higher education

Good teaching is difficult to define. This is because, as argued by Fitzgerald, Dawson, and Hackling (2013), understandings of what is 'good' or 'effective' are based on the experiences and opinions of stakeholders. This makes it difficult to identify what counts as good teaching and therefore a consideration of opinions and suggestions from various sectors is necessary. A survey of self-study literature also shows that teaching is a complex endeavour (e.g. Berry, 2007; Bullock, 2011). Therefore in the next paragraph, as I try to build a description of what good teaching entails, I am cognizant of the complex nature of teaching.

From a study by Entwistle (1990) which was looking at teaching in higher education, students identified the following as good teaching practices: pitching lectures at the right level, presenting material at a sensible pace within a clear structure, providing lively and striking explanations in an enthusiastic manner, showing empathy with student difficulties, and using real-life illustrations in explanations as such illustrations help students to share the lecturer's enthusiasm. Entwistle (1990), got these features of teaching from students because as argued by Fitzgerald et al. (2013) students as stakeholders have a clear idea of what good teaching may involve. As can be seen above, students' descriptions of good teaching focus on the technical side of delivering good lectures and therefore on what the lecturer should do and nothing on what the student should do in the teaching learning process. The students' list therefore reflects a transmission model where the lecturer does everything and the students passively receive the information. The descriptions however give ideas on aspects of pedagogy that lecturers may have to consider to improve their teaching.

Students in Marris' study (1964) described what they thought would distinguish good lectures from bad. Although students were responding to the question which required them to say what they would want from their lectures, I see what they wanted from their lectures as describing what they would consider as good teaching. While the study was done more than five decades ago, and some of the issues may appear trivial, I see the issues that the students raised as still applicable today and therefore important to consider when looking at students' views of what a good lecture entails. The students pointed out a number of

features about teaching that they would consider to be features of a good lecture. These features include techniques of delivering a lecture and a lecturer's manner when delivering lectures. The students also emphasized that the lecturer must know his/her subject (**lecturer must have adequate content knowledge)** and also know how to present that subject in a way that his or her audience can understand (**pedagogical knowledge)**. On the techniques of delivering a lecture, students pointed out issues like the lecturer must speak audibly, the lecturer must have a sense of humour, the lecturer must be confident and should provide them with notes. Students raised a number of issues regarding the provision of notes; quantity, structure, and form. The students suggested that the structure of the notes should be understandable e.g. the notes should be orderly with headings. The students also suggested that if they have to copy down the notes, then the amount of the notes and the time available should equate. Some students suggested that they should be given copies of the notes and the lectures should then be for discussion not writing notes. In terms of presentation, students wanted the lectures to be delivered in a clear logical manner. Regarding the lecturer's manner, students made reference to enthusiasm for the subject, ability to make the students interested and originality. Just like in the study by Entwistle (1990), what the students described reflects an emphasis on the techniques of delivering lectures as the features of good teaching or a good lecture. The descriptions of a good lecture by students in Marris' study (1964) also reflect a transmission focus by the students. Unlike students in Entwistle's study however, students in Marris' study mentioned that the lecturer must have content knowledge of the subject and pedagogical knowledge.

In contrast to what the students said in the two studies above, Prosser and Trigwell (1999), are of the idea that good teaching in higher education is not about applying pre-determined recipes, techniques or templates to teaching and learning situations but rather careful monitoring of what students are experiencing in their learning situations and how they are doing so. Good teaching also involves a continuous awareness of students' present learning situation, of the **contextually** dependent nature of teaching, of students' perceptions of teaching technologies used in teaching, of the **student diversity** (including cultural diversity) in classrooms and of the need to continually evaluate and improve teaching. There is an emphasis on **context** and **knowing one's students** in the description of good teaching by Prosser and Trigwell (1999). Prosser and Trigwell did not however discuss class size. It is therefore, not clear whether class size would impact their idea of what good teaching entails. There is also a consideration of **context** by Fitzgerald et al. (2013, p. 983) who have considered good teaching as teaching that reflects "features of teaching that work for that particular setting or situation, and implies a certain contextual awareness" (sic).

While students' descriptions seem to be focusing on the techniques of delivering good lectures, a closer look at what they said also points to a consideration of context. For example, one of the issues that was raised by students in Marris' study is that the lecturer must speak audibly. This issue might appear trivial but in the **context** of higher education where the classroom maybe a big lecture room, that can become an important issue to consider which points to the importance of knowing your context as a lecturer or teacher educator. The students also raised an issue of being provided with notes. In this age of information technology (IT) and E-learning, lecturers would have to study the context and decide on what would work as some students would prefer electronic access to the notes and others, hard copies. Therefore, what both students and researchers said are important to consider in the conceptualization of good teaching. The study by Entwistle (1990) reflected partially on the importance of **pedagogy** on the part of the lecturer. Students in Marris' study (1964) emphasized the importance of both **pedagogy** and **content**. Prosser and Trigwell (1999) emphasized the importance of knowing one's **students** and **context**. Fitzgerald et al. (2013) in their definition of good teaching made reference to 'features of good teaching' which I think refers to **pedagogical** aspects and **contextual** awareness. By considering the accounts of good teaching by students and definitions of good teaching by researchers together, good teaching will require knowledge of pedagogy, knowledge of content, knowledge of students and knowledge of context. All these four aspects make up knowledge domains of a teacher in the PCK model by Rollnick et al. (2008) - (see section 2.10.1) which may imply that there is a correlation between PCK and good teaching.

When I consider what teaching entails when it comes to teaching pre-service teachers as discussed earlier and features of good teaching described above, good teaching in pre-service teacher preparation would mean a consideration of the setting which is the lecture room and a consideration of the context which in my case is the teaching of a content course to pre-service teachers and a consideration of students who in my case are pre-service teachers. The features that will work in my context will include those which will assist and enable students to acquire and understand the content knowledge of genetics and at the same time to acquire *skills* and *competencies* for teaching that content. While it may be easy to put together the description of what good teaching is, how does one achieve it? In this study, I decided to consider all the four aspects; **context**, **students**, **pedagogy** and **content** as part of investigating how I should teach genetics to pre-service teachers. In this study, the students were students training to be science teachers taking life sciences as their major or sub major. The context was described in chapter one section 1.2. The content was genetics. Finding out what literature says about the teaching and learning of genetics became

important in this study as a way of enriching my content and my pedagogical knowledge before teaching the course but what is content and what is pedagogical knowledge? What does it mean to have content knowledge in the context of teaching a content course like genetics to pre-service teachers?

2.3 Content knowledge

In section 2.2.1 above I looked at what literature says about good teaching and I have come to a conclusion that both content and pedagogy are central to good teaching. The centrality of content knowledge to teaching is agreed upon by other researchers who have also said that content knowledge is central to the work of a teacher and is one kind of knowledge that student teachers must have before their certification (Ball, Thames, & Phelps, 2008; Shulman, 1986, 1987). Forthwith, I review the literature on content knowledge so that I can understand what content knowledge is and what kind of content knowledge should be taught to pre-service teachers.

Shulman (1986) described content knowledge as defined by three distinguishable categories namely subject matter content knowledge, pedagogical content knowledge and curricular knowledge. Each of these three content knowledge categories is described below.

2.3.1 Subject matter content knowledge

Content knowledge refers to the amount and organization of subject matter in the mind of a teacher. Content knowledge also includes the facts and concepts that make up the subject matter. In science factual knowledge consists of theories, models and empirical data that is interpreted by models in accordance with the theory. Factual knowledge is what is presented in science textbooks (Hestenes, 1987). Content knowledge however, extends beyond an understanding of the facts and concepts to an understanding of the variety of ways in which the basic concepts and principles of the discipline are organized to incorporate the facts. In addition, it requires an understanding of the rules by which "truth or falsehood, validity or invalidity" are established (Shulman, 1986, p. 9). In science, this kind of understanding is described as procedural knowledge or the scientific method i.e. knowledge of the strategies, tactics and techniques for developing, validating and utilizing factual knowledge (Hestenes, 1987). Furthermore, content knowledge is not only understanding *that* something is so but also *why* it is so (Shulman, 1986).

2.3.2 Curricular knowledge

Curricular knowledge is the second category of content knowledge that was distinguished by Shulman in 1986. Shulman described curricular knowledge as the knowledge of the curriculum which is knowledge of the full range of programs designed for the teaching of particular subjects and topics at a given level. Shulman identified two other forms of curricular knowledge that he said were important for teaching. These forms of knowledge are the lateral curriculum knowledge and the vertical curriculum knowledge. Lateral knowledge refers to the knowledge of what the students are learning in their other subject areas and vertical curriculum is knowledge of the topics and issues that they have been taught in the same subject area in the preceding years or they would be taught in later years. Knowledge of the vertical curriculum is important for teachers or teacher educators as it helps them not to teach content that was covered before or content that will be covered in future. Knowledge of the lateral curriculum is also important as teachers may make use of the concepts that are taught in other subjects to promote an understanding of concepts in their own subject. For example in biology we can make use of Venn diagrams to explain relationships. One can use a Venn diagram to show the relationship between plants and animals (Loughran, Berry, & Mulhall, 2012).

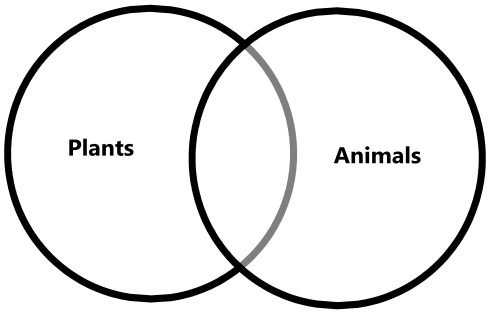

Figure 5: Diagram showing the relationship between plants and animals

The simple relationship that is depicted by the Venn diagram in Figure 5 is that plants and animals are different but there are features that they have in common such as that they both respire and reproduce. The Venn diagram technique would therefore be more effective to use after the students have covered the concepts of Venn diagrams in their Mathematics syllabus. Therefore knowing if students have already covered or would cover the concept of Venn diagrams in Mathematics will help the biology teacher in his or her planning and in choosing appropriate teaching and learning procedures.

2.3.3 Pedagogical Content Knowledge (PCK)

The third category of content knowledge that Shulman distinguished was PCK. Shulman described PCK as a particular form of knowledge that *embodies the aspects of content most germane to its teachability*. Shulman went further to describe PCK as knowledge that *goes beyond knowledge of subject matter per se to the dimension of subject matter knowledge for teaching---a special amalgam of content and pedagogy* needed for teaching the subject. Shulman further stated that PCK, in terms of the most regularly taught topics in one's area, includes;

> The most useful forms of representations of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations---in a word, the ways of representing and formulating the subject that makes it comprehensible to others. Pedagogical content knowledge also includes an understanding of what makes the learning of specific topics easy or difficult: the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons (Shulman, 1987, p. 8).

While Shulman initially listed subject matter knowledge, curricular knowledge and PCK as categories of content knowledge (1986), later on (1987), he separated them and listed them as distinct categories in the knowledge base for teaching with subject matter content knowledge simply listed as content knowledge. Of all the three categories of content knowledge described above, PCK generated the most interest in researchers. However, according to Ball et al. (2008), while researchers appeared to be in agreement that PCK was a form of content knowledge unique to teaching, very few studies were done to actually try and identify this knowledge and no theoretical framework was also developed that could be used to identify this unique body of knowledge. This motivated Ball et al. to carry out practice-based empirical studies with the aim of finding out what constituted this special kind of knowledge in the teaching of mathematics. The studies involved analysing the teaching of specific mathematics topics. From these studies, Ball et al. developed what they conceptualized as content knowledge *for* teaching, a theoretical orientation which posits that there is a special kind of content knowledge that is required in the teaching of a subject.

2.3.4 Content knowledge for teaching

The content knowledge for teaching that was hypothesized by Ball et al. (2008) has two domains of content knowledge namely common content knowledge (CCK) and specialized content knowledge (SCK) and two domains of pedagogical content knowledge namely knowledge of content and students (KCS) and knowledge of content and teaching (KCT). These four domains of content knowledge are described next.

Common content knowledge

Ball et al. (2008) defined CCK as "the mathematical knowledge and skill used in settings other than teaching". It is the material that teachers teach. It is also the kind of mathematical knowledge that will enable teachers to recognize wrong student answers or inaccurate definitions in a textbook. CCK also includes an understanding of the mathematics in the student curriculum. In terms of the science subject, I would regard the science knowledge that is described in a curriculum such as the school curriculum and the knowledge that is presented in textbooks as constituting CCK of science.

Specialized content knowledge

SCK was defined as 'the mathematical knowledge and skill unique to teaching' (Ball et al., 2008). It is a kind of subject matter knowledge which teachers use to make 'features of particular content visible to and learnable by students'. Ball et al. did not just make claims about the presence of SCK, they actually identified that knowledge by observing the actual teaching of mathematics and analyzing the mathematical demands of teaching. Examples of SCK in maths that was identified included error analysis (when teachers look for patterns in students errors), mathematical reasoning (such as when figuring out which story problem fits with which type of calculation) and mathematical language (when teachers have to use language that is specific to mathematics to help students to develop an understanding of the mathematics they are teaching. The study by Ball et al. (2008) implies that there should be SCK in every subject and that SCK can be identified. While Ball et al. (2008) identified the SCK for teaching mathematics during actual teaching, I am of the idea that research literature that is based on the actual teaching of a subject can also be a source of SCK. There is a vast amount of literature on genetics teaching and learning. Such literature can be a source of the SCK for genetics and a review of such literature can help a teacher educator to identify such knowledge

Pedagogical content knowledge as conceptualised by Ball et al.

Ball et al. (2008) subdivided Shulman's PCK domain into two domains of KCS (knowledge of content and students) and KCT (knowledge of content and teaching). However, when I compare these two domains with the concept of PCK that Shulman wrote about, I see these categories as encompassed in Shulman's conception of PCK. Shulman defined PCK as comprising the "most useful forms of representations---the most powerful analogies, illustrations, examples---". A teacher can only know about appropriate representations, analogies and examples if s/he has knowledge of content and for a teacher to appropriately use these aspects of teaching is part of the knowledge of teaching. Shulman's definition of PCK also makes reference to knowledge of conceptions and preconceptions that students bring to class. This is knowledge of students. Therefore, what Ball et al. (2008) did was combining the features of PCK as conceptualized by Shulman into distinct categories which are knowledge of content, knowledge of teaching and knowledge of students.

2.3.5 Content knowledge and the teaching of genetics

The concepts of content knowledge as described above can be applied to my study. What the concepts imply is that there is CCK of genetics that anyone who has studied genetics at university should have. There is also a body of knowledge that is unique to the teaching of genetics that teachers and teacher educators of genetics should have. This SCK can be identified from the actual practice of teaching but as I said earlier, I am of the idea that SCK for genetics can also be identified from research that was done on teaching and learning of genetics. The knowledge of content of genetics (CCK and SCK) together with the knowledge of students (which includes the conceptions that they bring to class) and knowledge of teaching genetics (pedagogical knowledge) is likely to contribute to the development of PCK or the development of good teaching practices in teaching genetics. I reviewed the literature on content knowledge (CK) in section 2.3 above. Below I review the literature on pedagogical knowledge (PK).

2.4 Pedagogical knowledge (PK)

Shulman in his paper (1986, p. 10) defined general pedagogical knowledge as "broad principles and strategies of classroom management and organization that appear to transcend subject matter". Shulman's definition focuses on the general aspects of teaching but I am of the idea that there is more to PK than the broad principles articulated in Shulman's definition. I have therefore decided to discuss the term pedagogy on it's on to

figure out what else can be included under pedagogical knowledge. In some literature, the term pedagogy is used as a synonym for teaching (Loughran, 2006). In that sense, PK would then cover the knowledge of all the aspects of teaching such as teaching procedures and teaching activities in addition to what is in Shulman's definition and what was described by the students in the studies by Entwistle (1990) and Marris (1964). A consideration of pedagogy as teaching suggests teaching to be an activity of one person, the teacher. The definition of pedagogy by Watkins and Mortimer (1999, p. 3) which says "any conscious activity by one person designed to enhance the learning of another" support the same idea of pedagogy as an activity that is done by the teacher. Loughran (2006) however brings a different perspective of what pedagogy means. He argues that teaching influences learning and learning influences teaching and therefore pedagogy is not only about the action of teaching but also "about the relationship between teaching and learning and how together they lead to growth in knowledge and understanding through meaningful practice. Loughran's perspective of pedagogy considers the learner which then implies that PK will now include the knowledge of the different aspects of teaching and the relationship between the teaching actions and students' learning. The different aspects of teaching include planning and preparation during which the teacher chooses the teaching procedures and decides on teaching activities and the teaching actions that would be used in the implementation of the planned activities. Knowledge of how the teaching actions impact learning becomes part of a teacher's PK and this knowledge of PK is learned from practice. This definition of PK which encompasses all the aspects of teaching and the relationship between teaching and learning will be used in this study.

I have reviewed the literature on CK and PK. Below I review the literature on the teaching and learning of genetics with these components in mind.

2.5 What literature says about the teaching and learning of genetics

Before embarking on this self-study, I was vaguely aware of the importance of research literature to my own teaching. My main sources for planning my teaching were syllabus documents and textbooks. Now I am aware that research literature can be a source of information such as misconceptions and effective teaching activities that may contribute to good teaching. In addition, according to Mclernon and Hugh (2005), for good teaching to occur, it must be based on firm research evidence. Furthermore, Chetty and Lubben (2010) assert that students benefit greatly when teaching is based on sound research findings. These insights from literature motivated me to do an extensive review of literature on

genetics teaching and learning so that I could base my teaching on what research says about the teaching and learning of genetics.

There is not much documented research on genetics teaching and learning before 1980. From 1980 onwards there was growing interest in researching the teaching and learning of genetics as evidenced by the occurrence of a number of studies in this area. About 12 of the approximately 20 studies that were done within the decade from 1980 to 1990, focused on problem solving involving Mendelian inheritance problems such as monohybrid and dihybrid inheritance problems (e.g. Stewart, 1982, 1988; Tolman, 1982). Note that monohybrid and dihybrid inheritance problems form part of the CCK of genetics. The studies referred to above involved identifying misconceptions[6] that students were displaying during problem solving a number of which were identified from these studies. Below, I discuss these misconceptions and difficulties. I also discuss the possible causes of these misconceptions and/or difficulties. Knowledge of misconceptions and difficulties associated with the teaching and learning of genetics is not found in textbooks. It is knowledge that is identified from the teaching and learning process. Therefore, I see this knowledge as forming part of the SCK for teaching genetics. The knowledge of the misconceptions and the difficulties associated with the teaching of genetics is likely to promote effective teaching as I will be able to consider these misconceptions and the difficulties of teaching and learning genetics in my planning and how to deal with them (PK).

Tolman (1982) found out in his study of 30 high school students that one major difficulty that the students were encountering was the inability to relate meiotic events like segregation and independent assortment to Mendelian genetics when solving Mendelian genetics problems. Students would erroneously assign two alleles to each gamete resulting in offspring with four alleles for each trait. The difficulty described above reflects a knowledge gap in students of the link between the events of meiosis and Mendelian genetics. It is

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[6]The literature on genetics refers to misunderstandings, misconceptions and difficulties shown by students. The literature shows that sometimes one researcher describes a problem as a misunderstanding and another researcher describes the same problem as a misconception reflecting that researchers interpret these terms differently. As a result, it is difficult to group the problems of learning genetics 'neatly' into the three categories. In this study, where reference is made to the researchers findings these terms will be used as they are used by the researchers. However, where I make reference to the terms myself, misunderstanding will be taken to mean *incorrect meanings or explanations of concepts or phenomena that students hold, which they may have acquired from textbooks or from teachers during instruction* (Cho, Kahle, & Nordland, 1985; Sanders, 1993)

[6]and a misconception will be taken to be *an idea or ideas that students strongly and persistently hold, that they would have constructed in response to their everyday experiences* (Abimbola, 1988; Sanders, 1993).

difficult for students to make such a link on their own. Teachers need to help students to see such links. Teachers can however only be able to do that if they themselves have what Geddis, Onslow, Beynon, and Oesch (1993) called horizon knowledge; an awareness of how topics in a curriculum are related and deliberately make the links explicit during the teaching of such topics. The knowledge of the errors that learners make and the possible sources of such errors is SCK.

A-level (high school) students in the study by Brown (1990) showed that they did not understand what sister chromatids are in their problem solving activities. Sister chromatids are a product of the replication of DNA and hence are identical and carry the same alleles (Campbell & Reece, 2008). Students in Brown's study lacked this content knowledge hence the errors that they showed of sister chromatids which carried different alleles. Knowledge about chromatids is not the kind of knowledge that students can encounter in their everyday experiences. It is CCK that has to come from the teacher during instruction or from textbooks or in modern days from the internet as students read about the topic. Therefore, although Brown referred to them as misconceptions, I see them as misunderstandings. Brown's findings were later supported by Kindfield (1994) who found out that students in her study could not understand the origin of chromosomes that are made up of two chromatids and a centromere. Again, as I highlighted above, the terms chromosome and centromere are not terms that students encounter in everyday language. Students encounter these terms and knowledge about them during instruction or from reading textbooks. Both the content that was taught and the pedagogical process are therefore possible causes of students' lack of knowledge about chromatids and chromosomes. Content about what chromatids are and their origin is CCK that may have been absent in what the students were taught or the content was not adequately explained during instruction to bring about the required understanding of the concepts.

In the light of what I have discussed above, I am of the view that the actual content that was taught and/or instruction played a role in the proliferation of the difficulties and misconceptions that were identified in the studies described above. My view is supported by the main recommendation that came out of these studies which was that teachers need to make explicit in their teaching of the relationships between concepts such as DNA, gene, chromatin and chromosomes. This recommendation covers both CK and PK. Teachers should also make explicit the steps that are involved in problem solving e.g. what each step is for in a genetic diagram. This suggestion from literature if it is considered by the teachers during teaching would enrich the teachers' knowledge of teaching genetics.

After 1990 researchers in the area of genetics teaching and learning shifted from problem solving studies to students' conceptions of genetic phenomena and the conceptual difficulties that they encounter when learning genetics. Since then considerable research has been done and evidence has accumulated which identifies difficulties and misunderstandings associated with the teaching and learning of genetics in high school and even in university programmes (e.g. Brown, 1990; Kindfield, 1994; Lewis, Leach, & Wood-Robinson, 2000a; Lewis & Wood-Robinson, 2000). These studies have shown that students in both high school and at tertiary institutions have difficulties understanding genetics and as a result exhibit many misunderstandings and misconceptions after instruction. These difficulties are described next.

There is a huge amount of terminology that students of genetics need to know and understand in order to understand genetics. This terminology includes terms like chromatids, chromatin, allele, homologous, homozygous, heterozygous, dominant and recessive. Terminology was identified by Bahar, Johnstone & Hansell (1999) as a source of difficulty for students learning genetics. Bahar et al. (1999) observed that first year university students get confused with these many terms. The other causes of student difficulties that Bahar et al. (1999) identified were the mathematical content of Mendelian genetics and the fact that genetics concepts belong to different levels of biological organization (the macro, the micro and the symbolic) which students need to transcend when learning genetics. Bahar et al. describe the macro level as made up of morphological characteristics that are accessible to the senses such as height, skin colour and hair colour. The micro level is occupied by microscopic material that can be accessible to our senses after some form of treatment such as staining or extraction. Chromosomes and DNA occupy this level. The symbolic level describes the level at which symbols are used to represent genetic entities such as the nucleotide bases and triplet codes.

Textbooks do not make explicit the concepts that belong to each of the different levels of biological organization. According to Bahar et al. (1999) the problem above is compounded by the observation that these levels are taught at different times and are not always integrated enough to make clear the processes underlying the genetic phenomena and the overall picture of the inheritance process. Such knowledge and an ability to link those levels during teaching is SCK that can enhance the teaching of genetics. This observation by Bahar et al. (1999) again points to teaching as a possible source of the difficulties that are faced by students when learning genetics. Marbach & Stavy, (2000) confirmed the findings of Bahar et al. (1999) in ninth graders, 12th graders, college and university students that one source of difficulty in genetics teaching and learning is the fact that the content in genetics is

found at different levels of biological organization. The levels of biological organization in Marbach and Stavy were however described as the macro and the micro with the micro sub-divided into cellular phenomena and biochemical structures. As a teacher of genetics, I need to consider these different levels of biological organization in my teaching in order to promote learning.

Another source of difficulty for students is the ideas that they bring to the classroom that are not in line with the scientifically correct knowledge. The knowledge of these ideas will contribute to a teacher's understanding of what Shulman (1986) referred to as the conceptions and preconceptions that students bring to class which is an aspect of a teacher's PCK. Lewis et al. (2000b) in their study of 482 high school students found out that many students had the misconception that cells of different types contain different genetic information because they have different functions and that each type of cell contains just that genetic information which it needs in order to perform its function. Although the researchers referred to their finding as a misconception, there is no evidence to support that. These students lacked conceptual information about gene expression and according to Donovan & Bransford (2005) such conceptual information cannot be induced from everyday experiences. Donovan & Bransford suggested that students need to get the correct explanation from those who have knowledge about the concept. They however did not make clear how the correct explanation is given. It can be through direct instruction or any other method of teaching. I am of the opinion that the findings from Lewis et al. (2000b) might just be students' intuitive ideas due to a lack of exposure of students to the appropriate content regarding gene expression and regulation. This lack of exposure to scientifically correct explanations could have made students to come up with their own views about the concept especially when one considers that the actual content that was taught and how it was taught is not known. This so called misconception however, reflected that students had a poor understanding of the purpose, processes and products of cell division. For teachers of genetics therefore, it is important to know the ideas that students are bringing to class and consider them in their planning. This is part of a teacher's knowledge of students which is important in effective/good teaching of science (Cimer, 2007).

Students were also found to struggle to understand the structure of and relationship between chromosomes and genes. One of the concerns of (Lewis & Wood-Robinson) "was the limited understanding of the nature of genetic information and the level of confusion about basic biological structures (such as cells, chromosomes and gene) and their relationship to each other" that was displayed by the students (2000, p. 190). Marbach-Ad in his study (2001) confirmed this lack of understanding of the relationship between the concepts DNA,

chromosome and gene from his sample of high school students and pre-service teachers. Many other researchers also found similar results (e.g. Quinn, Pegg, & Panizzon, 2009). Lewis and Kattmann (2004) like Venville and Treagust (1998) found out that a big sample of British high school students (482) and a few high school students from Germany (10) showed a lack of understanding of how phenotypes result from the information in our genes, that is, they are not aware of how a gene is expressed. They (Lewis & Kattman, 2004) also confirmed the findings by Lewis et al (2000b) and Marbach-Ad (2001) that students show a lack of understanding of the relationship between genes, chromosomes and DNA. The findings by Boujemaa et al. from Moroccan university students supported the above findings regarding the genetics concepts as reflected in the quotation below;

> Students know and often hear words such as DNA, chromosomes, mRNA, genetic information, genes,…, but they were unable to link with related gene concepts (chromosomes as organizers of genetic information; the physical entity of the gene; interrelationship between replication of the chromosome and genetic information; distinction between genes and genetic information, regulation of genes, interactions between gene and environment; …(2010, p. 13)

The content knowledge that students failed to understand in the studies above is CCK that is found in textbooks. It will then be important to find out why students find it difficult to understand this CCK. The study by Banet & Ayuso (2000) showed that poor knowledge of biology concepts necessary for the understanding of genetics concepts in the studies described above (for example cell structure) may contribute to students' difficulties in understanding the genetics concepts. This knowledge of the biology concepts important for an understanding of genetics concepts then becomes SCK for the teaching of genetics.

Pashley's study (1994) identified other sources of student difficulties which included a failure by students to make the connection between the concepts of DNA, gene, genetic code and phenotype of an organism and a lack of connection of protein synthesis to genes. Duncan & Reiser (2007) found out that students in their study had the idea that genes were responsible for directly coding for both the structure and function of cell organelles, cells, tissues and organs. The students were not aware that genes are first transcribed into RNA and then translated into a polypeptide that forms a protein. Proteins in turn then interact with each other to bring about the structure and functioning of the organism; the observable phenotype (Campbell & Reece, 2008). Boujemaa et al. (2010) confirmed these erroneous ideas in their study of 94 Moroccan university students.

Infante-Malachias, Padilha, Weller, and Santos (2010) alluded to tertiary students' prior knowledge as a possible hindrance to acquisition of more complex genetic concepts if that prior knowledge is scientifically distorted. They therefore suggested that effort must be made by teachers at tertiary level to take into consideration the knowledge that students bring to class about the elementary aspects of genetics as they get into introducing complex ones (knowledge of students). The authors did not however suggest how teachers can identify such knowledge that students bring to the tertiary institution. One way of identifying students' prior knowledge is by administering a pre-test.

It is evident from the literature review above that SCK of genetics can be identified from research literature on teaching and learning of genetics. Knowledge on how to teach genetics that is supported by research can also be obtained from the same literature as evidenced by suggestions of several teaching strategies by some of the researchers (e.g. Baker & Lawson, 2001; Johnson & Stewart, 2002; Pashley, 1994) and the designing of intervention strategies by others (e.g. Aznar & Orcajo, 2005; Knippels, 2002). The strategies that have been suggested by various researchers and some of the intervention strategies that were implemented are described next.

Traditionally, the teaching of genetics involves teacher explanations, the use of textbooks and problem solving where problems are solved by application of an already known algorithm (Banet & Ayuso, 2000). According to research, these methods have not been effective in promoting a scientifically acceptable understanding of genetics concepts. Researchers have therefore been suggesting a variety of strategies from their studies.

Tolman (1982) thought that the sequencing of genetics topics could be a source of difficulties for learners and suggested that the teaching of genetics should start with meiosis then move on to Mendelian genetics. The knowledge of what the student should know first in order to understand a topic or concept is what Mavhunga and Rollnick (2013) described as curricular saliency. In addition, to the above suggestion, Tolman also suggested that the teaching of meiosis should include an indication of genes or alleles on chromosomes. He also suggested that segregation and independent assortment should be treated concurrently with meiosis. These suggestions emanated from his research findings which showed that students had problems in associating the events of meiosis (segregation and independent assortment) to their illustrations in Punnett squares. Students would assign two alleles to each gamete resulting in offspring with four alleles for each trait. Tolman hypothesized that starting with meiosis when teaching genetics will help students to overcome the above difficulties and to trace alleles back to parents when looking at Mendelian genetics.

Marbach-Ad & Stavy (2000) suggested that teaching should start at a macro level whereby students are exposed to aspects of genetics in human beings or higher animals before moving on to the micro-level. Knippels (2002) identified the different levels of biological organization of the genetics content as a major hindrance to understanding genetics and devised an intervention instruction strategy (the yo-yo strategy) in which attention focusses on teaching starting from the organism level as the anchor point. The yo-yo teaching and learning (TL) strategy works on the concept of a yo-yo toy. In a yo-yo toy, the rope can roll down or up along a pathway from an anchor but can never skip part of the pathway. In the yo-yo TL strategy, the different levels of organization of the genetic content form the pathway. The organism level is the anchor point from which the teaching and learning can yo-yo downwards to the cellular and the molecular level or yo-yo upwards to the community and population level. In addition to making sure that the teaching process does not jump any sections of the pathway, the yo-yo TL strategy confines the teaching to the genetics concepts that are only found at that particular level and emphasizes that the genetics vocabulary be tuned to the level under discussion. The TL strategy also stresses the teaching of the links between sexual reproduction, meiosis and inheritance. The strength of the yo-yo TL strategy is that it was designed in response to the observed teaching and learning difficulties and when tested, was found to diminish those TL difficulties. While the yo-yo TL strategy is about the teaching approach, content is at the centre of the strategy. The researcher was aware of the content to be taught (CCK) and the vocabulary at each level and the relationships that needed to be explained (SCK).

Aznar & Orcajo (2005) investigated the effect of using a problem-solving approach strategy in students' learning process. The research design involved two teachers, one who used open problems in his teaching and another one who used the traditional method involving use of text books, notes, exposition of concepts and closed problems. The analysis of written responses at the end of the course showed that the group that had used the intervention strategy (an open problem solving approach) had a better understanding of the concepts. The open problem approach had made it possible for the students to restructure their knowledge generating a conceptual change.

Banet & Ayuso (2000) suggested a constructivist approach in which the teaching strategies to be implemented should allow students to construct their own knowledge about genetics phenomena by taking into account students' previous knowledge. Banet & Ayuso also concluded that genetics is difficult to understand and requires some level of abstract thinking. These researchers are therefore of the opinion that general aspects of genetics should be taught first and that during the teaching process, the aspects of genetics under

consideration should be linked to concrete examples then move on to more specific concepts. It is important to note here that there is an allusion to content. What is to be taught is of importance in promoting effective learning. In their study, content was carefully selected and structured (Banet & Ayuso, 2000). So, it was not just an issue of methods but of content selection too. They also suggested the use of many examples related to human genetics and to carry out specific activities. Lewis & Kattman (2004, p. 202) like Banet and Ayuso (2000) also suggested that the teaching of genetics should start by considering "students' everyday conceptions from which scientific understanding can be developed". A Boujemaa et al. (2010), suggested the use of what they called a historical approach in which in addition to citing the chronological record of discoveries regarding genetics concepts like DNA and genes, they should also teach about the 'epistemological and methodological obstacles' of the science of the time of the discoveries.

The research literature on genetics teaching and learning that I have reviewed above identifies the misconceptions and misunderstandings that students exhibit after instruction and the difficulties associated with the teaching and learning of genetics (SCK). The literature is also replete with suggestions on how to teach genetics in a way that will overcome the identified difficulties and misunderstandings which will promote an understanding of the genetics concepts. While the research has contributed a lot to my understanding of the difficulties associated with the teaching and learning of genetics and how those difficulties can be overcome during teaching, the research shows a bias towards the teaching process as the main cause of the problematic issues associated with the teaching and learning of genetics. However, as suggested by Flodin (2009, p. 74), the problems associated with the learning of genetics maybe "a problem of content instead of a problem of learning" whereby students are actually learning what is being taught. In her yo-yo developmental project, Knippels (2002) showed that both content and pedagogy were central to the success of the intervention. This shows that both content and pedagogy are also central to the successful teaching and learning of genetics thereby supporting an earlier discussion that both content and pedagogy matter in good teaching. In this study therefore, I made both content and pedagogy central aspects in the design, planning and teaching of the course. In terms of pedagogy, my consideration was dual; teaching the subject for understanding of content and for teaching that content.

2.6 Teaching content for understanding and for teaching in pre-service teacher preparation

2.6.1 Metacognition

One of the ways of helping students of teaching to think about the teaching of the content that they are taught is to encourage them to be metacognitive (Hoban, 1997). According to Hoban (1997, p. 135), metacognition will enable students to become aware of "how they learn in teacher education courses". An awareness of how they are learning is important for students of teaching so that they can "overtly develop their understanding of the teaching practices they experience" which will enable them to link the manner in which they learn to the nature of teaching (Loughran, 2006, p. 4).

Metacognition can be defined as 'thinking about thinking' or 'thinking about one's own thoughts' (Hacker, 1998). It is "individuals' knowledge, control and awareness of their cognitive processes and those of others" (Thomas & Anderson, 2013, p. 1246). Metacognition describes a process when someone becomes aware of what they know about something and are able to think about that knowledge, to manipulate that knowledge in their thinking in a way that brings a better understanding of that knowledge. This is the metacognitive process that Hoban (1997) and Loughran (2006) envisage would promote learning about teaching in students of teaching. Metacognitive knowledge however, also encompasses a person's stored world knowledge about people, and about tasks and strategies (Flavell, 1979). According to Livingston (1977), knowledge about people includes knowledge about how human beings learn and process information, as well as individual knowledge of one's own learning processes. Knowledge of tasks includes knowledge about the nature of the task, the type of processing demands that the task will place upon the individual and ways by which those demands can be met under varying conditions (Hacker, 1998). Knowledge about strategies includes knowledge of strategies that can be employed to accomplish a task be it cognitive or metacognitive, and knowledge about when and where such strategy may be used (Livingston, 1977). While as teacher educators we are expected to encourage our students to be metacognitive as a way of promoting learning to teach, as teacher educators, we also need metacognitive knowledge because activities such as planning how to teach a concept or a topic will require knowledge about our students and knowledge of appropriate pedagogic strategies and tasks.

2.6.2 Modelling good teaching as a way of teaching for teaching and for understanding content

Another way of teaching about teaching in a content course can be derived from what Russell (1997) said, that is: *How I teach is the message.* This quote from Russell suggests modeling as another way of teaching pre-service teachers. The assumption here is that teacher educators would know what good teaching in pre-service teacher preparation entails and can practice it. Modelling as a method for teaching in pre-service preparation is suggested several times in the research literature (see LaBoskey, 2004; Loughran, 2006). In science, a model can be defined as a 'surrogate' representation of a 'real thing' (Hestenes, 1987, p. 4). The 'real thing' maybe an object, an idea, a concept, a process, a behaviour, a skill or a system and the model maybe abstract, concrete or theoretical (Harrison & Treagust, 2000; Rotbain, Marbach-Ad, & Stavy, 2006). Models in science act as a bridge between scientific theory and the world as experienced. In science education models act as teaching tools that function as a bridge between students and reality enabling students to examine abstract scientific phenomena in a way that meets students' cognitive ability (Clark & Mathis, 2000). The aim of using models is to enhance investigation, understanding and communication (Harrison & Treagust, 2000). When modelling something in science education, it means demonstrating that object, that idea, that behaviour or concept to the students. The students will learn by observing that demonstration. Modelling in teacher education however, means more than the modeling that is done in science teaching. In addition to demonstrating good teaching from which students are expected to learn, modelling in teacher education also means offering students of teaching access to the thoughts and knowledge underlying the purpose of using a particular teaching approach (Loughran, 2006). Modelling in teacher education can therefore be described as covering three things; content to be taught, how it is taught and the thinking and pedagogical reasoning behind the teaching that is employed to convey that content.

2.6.3 Constructivism

When I began this study, the theory of constructivism was not in my original plan. However, when I was analyzing my data which I presented as trigger incidents in chapter 5, one of my critical friends pointed out that my teaching as described in one of the trigger incidents was reflecting the tenets of constructivism. I then decided to include this short section on constructivism as an introduction that would set the scene for the discussion in chapter 5. I am explaining here how I came to include this section in my literature review to bring out the

reality of research; that it is complex and problematic and one has to keep moving forwards and backwards until the research is complete. Bringing out the complexity and problematic nature of research is important so that those who are going to follow after me can see that it is not a neat and straightforward endeavour.

Diverse forms of constructivism are found in the literature today (Brickard, 1997). However, according to Leach and Scott (2003), two main strands of the learning theory of constructivism are drawn upon in science education. The first of these strands is cognitive constructivism which has its origins in Piaget and the second one is socio-cultural constructivism which has its origins in Vygotsky (Leach & Scott, 2003). In this section, I discuss the two strands as they both speak to my study. Cognitive constructivism is a theory of learning which postulates that individuals learn by constructing new knowledge from prior experiences (Novak, 1977). Meaningful learning occurs when the learner's appropriate existing knowledge interacts with the new knowledge (Mintzes, Wandersee, & Novak, 1998; Novak, 1977). Cognitive constructivism emphasises the importance of an individual's mind in which learning is said to occur. Learning is prompted by action which leads to re-organisation of internal structures (J. P. Smith, DiSessa, & Roschelle, 1993).

In the sociocultural perspective, learning is defined as internalisation of social interaction (Vygotsky, 1978). Unlike in the cognitive perspective, in the socio-cultural perspective, there is more emphasis on the social plane (rather than the cognitive plane) where ideas are discussed between people. Learning is triggered by social exchanges such as gestures, words, talk, writing, visual images as well as action and it (learning) occurs when these ideas are internalised (Mortimer & Scott, 2003). The socio-cultural perspective emphasises the undertaking of collective activities by adults and children or by children amongst themselves. The role of the adult is to direct and guide the children in activities, making corrections when needed and providing greater challenges when appropriate (Wertsch & Kanner, 1992). The child's peers contribute to acquisition of knowledge by exposing the child to other points of view and conflicting ideas that may encourage him to rethink or review his ideas. In a teaching situation, the teacher takes the place of the adult who faciltates the learning process and the children are the learners or students. The teacher's role includes assisting and guiding the learner, directing the activities of the learners by setting appropriate tasks, allowing learners to perform the tasks, giving support, assessing and giving feedback (Eunice Nyamupangedengu, 2010).

Vygotsky's socio-cultural theory also emphasises the idea that learning is a joint activity of a group rather than the activity of one person and also that learners do not come with nothing to the social plane. They bring their own personal contribution which maybe prior knowledge, interest and motivation (Davydov, 1995). This concept of personal contribution requires that teachers engage learners in a way that develops further this personal contribution (Nyamupangedengu, 2010). Note that in both strands, the role of the teacher is the same; facilitating the learning process. In addition, prior knowledge of the learner is important. The main difference between the two strands is the process of learning. In the cognitive strand, the process of learning occurs in the individual's mind. In the socio-cultural strand, the process occurs on the social plane outside the individual the product of which is then internalised. I am of the idea that an individual learner's learning style dictates how that learner learns. For example, for a learner who prefers to learn through introspection then the cognitive perspective explains how that that learner will learn. For a learner who learns better through discussions, the socio-cultural theory then explains how that learner will learn. Therefore, both learning perspectives explain what happens in a classroom situation.

2.7 Teacher educator professional identity

When I looked back at how I have been teaching from the time I became a teacher educator in 2007 until 2011 when I began this study, I can see that I was focusing on teaching content only without considering pedagogy as required in teaching in teacher education contexts. When I reflect on why I was teaching in that manner, I realize that I had not developed the second level of thought about teaching that needs to be developed when one becomes a teacher educator. That second level of thought is what Russell (1997) called the pedagogical turn; when teacher educators are able to consider and to pay careful attention to the way they are teaching when presenting the subject matter. I was being what Loughran has described as "a teacher teaching in teacher preparation" (2006, p. 13). In other words, I had not changed my identity from a high school teacher to a teacher educator although I was now called a teacher educator. Research shows that this transition from teacher to teacher educator is problematic because there is a perception that teacher educators, many of whom are appointed to teacher education straight from being classroom teachers (Berry & Scheele, 2007; Dinkelman et al., 2006; Young & Erickson, 2011) come adequately prepared to be teacher educators (Chetty & Lubben, 2010). As such, there are no induction or training structures in HEIs that help new teacher educators to develop the knowledge, skills and expertise required in teacher education (Chetty & Lubben, 2010; Murray, 2005b). However, Murray's study (2005a) showed that pedagogical knowledge and experience that have been

acquired through school teaching cannot be transferred directly to HEI contexts. Therefore, while anyone who assumes responsibilities that put him/her in a position to participate in the preparation of future teachers can potentially be labelled a teacher educator, there is need for an identity transition from the first order practitioner (the teacher) to that of a second-order practitioner (the teacher educator) (Murray & Male, 2005). This transition from first-order to second-order practitioner requires the development of a new body of knowledge, skills and expertise that are suitable for teaching teachers (Berry & van Driel, 2013; Murray, 2005b). The need for the development of new skills and expertise means that the transition requires that professional development opportunities be available to teacher educators which are rare in many HEIs. The transition also requires that individuals actually identify themselves as being teacher educators (Erickson, Young, & Pinnegar, 2011). Therefore, what happens in a teacher educator's practice is likely to be influenced by the nature of the identity transition the teacher educator makes from a first-order to a second-order practitioner. If that transition does not occur, then the teacher educator is likely to carry over to teacher education, the competences and skills that are suitable for school teaching. Sachs (2005), asserts that teachers' identities provide a framework that guides their understanding of their work and how they should act as teachers. Considering the interrelatedness of the professions of a teacher and a teacher educator, I argue that the view of Sachs (2005) can also be applied to the formation of a teacher educator's professional identity. As shown in my reflections in the introductory chapter, as far as my teaching was concerned, I did not make the required transition from the first order to the second order practitioner and my high school identity was the framework that was guiding my teaching until I became dissatisfied with my teaching and decided to do this self-study for my PhD. In a way therefore, this self-study was acting as the vehicle for my identity transition from being a teacher to being a teacher educator. At the end of this study, I therefore identify and articulate the aspects of the study that facilitated the transition of my identity from that of a teacher to that of a teacher educator.

2.8 Learning experiences

In this self-study, I investigated my teaching in pre-service teacher preparation. I looked at what to teach (content) and my teaching and pre-service teachers' experiences of my teaching (pedagogy). To find out how pre-service teachers experienced my teaching during the course, I decided to find out their learning experiences through interviews. I therefore envisaged that students' experiences of my teaching could partly be explained using the components that Alsop and Watts (1997) have described as lenses in their extended model

of conceptual change namely the cognitive, the affective, the conative and self-esteem. Although this study is not about conceptual change, I see the four components above as frames that not only can be used to describe how students engaged with the teaching phenomena that they were encountering during my teaching of the genetics course but also how they felt about that phenomena. I therefore describe these four components in detail below using related literature to explain them.

The cognitive frame describes what happens when information in the environment is transformed into knowledge. Cognition involves mental processing of stimuli that result in the formulation of concepts about those stimuli. The mental processes maybe triggered by internal or external factors. Affective refers to the expression of emotions or feelings. According to Alsop and Watts (1997), the affective domain is made up of three ingredients namely germane, salient and palatable. Lelliott (2007), identified four ingredients but he referred to them as categories. These categories are enjoyable, germane, and salient and wonder. Lelliott's categories are more elaborate and will be described here as representing the affective domain. Lelliott (2007, p. 171) described the category **enjoyable** as "the extent to which the learning experience is enjoyable". The category covers anything a student enjoys, likes or dislikes. Alsop and Watts referred to the category enjoyable as palatable. **Germane** was described as "the extent to which something is personally relevant". Research shows that personal relevance and meaning to students' lives are important contributors to enjoyment of learning a topic (Ainley & Ainley, 2011). The third category from Lelliott's study which was similar to that of Alsop and Watts was **salient.** Salient describes "the extent to which the learning experience is prominent" or important in the learners' environment. The fourth category that Lelliott identified which is absent in Alsop and Watts is that of **wonder.** This category describes the dimension of affective when students show "amazement or awe at something" they have learnt about. The components of the affective domain be they positive or negative influence cognitive functioning (Alsop & Watts, 1997).

Ainley and Ainley (2011) have found out that there is a close association between cognition and affect. They assert that when students experience joy and interest while working on a science topic, they engage with the content topic and are likely to express a desire to continue their engagement with the topic. This finding links with the perspective from Dewey (1933) that conditions for learning are maximized when the learning activity is both playful and serious. From the perspective of Dewey and from the findings of Ainley and Ainley (2011), we can argue that a learning activity that has personal relevance and meaning to students' lives can generate enjoyment. Enjoyment in turn can promote students' engagement with the content being taught which in turn brings about learning. It is however

important to note that students bring experiences, thoughts and feelings associated with earlier learning experiences to the new learning situation (Pekrun, 2002). Such experiences if activated can influence the outcomes of the learning activity. In the context of pre-service preparation therefore, students have experiences and beliefs about teaching and learning that they have accumulated in their 13 years of schooling and in this study in their two or three years of university learning. These experiences and beliefs are likely to influence their learning in the teacher education classroom.

The third component in the model by Alsop and Watts (1997) is conation. Conation "concerns the degree to which knowledge and understanding can be practically useful and made applicable" (Alsop & Watts, 1997, p. 640). According to Alsop and Watts, conation is concerned with questions by the learner and in my case by the student such as: "How can I use that knowledge? Does it empower me to act? Does it help me to solve a practical problem? Am I sufficiently confident of that understanding to put it to immediate use?" With the questions above in mind, Alsop and Watts delineated conation into three elements; **trust** which is the level by which learners are able to trust their understandings, **control** which is the quality of control learners have over the use of knowledge and **action** which is the degree of applicability of the knowledge. Self-esteem relates to how individuals see or feel about themselves. The ingredients for self-esteem include image, confidence and autonomy where image mean the perceptions learners have of themselves, confidence mean the sense of self-belief that allows individuals to persist in the face of incomprehension and autonomy relates to the individual's capacity and motivation to pursue issues and to find answers to questions. While these components were defined in the context of learning science, they also apply to other learning situations. I have described all the components and their subcomponents although not all of them may be useful in explaining students' experiences.

2.9 Pedagogical content knowledge (PCK)

The focus of my study is my teaching and as could be seen in an earlier discussion above, some of the factors that contribute to good teaching namely knowledge of context, knowledge of students, PK and CK, are factors that also contribute to the development of a teacher's PCK as described in a number of models of PCK. I therefore see the literature on PCK as having a big influence on my study and I review it in some detail.

As explained earlier, PCK was conceptualized by Shulman (1986, 1987). The definition of PCK by Shulman was given in section 2.3.3. After defining what PCK is, Shulman (1987)

went on to present seven categories of knowledge that he considered to be the knowledge base for teaching that teachers can draw from. He included PCK as one of the categories. These categories of knowledge are content knowledge, general pedagogical knowledge, curriculum knowledge, pedagogical content knowledge and knowledge of learners and their characteristics, knowledge of educational contexts and knowledge of educational ends, purposes and values (Shulman, 1987). Since then, a number of models of PCK have been developed by education researchers to explain what PCK is (Bishop & Denley, 2007; Cochran, DeRuiter, & King, 1993; Gess-Newsome, 1999; Morine-Dershimer & Kent, 1999); Mugnusson, Krajcik & Borko, 1999). In some of these models, researchers adopted categories from Shulman's knowledge base for teaching making them elements of PCK e.g. Bishop & Denley's model (2007). In others, they reinterpreted Shulman's categories and modified them before incorporating them into their models e.g. Morine-Dershimer & Kent's model (1999). Table 2 below shows how different scholars conceptualized PCK. The summary of PCK models in Table 2 is not exhaustive. The models were chosen to highlight the diverse range of perspectives on the notion of PCK.

Table 2: Knowledge components of PCK as conceptualized by various scholars

	Knowledge components								
Scholars	**Subject matter**	**Representations and instructional strategies**	**Students' subject specific learning difficulties**	**General pedagogy/ classroom**	**Curricular knowledge**	**Context for learning**	**Purposes/ orientations/ nature of science**	**Assessment**	**School knowledge**
Shulman (1987)	K	P	P	K	K	K	K	0	0
Cochran *et al*. (1993) (PCkg)	P	0	P	P	0	P	0	0	0
Gess - Newsome (1999)	P	0	0	P	0	P	0	0	0
Morine - Dershimer & Kent (1999)	P	P	P	P	P	P	P	P	P
Mugnusson *et al* (1999)	K	P	P	0	P	0	P	0	0
Bishop & Denley (2007)	P	0	P	P	P	P	P	0	0
Rollnick *et al* (2008)	P	P	P	P	0	P	0	P	0

Notes: 'P' shows components believed to comprise PCK; 'K' denotes a component in a teacher's knowledge base; '0' shows components not discussed explicitly

I will describe the model by Rollnick et al. (2008) in more detail as the components that make up the base for the development of a teacher's PCK in this model can be used to inform the planning of good teaching.

2.9.1 The PCK model by Rollnick et al. (2008)

The model by Rollnick et al. (see Figure 6) is divided into two sections; the upper and the lower sections. The lower section consists of domains of knowledge. The four domains of knowledge are: knowledge of subject matter, knowledge of students, general pedagogical knowledge and knowledge of context. These four knowledge domains are viewed by the researchers as the prerequisites for the development of PCK. As discussed earlier, the components can also be considered as pre-requisites for good teaching. The upper section consists of the manifestations of teacher knowledge. The knowledge domains amalgamate to produce PCK which then manifests in different forms in the classroom during teaching. The forms of manifestations include representations, curricular saliency, assessment, topic specific instructional strategies and explanations. The forms of manifestations that occur differ from one teaching situation to another as what manifests depends on what happens in a particular class (Rollnick et al., 2008). The manifestations will also differ depending on the level you are teaching i.e. primary, high school or tertiary. What is of interest in this model is that it provides a lens in the form of manifestations of teacher knowledge that one can use to analyse a teaching situation in the classroom.

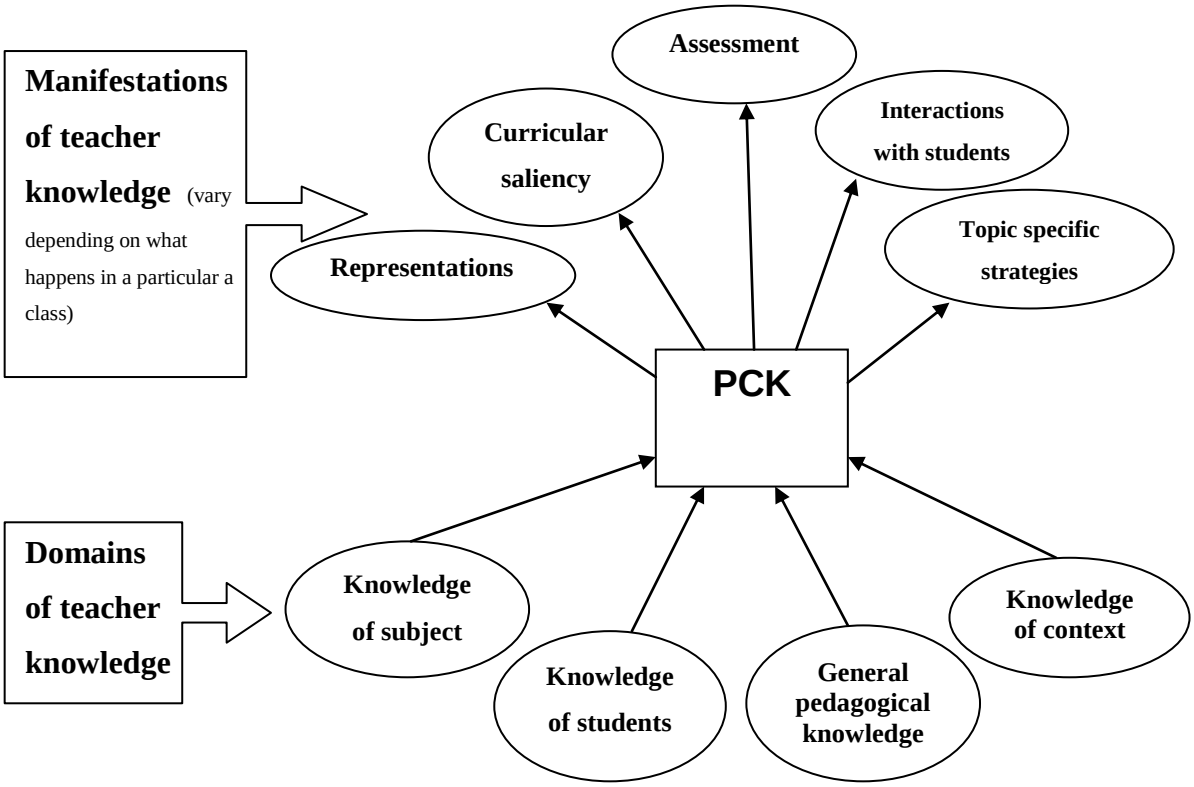


Figure 6: Tailored model for PCK (Rollnick et al, 2008)

The domains and the manifestations of teacher knowledge as shown in Figure 6 are described below.

The domains of teacher knowledge

Knowledge of subject matter: Shulman (1986) described knowledge of subject matter as "the amount and organization of knowledge *per se* in the mind of the teacher" (p. 13). Rollnick et al. defined it simply as "the teacher's raw untransformed subject matter knowledge" (p. 1384). This subject matter can also be regarded as the knowledge that Ball et al. (2008) described as CCK.

General pedagogical knowledge: Includes the teaching approaches and the strategies of classroom management and organization (Shulman, 1987). As I have argued in section 2.3.3 above, there is more to PK than what was described by Shulman. In this study therefore, general pedagogical knowledge which I have decided to call PK includes the knowledge of the different aspects of teaching such as teaching procedures and teaching activities and the relationship between the teaching actions and students' learning and would be described as PK.

Knowledge of students: Includes knowledge of students' prior knowledge, their learning styles, linguistic abilities and interests and aspirations (Rollnick et al., 2008).

Knowledge of context: Context includes all factors that influence the teaching situation. Rollnick et al. lists resource availability, class size, students' background and curriculum as some of the contextual factors that contribute to a teacher's PCK. Whilst knowledge of the curriculum appears as a knowledge domain in Shulman's paper, here curriculum knowledge is part of the knowledge of context. In the context of teacher education, the subject or content being taught is also an important contextual factor that needs to be considered.

According to Rollnick et al., these four categories of knowledge described above as domains of teacher knowledge interact to produce PCK the products of which manifest in the classroom in a variety of form such as representations, curricular saliency, assessment, interactions with students and topic specific instructional strategies.

In 2011, Davidowitz and Rollnick, modified the model by Rollnick et al. and added teacher beliefs as "an underpinning factor which influences the teacher's knowledge domains and *vice versa* which in turn integrate to produce PCK" (2011, p. 364). This modification was influenced by their observations of an expert lecturer whose beliefs about the teaching of organic chemistry which manifested in his philosophy of the organic chemistry subject matter and how to approach it in learning had shown to influence his teaching. The model is shown in Figure 7 below.

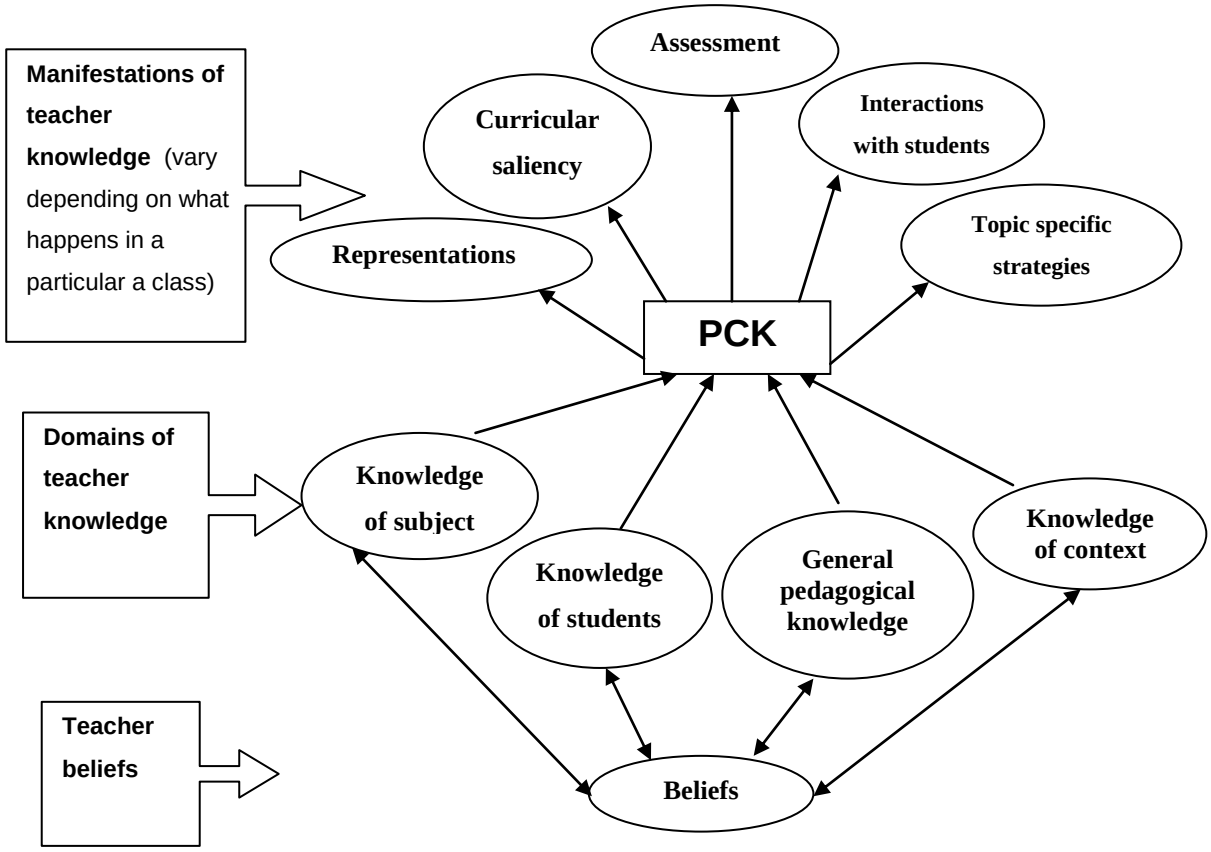


Figure 7: Modified model for PCK (Davidowitz & Rollnick, 2011)

Some examples of manifestations of PCK in the classroom

Representations: Representations can be analogies, illustrations, explanations or demonstrations, examples, metaphors or simulations (Geddis & Wood, 1997; Shulman, 1986). These representations are used by teachers in their classrooms to promote an understanding of subject matter. A teacher needs to have a blend of subject matter knowledge (SMK) and other domains of knowledge in order to be in a position to produce appropriate and effective representations for learners (Rollnick et al., 2008).

Curricular Saliency: Refers to a teacher's understanding of the emphasis they need to place on the teaching of a particular topic (Rollnick et al., 2008). Geddis et al. (1993) referred to curricular saliency as the importance of a topic to the overall curriculum of the subject area to which the topic belongs. Experience plays an important role in this case as it is from experience that teachers get to know how certain ideas relate to other ideas within a subject area. The importance of the topic provides perspectives to the teacher on what to cover and to what depth and breadth (Geddis & Wood, 1997). In the study by Rollnick et al. (2008), a teacher justified the teaching of the topic chemical equilibrium which was not in the syllabus

because it provides the basics required in the learning of the topic acids and bases which was in the syllabus. In teaching that topic, he didn't teach everything. He focused on the concepts that were relevant to the curriculum. Research literature can also be a source of the knowledge required for curricular saliency.

Assessment: Includes choices that a teacher makes for both formative and summative assessment (Rollnick et al., 2008). There are many different methods of assessment. Some methods are appropriate for certain topics and not for others. Examples of assessment methods include written tests and practical tasks. Written test are appropriate when assessing conceptual understanding whilst practical tests are appropriate for assessing students' understanding of scientific investigation (Mugnusson et al., 1999). Oral presentations can also be used to assess students' understanding of concepts.

Interactions with students: This can occur during whole class discussions or one to one when the teacher interacts with individual students or individual groups by listening to their discussions and giving feedback.

Topic specific instructional strategies: Topic specific strategies are teaching methods and techniques that a teacher uses that help students to understand specific concepts in a topic. The strategies maybe case studies, whole class teaching and problem solving activities (Mugnusson et al., 1999).

2.9.2 The notion of pedagogical reasoning and action

Pedagogical reasoning is a term that Shulman (1987) used to describe the process whereby teachers use their professional knowledge to make decisions about what to teach and how to teach it (Bishop & Denley, 2007). Pedagogical reasoning and action applies to this study of my teaching because in teaching pre-service teachers, just as when teaching in schools, teacher educators also use their professional knowledge to make decisions about what content to teach and how to teach that content. The pedagogical reasoning and action framework is therefore important in this study. I describe the framework below.

Pedagogical reasoning occurs in a cycle of six stages namely *comprehension*, *transformation*, *instruction*, *evaluation*, *reflection* and *new comprehension*. Every stage involves decision making by the teacher. The stages of pedagogical reasoning are shown in Figure 8 below.

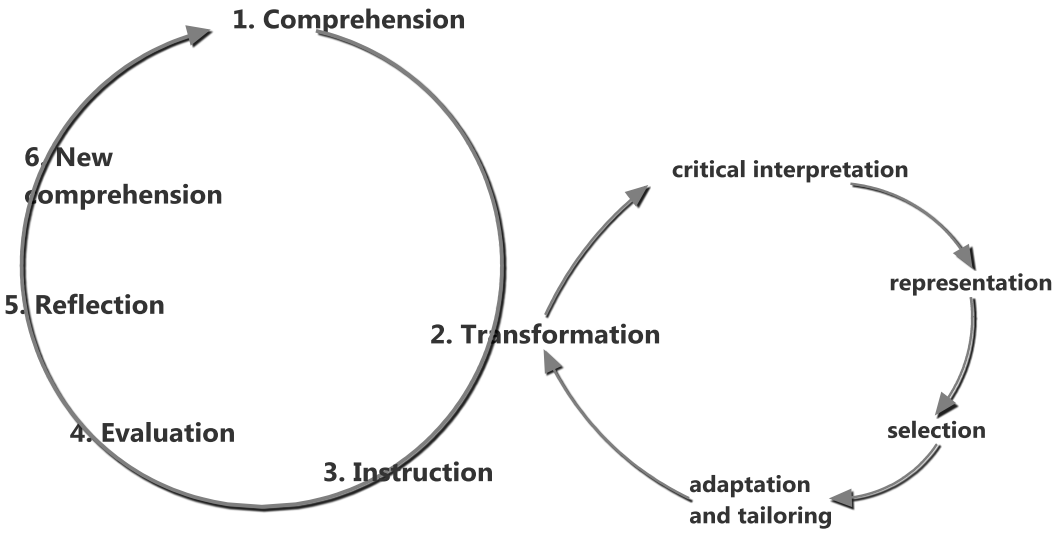


Figure 8: Shulman's model of pedagogical reasoning as adapted by Bishop & Denley (2007)

Comprehension: Is the first stage of pedagogical reasoning. This stage of comprehension refers to a teacher's understanding of the subject matter knowledge. For Shulman, "to teach is to understand" (1987, p. 14). Teachers must understand the content that needs to be taught. Teachers also need to understand the content in a variety of ways so that they will be in a position to present it in alternative ways when learning difficulties are encountered. Comprehension does not only refer to an understanding of content but also an understanding of purpose, of learners and of ideas within and outside the subject area (Shulman, 1987). Comprehension is a prerequisite if teachers are to be able to reason about their teaching and if they are to transform the content into a form that is more accessible to students.

Transformation*:* Shulman regarded the stage of transformation as highly complex and hence further divided it into four sub-stages namely critical interpretation (preparation), representation, selection and adaptation and tailoring (see Fig 8). These stages will be briefly described before moving on to the next stage of pedagogical reasoning which is *instruction*.

The first stage of transformation is c*ritical interpretation.* It is when teachers engage critically with the subject matter and the teaching material (e.g. modules, schemes of work) so that they can design suitable activities for students. I therefore see critical interpretation as an activity that occurs when a teacher prepares for teaching. Contextual factors come into play during the process of critical interpretation as teachers have to consider students in terms of their prior knowledge, their level of competence and cognitive abilities before they can make

decisions on what content to teach and how to teach it (Bishop & Denley, 2007). A teacher's past experiences and stored professional knowledge play an important role at this stage of transformation.

The next stage is *representation* which refers to anything that a teacher uses to make the subject matter comprehensible to others. It can be analogies, metaphors, illustrations, examples, explanations, demonstrations and models (Bishop & Denley, 2007; Shulman, 1986). To be able to choose and use appropriate representations requires enough knowledge of the subject matter. Teachers have to spend a great deal of time searching and examining their subject matter so that they can find appropriate ways of representing it confidently to their students.

The third stage of transformation is *selection.* Selection refers to the choices that a teacher has to make regarding the activities, models, analogies and others. that the teacher will use in the classroom. There are many reasons why teachers would choose certain activities and analogies and not others. Principal among them is the teacher's knowledge of the pupils which includes their cognitive levels, their attitudes and their predispositions towards the subject matter.

The final stage of transformation is *adaptation and tailoring.* This is a process when a teacher designs classroom materials and activities specifically for the students in the classroom. It is not a case of 'one size fits all'. A teacher has to modify the content to be taught to make it suitable for the teacher to teach and for the students in the classroom. The modification may involve a change to a facet of an activity or to the sequence of concepts to be taught. Some of the considerations that a teacher has to make include students' prior conceptions, social class, gender, ability and motivation (Geddis & Wood, 1997).

It is important to note that the four stages of critical interpretation, representation, selection and adaptation and tailoring are not discrete entities of the process of transformation. They influence and affect each other making the whole process of transformation an integrated one. For example when choosing activities for teaching a particular concept (selection), teachers must have made a good judgment of the content to be taught (critical interpretation). A teacher must select appropriate content first (critical interpretation and selection) before thinking of adapting and tailoring it. The adaptation and tailoring completes the process of transformation. A teacher will now be ready for **instruction**.

Instruction*:* Refers to the acts of teaching and learning which may include the presentations of explanations and descriptions of subject matter, questioning and probing

students, answering questions and discussing with students, group work. A teacher's *comprehension* of subject matter has a bearing on the choice of instructional strategies. Teachers with a good grasp of subject matter and high level of confidence are likely to choose flexible interactive teaching techniques. As instruction will be taking place, a new understanding will occur from what will be happening in the classroom. Hence teaching is an act of learning.

Evaluation: Evaluation includes checking for understanding and for appropriateness of instruction. It is when teachers check for understanding of content in their students. Checking for understanding can be formal (testing) or informal. Informal evaluation is employed during teaching through some form of questioning. Formal testing is when questions are prepared in advance and compiled for the students to answer and teachers provide feedback. Checking for understanding requires both an understanding of subject matter and transformation. Evaluation also refers to situations where teachers assess their own teaching to gage the goodness of the instruction process; teaching approaches employed, techniques used, and the teaching materials chosen.

Reflection: This is a process whereby teachers review the teaching and learning that has occurred in the classroom in the light of the educational goals and purposes and ends that were being sought. Reflection can be done through memory by re-enacting and reconstructing the teaching situation or with the help of recording devices. Reflection enables the teacher to learn from what happens in the classroom.

New comprehension: Through the acts of preparation, teaching, evaluating and reflecting, a teacher gains new insights into his/her teaching which usher in a new understanding of content to be taught, of students, of purposes, of self and of the process of teaching itself (Geddis & Wood, 1997). This new comprehension does not occur automatically, there is need for some documentation, analysis and discussion of the events, the emotions, the accomplishments experienced (Shulman, 1987).

The six stages of pedagogical reasoning described above are not fixed steps that occur in a linear fashion. The stages can occur in any order and some stages may not occur at all during a particular act of teaching (Shulman, 1987). I therefore consider the process of pedagogical reasoning as a process that continuously brings change and growth in one's domains of knowledge for teaching making it what Geddis and Wood (1997) described as a dynamic process. In such a case, the stages simply help paint an orderly conceptual picture of this dynamic process.

When I reflect on my own experiences as a teacher, in the light of the PCK model by Davidowitz and Rollnick (2011) and the description of pedagogical reasoning and action, I realize that the domains of teacher knowledge in the model are *inputs* that teachers need for them to reason pedagogically about their teaching. The domains of teacher knowledge *inform* pedagogical reasoning (processing of the input) which is influenced by the teacher's beliefs. As a teacher reasons out about teaching using the various domains of teacher knowledge, PCK will be developing. It can therefore be said that the domains of teacher knowledge inform the process of pedagogical reasoning which in turn influences the development of PCK the products of which are seen in the classroom (manifestations) when a teacher is teaching. Pedagogical reasoning therefore, seems to form the link between the knowledge of a teacher and the development of PCK in the model of Davidowitz and Rollnick (2011). The link that is made possible by pedagogical reasoning is not a linear process. This is because when teachers employ pedagogical reasoning new comprehension occurs and the new comprehension restructures the domains of teacher knowledge. Therefore, the domains of teacher knowledge are structured by what they are structuring making the whole process cyclical. This cyclical process is illustrated in Figure 9 below.

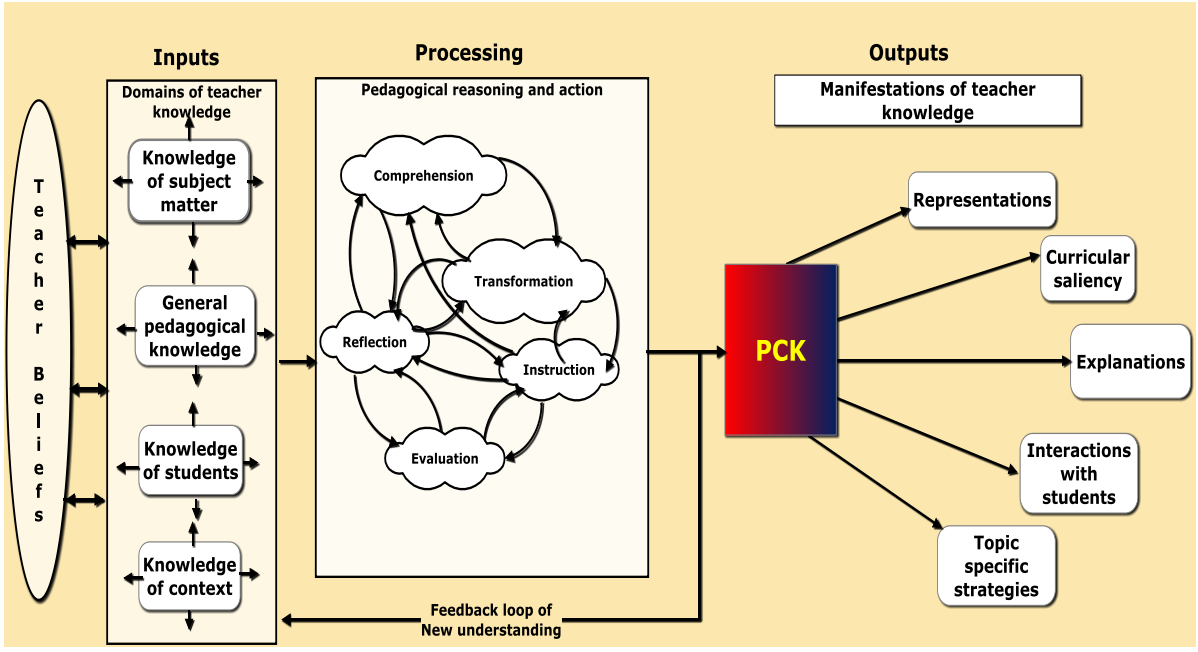


Figure 9: Diagrammatic representation of the amalgamated model of PCK of Davidowitz and Rollnick (2011) and of pedagogical reasoning as adapted by Bishop & Denley (2007)

The amalgamated model in Fig 9 shows that the different domains of teacher knowledge inform the pedagogical reasoning that teachers employ as they prepare for and teach their

lessons. From my experiences as a teacher, different aspects of pedagogical reasoning inform each other and are structured by the aspects they are informing and this is what is shown in the model in Figure 9 above. For example, the aspect of *reflection* can occur before *instruction* when teachers are planning for their lessons, and in the process think about what transpired in their previous lessons. In this case, *reflection* will be informing *instruction*. Reflection can also occur during and after instruction when teachers consider what transpired during instruction. In this case, reflection is structured and informed by instruction.

In addition to promoting the development of PCK, the model also shows that pedagogical reasoning can also result in teachers acquiring a new comprehension which restructures the knowledge domains of the teacher. Hence the processes that bring about the development of PCK occur in a cyclical and continuous process in a teacher's practice.

The arrows pointing out from each knowledge domain represent the conception of expanding knowledge taken from the Pedagogical Content Knowing (PCKg) model of Cochran *et al*. (1993). The arrows show that the teachers' knowledge becomes more and more elaborate through experience and reflective practice. This amalgamated model of pedagogical reasoning and of PCK by Davidowitz and Rollnick (2011) therefore incorporates the ideas from the model of Cochran et al. of PCKg (1993) that teaching is learning and the development of PCK continues throughout a teacher's career.

Although the blocks representing teacher domains depict them as being of the same size, that is not the case in reality. The levels of knowledge of the four domains in a teacher are likely to be different. The arrows also show that the four domains of knowledge will be expanding at the same rate as the teacher gains experience. Again, this is unlikely the case in reality. One episode of teaching or cycle of pedagogical reasoning may increase a teacher's knowledge of students and another one, a teacher's knowledge of subject matter or both. Hence, there is an uneven contribution of the knowledge domains to PCK at different points and there is also an uneven growth of a teacher's knowledge domains as teaching experience is gained.

It is important to note that the different shapes used in this model do not represent anything. It is just a way that I chose to represent my model as a way of increasing clarity. PCK in the model is represented as changing shades of colour. The different shades of colour represent a teacher's transforming PCK. I visualize a new teacher educator's PCK as starting from the red end and moving to the blue end. The purple colour shows the transition phase of the teacher educator's PCK.

2.10 The conceptual framework for my study

A conceptual framework is defined by Miles and Huberman (1994, p. 18) as a “graphical” or “narrative” explanation of “the main things to be studied” which include “the key factors, constructs or variables and the presumed relationships among them”. Maxwell defined a conceptual framework as a “system of concepts, assumptions, expectations, beliefs and theories that support and inform your research” (2005, p. 33). Therefore, a conceptual framework is basically a form of representation of phenomena to be studied which was teaching and learning of pre-service teachers in this study. Below, I discuss and present the conceptual framework that guided my research design, data collection and analysis.

This study was about my teaching and pre-service teachers’ learning. From the literature review that I presented above, I identified concepts that are important for teaching and learning in the context of pre-service teacher preparation. I present these concepts and the relationship among them in the form of a diagram (Figure 10) that illustrates the conceptual framework for my study. The framework shows a lecturer’s input on one side and student’s learning or experiences as an output at the other end. The underlying assumption is that the lecturer’s input is influenced by his or her beliefs, knowledge of context, knowledge of students, pedagogical knowledge and knowledge of content. Students’ experiences are studied with the assumption that they are a consequence of what happened in the lectures and will act as a predictor of their future behaviour as teachers.

Explanation of the conceptual framework

The objectives of my study were to investigate my own teaching of a genetics course and students’ experiences of that teaching i.e. their learning. The conceptual framework is therefore a detailed visual representation of my pedagogical practice. According to the literature review above, the aspects that impact teaching are the teacher educator’s beliefs, teacher educator’s knowledge and teacher educator’s pedagogical reasoning. The teacher educator’s knowledge includes **knowledge of context**, **knowledge of students**, **pedagogical knowledge** and **content knowledge**. The teacher educator’s pedagogical reasoning and action involves understanding the content, transforming the content into a teachable form, carrying out instruction (teaching) evaluation and reflection. The teaching that is done by the teacher educator should aim to achieve certain outcomes. These four aspects namely teacher educator’s beliefs, (blue) teacher educator’s knowledge, (green) teacher educator’s pedagogical reasoning and action (yellow) and teaching and learning

outcomes (pink, red and grey) form the four components of my conceptual framework and are described in detail below together with the relationships between them.

The first component of my conceptual framework under teaching is the teacher educator's beliefs in blue. As explained by Davidowitz and Rollnick (2011) a teacher's beliefs represents what the teacher educator believes to be good teaching and considers as important for good teaching to occur. The teacher educator beliefs influence the knowledge components and ultimately the teaching that will occur. For example, before embarking on this self-study, my belief was that since genetics is a content course, my responsibility was to teach the content of genetics. I therefore did not consider developing any competencies in students for teaching that content. My teaching approaches focused on making students understand the content and nothing else. Now my belief is that I should teach genetics for both content understanding and for teaching it. As a result, my approaches have changed. Therefore, teacher educators' beliefs influence the content that they teach, the pedagogical approaches they use, the teaching context and the knowledge of students that the teacher educator considers during planning which then influences what happens during teaching. Note that there is a two-way arrow between the teacher educator's beliefs and the teacher educator's knowledge domains. This two-way arrow means that a teacher educator may have certain beliefs about students, about the content or about pedagogical activities which influence his/her teaching but during teaching the teacher educator learns somethings about the students which then change his/her beliefs and teaching approach. For example, I have always considered that a short discussion of the concepts during teaching is an effective way of helping students to find out if they have understood a concept before moving on to teach the next concept. So in my lectures, I used to ask students to explain a concept or concepts that I would have taught to each other and I expected all students to participate fully in these discussions. However, when I embarked on this study, I observed that there were always some students who would just sit and not participate in those discussions. One day, I decided to ask one such student why he was not participating in the discussion. The student in reply said that what I had just taught them was too much information for him. Therefore, instead of trying to explain it to the student next to him, he wanted to organize it mentally first by pondering over the explanation in silence before trying to explain it to someone. On reflection I realized the importance of what the student had said. Students learn differently and I needed to accommodate those differences.

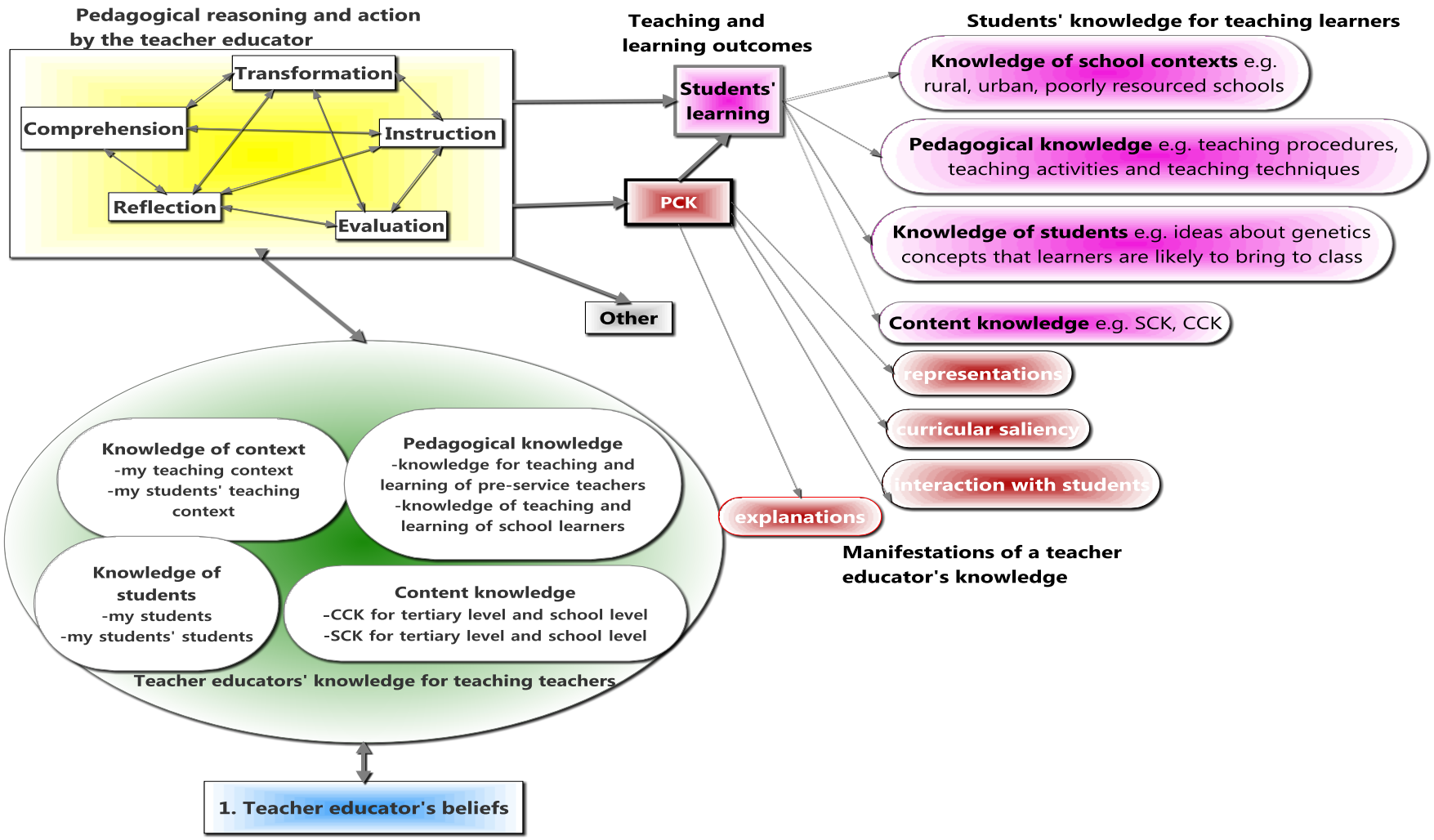


Figure 10: Conceptual framework for the study

Therefore, the knowledge that I gained from the student about the student re-shaped my beliefs about the use of the discussion activity and from that day I give students several options; discuss, think about it in silence or write down or draw.

The second major component of my conceptual framework is the teacher educator's knowledge for teaching pre-service teachers in green. I have made this aspect specific to teacher education for two main reasons. The first reason is that the role of teacher educators is dual; teaching for content understanding and for teaching. The second reason is that this study is a self-study and one characteristic feature of self-study methodology is that it is improvement aimed (LaBoskey, 2004). This improvement that self-study focuses on is not improvement of self only. It also includes the improvement of one's students and their own learners (Pinnegar & Hamilton, 2009). When I look at the dual role of a teacher educator and the feature of self-study described above, I realize that the knowledge that I will need in this context should be dual. I would need knowledge of two contexts (my context which is teacher education and my students' context which is the school), two types of knowledge of students (knowledge of students in my classroom and knowledge of their future students that is school learners), pedagogical knowledge (for teaching and learning of pre-service teachers and of school learners) and two forms of content knowledge and (that is content for both tertiary level and school level contexts). Knowledge at these dual levels will enable me to focus students beyond the classroom to their own future teaching which is what teacher education and self-study are about and also what this study was about.

The third major component is the teacher educator's pedagogical reasoning and action in yellow. This aspect was explained in detail in section 2.8.2. Pedagogical reasoning and action describes what teacher educators have to engage in in order to successfully carry out their teaching role.

The fourth component is the teaching and learning outcomes in pink, red and grey. One of the outcomes of any teaching is students' learning. What only differs is what is learnt. The other outcome of any teaching is PCK which manifests during the teaching process. The quality of a teacher's PCK impacts students' learning and therefore is an important aspect in the teaching and learning process. Depending on the purpose of a study, one may focus on one's PCK or students' learning or both. In my case, I focused on both as I was interested in knowing the quality of my PCK because it was going to influence what students were going to learn from those lectures.

As indicated above, the expected outcomes of students' learning differ from one context to another. To decide on possible outcomes for students in teacher education, I went back to

the purpose of a teacher educator which is teaching content and developing in pre-service teachers, the competencies for teaching that content and derived outcomes from that purpose. Therefore, one of the outcomes of students' learning should be a gain in content knowledge. Other outcomes should be evidence of a gain of pedagogical knowledge, knowledge of their future contexts and their future students. I consider these aspects to form part of the competences and skills for teaching that a pre-service teacher should develop from the teaching they get. I have included a third group of outcomes which I have labeled **other**. This group will cater for any other outcomes of teaching that may manifest in students' experiences that are not learning outcomes.

The interactions that occur between the components that form my conceptual framework do not occur in a linear fashion. What happens is that one component of the framework influences another component which then influences it in turn. For example, during the pedagogical reasoning and action process, teacher educators use the knowledge of content, of students and of context that they already have. However, they (teacher educators) may decide to read books and research articles, discuss with colleagues and reflect on their teaching during the pedagogical reasoning and action process. These activities of reading, discussing with colleagues and reflecting on the teaching process will result in the gain of knowledge of one or more components by the teacher educator. Therefore, the teacher educator's knowledge domains influence the pedagogical reasoning and action process which in turn feeds back into the teacher educator's knowledge domains hence the two-way arrow joining the knowledge domains and the pedagogical reasoning and action. A teacher educator's PCK that manifests during the teaching process influences students' learning hence an arrow from PCK to students' learning. I have used thinner arrows from students' learning to the actual learning outcomes and from PCK to the manifestations to indicate that those outcomes are possibilities not absolutes.

2.11 Terminology in the practice of teaching

There are many terms that are used to describe many aspects of teaching. These terms include teaching strategies, teaching activities, teaching procedures, teaching approaches and teaching styles. It was important for this study to have a similar understanding of the meanings of these terms which then necessitated a review of literature about these terms. Loughran (2006) used the concept of concept mapping to explain most of these terms. I will use the concept of a Venn diagram to explain the same terms using ideas from Loughran. A teacher can ask learners to draw a Venn diagram to show the relationships between the

concepts of DNA, chromosome and gene. The concept of Venn diagrams can be regarded as a generic teaching procedure because it can be applied in many other teaching situations for different teaching activities. Drawing of the Venn diagram is an activity and the activity is an approach to promoting the teaching and learning of specific content; relationships between concepts within the topic of genetics. A teaching strategy on the other hand is, according to Loughran (2006, p. 91), 'the development of an overall approach, aim or enactment of a principle such as build a classroom environment that supports risk-taking'. According to Felder and Silverman (1988), the term teaching style covers many aspects of teaching which may be described in terms of 1) **content**; when the teacher emphasises *concrete* or *abstract* form of content, 2) **forms of presentation** used (visual or auditory), **how the presentation is organized** (inductive or deductive), **the mode of participation that is facilitated by the presentation** (active or passive), and **the type of perspective that is provided by the information that is presented** (sequential or global). Many scholars do not cover all the five categories above when describing teaching styles. They may describe teaching styles in terms of the form of presentation only, that is visual or auditory or in terms of mode of student participation that is facilitated by the teacher. Pre-service teachers use the above terms interchangeably. In this study, I used the teaching terms in the context of meanings described above. However, wherever I used the terms in response to their use by students, I have used them in the context as given by the students.

2.12 Conclusion

In this chapter, I have described the bodies of literature that guided my study. My study was looking at my own teaching of the genetics course to pre-service teachers. Therefore, I reviewed literature on teaching in pre-service teacher preparation much of which focuses on teaching for teaching. The literature shows that there is very little research on how to teach content subjects to pre-service teachers. This study will therefore contribute to research in this context of teaching content for understanding and for teaching in pre-service teacher preparation. I reviewed literature on content knowledge because my study is about teaching content to pre-service teachers. The literature gave me insights into the different kinds of content knowledge which are important for teaching such as SCK and PCK. There is a need for identifying and documenting SCK for teaching genetics. I reviewed the literature on genetics teaching and learning. The review showed that the difficulties associated with the teaching and learning of genetics maybe a problem of content instead of a problem of learning. The content that is taught, how the content is structured in the teaching and how it is taught may be sources of difficulties. In trying to improve the teaching and learning of

genetics therefore, there is a need to investigate the whole pedagogical enterprise of teaching genetics; content, pedagogy, and the actual teaching. In this study therefore, I looked at my whole enterprise of teaching genetics to pre-service teachers which included the selection of content, planning and teaching. Content knowledge, pedagogical knowledge and knowledge of students are all domains of a teacher's knowledge that contribute to a teacher's PCK. In the chapter I described PCK in general and one model in detail as I used it in the conceptualization of my own framework for the study. I also described some literature on good teaching as I sought to find out what would be considered to be good teaching when it comes to teaching a content course to pre-service teachers. I added literature on the conceptions of learning experiences: cognitive, affective, conative and self-esteem. The review of the literature on the conceptions of learning experiences was necessitated when I foresaw that students' experiences could be described in terms of these conceptions. There are many other bodies of literature that I have described above that guided or impacted my teaching practice; metacognition, teacher educator identity and modeling teaching. I ended the literature review by building a conceptual framework that guided my research design and analysis which are described in detail in the next chapter.

Chapter 3: My research design and methodology

3.1 Introduction

In this self-study, I investigated my own teaching of genetics to pre-service teachers. I chose to do a self-study as it enabled me to practice my teaching and to study it at the same time. Self-study allowed me to enact research inside my own classroom receiving support and direction from colleagues. It (self-study) allowed me to plan, to enact and assess my efforts and examine the impact of my efforts on my students' learning. In this chapter, I describe my research design and methodology that is the approaches, practices, methods of data collection and data analysis and guidelines that I used to engage in my self-study enquiry. I also describe the research setting and the participants.

3.2 Approaches to the methodology of self-study

The methodology of self-study was described in chapter 1 section 1.9. In this section, I describe the approaches that influenced self-study methodology. Self-study has been influenced by action research, reflective practice and teacher inquiry (Samaras & Freese, 2006). Although these approaches to enquiry vary, there are overlaps as they have many similar features in common and they all focus on issues of practice (Ball, 2000). Each of these will be briefly described to bring out how they have influenced self-study.

3.2.1 Action research

Action research is one of the research approaches that has strongly influenced self-study research. According to Opie (2004a), action research is used to study and understand a problematic situation with an agenda for bringing change. In teacher education, it is when teachers study their teaching and their students' learning as a basis for making change and improving practice. McKernan (1991, p. 5) defined action research as:

> The reflective process whereby in a given problem area, where one wishes to improve practice or personal understanding, inquiry is carried out by the practitioner - first, to clearly define the problem; secondly, to specify a plan of

> action - including the testing of hypothesis by application of action to the problem. Evaluation is then undertaken to monitor and establish the effectiveness of the action taken. Finally, participants reflect upon and explain developments, and communicate these results to the community of action researchers.

The definition above by McKernan brings out four fundamental aspects of action research which were described by Kemmis and McTaggart (1992). The four aspects are: Plan, Act, Observe and Reflect. To do action research is to plan, act, observe and reflect carefully, systematically and rigorously and use whatever comes out of these processes as a source of improvement and knowledge. The four activities are carried out **collaboratively** with those affected by the action. Action research can be an individual or a group activity. Whether it is a group or an individual activity, action research requires a decision (individual or group) and commitment to improvement. An individual or people in a group describe their concerns, explore what they think and discuss what can be done. The group plan action together, act and observe individually or collectively and reflect together making action research both participatory and collective (Kemmis & McTaggart, 1992).

The comparison of self-study with the description of action research above show that in both action research and self-study, researchers enquire into problems related to their practice with a commitment to improving practice. In addition, the researchers are participants and are involved in a reflective process. In self-study, inputs from other participants are interpreted in terms of the self. My study is a form of action research in that I invited my colleagues to reflect on my teaching and give their feedback on my practice. Unlike in action research where the other participants may be involved in the planning and the action, in self-study the role of the other participants is to observe and help the self to understand personal practice. Self-study, though it operates via the parameters of action research, goes beyond action research in a number of ways: Firstly, self-study is not restricted to a pre-defined problem action cycle but rather responds to a given situation. Secondly, self-study is not always influenced by an identified problem but may just be initiated by a quest to know more about your own practice. As such, in self-study there is no closure or settlement, the goal is to continuously transform as educators and that it (self-study) yields knowledge about a practice. It does not necessarily solve a problem. A self-study can be action research but not all action research is self-study. Thirdly, self-study researchers use their experiences as a resource for their study and they regard the selves in the practice situation as the focus of the research so that they can reframe their beliefs or practice (Feldman, Paugh, & Mills,

2004). Since the focus is the self, openness, vulnerability and dialogue are required for new understandings to be built, reframing to occur and findings to be validated.

3.2.2 Reflective practice

Reflective practice is when teachers consciously study their teaching by reflecting on their practice. (Samaras & Freese, 2006). It is when a teacher looks back at an event, understands it and learns from it. Reflective teachers look at events in their everyday practice; analyse them in order to learn from them. Reflective practice need no special design or conjecture (Ball, 2000). Its primary purpose is to help sharpen teachers' foci when deliberating on what is going on in their work. When one looks at reflective practice and self-study, both have teachers as the researchers researching their own practice. Whilst reflective practice looks for steps to take regarding issues at hand in the classroom, self-study pays more attention to the production of insights to be shared broadly with others (Ball, 2000). Therefore, self-study goes a step further beyond the individual level by making what is learnt at personal level available to others (Berry, 2008; Loughran, 2007a). Reflective practice can therefore be taken as a tool in self-study where it offers a means for teachers and teacher educators interested in better understanding and developing their knowledge to examine their practice and will be used in this respect in this study.

3.2.3 Teacher inquiry

Teacher inquiry is when teachers question and conduct research about their own teaching. It is a form of action research which focuses on the concerns of teachers and engages teachers in the research design, data collection and interpretation. Just like self-study, the teachers are the researchers and their practice is the focus of the study. Self-study is a form of teacher inquiry in which the self is the inquirer.

3.3 Narrative inquiry/Teachers' narratives

This research is a self-study which involves an examination of my teaching and my practice as a whole. An examination of one's teaching entails a look at self. An individual's sense of self can be understood as a story or through a story. That story can be told as a narrative. Narrative is a mode of inquiry involving an intentional reflective process. It is telling a story of one's experiences through the process of reflection (Clandinin & Connelly, 2000). Through narratives, human beings play an active role in constructing their own lives (Jonhnson & Golombek, 2002). Teachers' narratives can be described as teachers' own accounts of their

experiences as teachers; their problems, puzzles and excitements of practice. Teachers' narratives tell stories of their professional development within their own worlds. Just like in self-study, communication with others is also central in teacher narratives. As teachers or teacher educators, "we construct our identities by constructing a narrative around what we believe, value, know, think and can do" (Hobbs & Davis, 2013, p. 1290). Narrative experiences provide a way of exploring the connections between what teachers know about the subject and its content and their personal response to that knowledge. A person is transformed by what they have experienced and what they have come to know out of that experience (Hobbs & Davis, 2013). Narrative requires a balanced treatment of the past, the present and the future (Clandinin & Connelly, 1989).

Narrative studies can be distinguished by the analytic strategies that are used by authors or by the forms found in narrative research practices (Creswell, 2007). Polkinghorne (1995), distinguishes between *analysis of narratives* and *narrative analysis*. Analysis of narratives is when a researcher uses paradigm thinking to identify and create themes that run across stories and narrative analysis is when researchers collect descriptions of events and then use them to create a story with a plotline (Polkinghorne, 1995). My research study falls under analysis of narratives. Being a self-study, the stories that I analysed were my stories about my teaching and students' learning that I was recording in my journal during my teaching of the genetics course. During the analysis of the stories, my thinking was guided by the PCK model from Davidowitz and Rollnick (2011) as presented in chapter two.

There are many forms of narrative study. These forms include biography, autobiography, life history, oral history and personal experience stories (Creswell, 2007). The form that I used in this study is **personal experience stories**. Personal experience story is the study of an individual's personal experience of a single or multiple events or private situations. In this study, my personal experience stories were descriptions of the events that occurred during my teaching of the genetics course. The stories had a specific contextual focus which was the self in relation to my teaching practices and students' learning.

3.4 How I conceptualized my research

To conceptualize my study, I did an autobiographical account of my teaching experiences as a high school biology teacher and as a novice teacher educator. The production of this topic-focused autobiography helped me to put into focus what was happening in my practice at that time. I reflected on my experiences and through that reflection, identified turning points that I had encountered as a novice teacher educator (see section 1.3.4). These turning

points helped in conceptualising my study. I became clear on what my concern was and what I wanted to do about it and to formulate my research questions. Reflecting on my experiences as narrated in my autobiography also helped me to become aware of the way I was teaching genetics to pre-service teachers. This understanding also enabled me to pose questions: How would an examination of my teaching and my practice transform both my teaching and my practice? This questioning led me to seek for content and ways of teaching that would improve my teaching and make it relevant to my context. I searched from literature ways of teaching that would create an environment where pre-service teachers would learn both content and get ideas on how to teach that content. When I started wondering about my teaching of genetics to pre-service teachers, I also began to converse with colleagues about these wonderings and to read literature. Conversations with colleagues and insights from literature helped me to conceptualise my self-study and to formulate my research questions indicated below, as a reminder for the reader.

The research questions

1. What knowledge should I have as a teacher educator in order to effectively teach genetics, a content course, to pre-service teachers?
2. How is my practice as a teacher educator transformed as I examine and reflect on my teaching of genetics to pre-service teachers?
3. What are students' experiences of my teaching practices?
4. What do I learn from students' experiences and how can I use that knowledge to improve the teaching of pre-service teachers?

3.5 Participants

Being a self-study, the self was the focus of the study. The self was me the teacher educator. The students were also participants in the study. The students and myself as the teacher educator were intertwined in this study in the sense that studying myself inevitably led to the study of my students. For example I was looking at my actions in my teaching and at the same time looking at the impact of those actions on students' learning. Students in my course were interviewed as a way of trying to understand the impact of my teaching on students' learning. The participants were therefore myself, third year students who were taking Life Sciences as their major and fourth year students who were taking Life Sciences as their sub-major. The reason why I chose Life Sciences students was because genetics is taught in the Life Sciences curriculum and I am the teacher educator responsible for teaching the genetics course to this group of students.

3.6 Why genetics

As explained in chapter 1, when I became a teacher educator, I was employed to teach a genetics course to pre-service teachers. Two years as a teacher educator, I was invited to facilitate at a workshop for teachers on how to teach genetics. It was the experiences from the preparation that I did for the workshop and the facilitation at the workshop that I became dissatisfied with my teaching of the genetics course to pre-service teachers. Therefore, the focus of my study was to investigate my own teaching of genetics, the course that I was teaching when I became dissatisfied with my teaching.

3.7 Critical friends (CFs) and collaboration

Critical friend is a term that is used widely in self-study research. According to Kemmis and McTaggart (1992), the term critical friend describes someone who can listen to a researcher's account of practice and critique the researcher's thinking behind that account and according to Samaras (2011), critical friends are trusted colleagues who serve to mediate, provoke and support new understandings. Collaboration is when you enlist a colleague or colleagues to engage in conversations with you about your practice. Collaboration serves to extend individuals' analyses beyond their personal views thereby addressing potential biases. In this study, I made use of both critical friends and collaboration. (See Appendix A for the list of critical friends and their statuses).

3.8 Forms of the collected data

After choosing the participants, I had to make a decision on the type of data that I needed to collect. Gathering data from a multiple of sources is one of the principal features of a self-study methodology (LaBoskey, 2004). As suggested by Pinnegar and Hamilton (2009), the data needed to be commensurate with the study and research questions. The data was collected at three points; before the teaching of the course, during the teaching of the course and at the end of the course. The data that was collected before the course included journal entries, notes from discussions with colleagues and from discussions with critical friends. Data collected during the teaching of the course included video-recordings of lectures, journal entries, notes from discussions with colleagues and with critical friends and interviews with students. Data collected after the course included journal entries, interviews with students and notes from the discussions with critical friends. Note that journaling and discussions with colleagues and critical friends were continuous processes throughout the

research process. This wide-ranging selection of data sources was used in my study so that a rich picture of my practice could be revealed from a wide range of perspectives. The choice and use of each of these data sources is now explained in detail.

3.8.1 Journaling

A journal is a record of thoughts, ideas and experiences by an individual through writing (King & LaRocco, 2006). A journal can also be a record of educators' accounts of their classroom life; observations that they have made and processed or analyses of their experiences and reflections on their practice (Cochran-Smith & Lytle, 1993). Journaling was therefore a method for data collection that I used to capture my observations, experiences, thoughts and ideas before, during and after my teaching of the genetics course. Journaling serves to create what Samaras (2011, p. 164), described as an "audit trail" that increases the validity of a study. A journal not only serves as a permanent record of thoughts and experiences but it also aids reflection and provides a means for sharing those thoughts and experiences with critical friends so that they can offer their input and perspective (Samaras, 2011). While a journal can be a safe outlet for personal concerns and frustrations, in self-study there is a dilemma that you need to share those thoughts and experiences with critical friends for a critical examination. Having critical friends who encourage a free flow of ideas and you trust to share those thoughts and experiences becomes essential.

3.8.2 Discussions with colleagues

Colleagues are sources of teaching ideas. Therefore, throughout the course when I was preparing for my lectures, I sought colleagues' ideas on how to teach certain genetics topics and concepts. Initially, I would set up appointments with colleagues to seek ideas on how to teach certain concepts. However, setting formal meetings had two challenges. The first challenge was that colleagues would look for vacant slots in their busy schedules which sometimes pushed the meeting to a few days or even a week later and yet I would be seeking ideas for immediate implementation in response to what would have happened in the lecture. The second challenge is that a colleague would feel inclined to prepare for the meeting. To overcome these challenges, I would just ask colleagues for a few minutes of their time and solicit ideas. For this approach to work, I had to make myself vulnerable first by being upfront with my current teaching approaches so that I put the colleagues at ease to share their ideas. I did not get this approach of discussing teaching ideas with colleagues from literature; it was my own creation. The innovation was necessitated by my quest to

improve my teaching but at the same time by an ethical responsibility to protect and respect my colleagues (See section 3.13).

3.8.3 Discussion with critical friends

Self-study requires constant dialogue with critical friends for purposes of mediating and critiquing one's work. By making use of critical friends in my study, the aim was to increase my awareness of the things that I could have been taking for granted in my teaching and at the same time, it provided opportunities for support (Brookfield, 1995; Samaras & Freese, 2006). In addition, critical friends contributed to validation of my findings. This method of data collection has a number of challenges. The first challenge is securing the services of a colleague who understands the role of a critical friend. The second challenge is finding a person who is willing to commit to play the role considering the demands of time for listening, reading and critiquing the work. To overcome these challenges, I invited four of my colleagues in the Life Sciences division to be my critical friends and explained to them what their role would be. The reason for asking all of them was to increase chances of getting feedback quickly at any given time.

3.8.4 Collaboration

We formed a support group comprising of me and three colleagues who were also doing their PhDs to help each other. Two of these colleagues became my main critical friends and respondents during the times when I would be presenting at PhD weekends (see section 3.10). As pointed out in section 3.7 above, collaboration provides constant support for each other through conversations, which is essential in a self-study project.

3.8.5 Video-recordings of lectures

Video-recording is the filming of an event which captures the 'physical' happenings of that event that is both the audio and the visual: I was not able to get a critical friend who was available to observe my lectures in real time so as to provide me with critical feedback after the lectures. This is because my colleagues were already overburdened with their own responsibilities. Therefore, I video-recorded all my lectures so that my teaching could be available to critical friends after the lectures for feedback. Video recordings recreated the teaching situations which offered me and my critical friends opportunities for post event scrutiny of my lectures. One problem of video-recording lectures is reactivity (Mouton, 1996). Reactivity is when participants change their normal behaviour because they are aware that

they are participants. Reactivity was not a big issue in this study as far as the students were concerned as the video-recording focused on me only. In addition, I had promised anonymity and confidentiality of the students in the audio transcripts. Furthermore, for me not to be too aware of the video-recording, the cameraman's position was such that he was not in my immediate view. Therefore, I would consequently quickly forget that I was being recorded.

3.8.6 Interviews with students

An interview is a meeting between two or more people in which the people exchange views on a topic of interest (Cohen, Manion, & Morrison, 2000). In this study, the topic of interest was my teaching. I took an interview to refer to a meeting during which I was going to ask students questions about their experiences of my teaching. According to Cohen et al. (2000), interviews enable participants to discuss their interpretation of the world in which they live and to express how they regard the situation from their own point of view. Students were the main participants in this study. Therefore, by interviewing students about their experiences during and at the end of the course, my anticipation was to find out students' interpretation and perspective on my teaching. The strengths and weaknesses of the interview process are discussed later in section 3.9.5.

3.8.7: A summary of the data collection methods used in this study

As outlined above, I used multiple methods for collecting my data. The methods and when I used them in the study are summarised in Table 3 below.

Table 3: A summary of the methods that I used for data collection

Method of data collection	**Period of data collection (2012-2014)**
Journaling	Throughout the study (from the designing, planning, data collection, data analysis and during the writing of the thesis)
Discussion with colleagues	Throughout the study
Discussion with critical friends	Throughout the study (from the designing, planning, data collection, data analysis and even during the writing of the thesis)
Collaboration	Throughout the study
Video-recording	During lectures. All lectures were recorded
Interviews	3 interviews during the course and 2 interviews after the course

3.9 Implementation of the study and data collection

My research proposal was approved in April 2012. The implementation of the study began soon after the acceptance of the proposal. As described above, the data collection methods included video-recording and interviewing of students. I needed to pilot both the video-recording and the interviewing to pre-evaluate the feasibility of the two data collection processes. Therefore, in preparation for data collection, I piloted these two methods. I also produced a new course outline for the genetics course. The actual teaching of the course and interviewing of the students happened in the first quarter of 2013. All the data collection activities and analysis processes are described next.

3.9.1 Journaling

I used journaling to document my thoughts and insights as I was planning, preparing and reflecting on my study. I documented my reasons for choosing particular content and particular approaches and techniques and for structuring content for my lectures in a particular way. Below is an example of a journal entry that I did on 24/02/2013 as I was preparing to teach the topic inheritance:

> *I am not looking forward to the lecture on inheritance. How am I going to introduce this topic? I don't want to start by talking about Mendel and his experiments. Students get bored. It's always a teacher centred lecture. I really don't know how to start teaching this topic.*

I wrote that journal entry as I was preparing to teach the topic of inheritance. I was not looking forward to repeating the story of Mendel as the introduction and noted in my journal my thoughts and previous observations. (See section 4.6.6 for the details of the ideas that I eventually came up with).

I also documented my experiences, emotions and feelings before during and after lectures. Below is an excerpt which brings out my emotions after a lecture in which I had invited a person with cystic fibrosis to come and share her experiences of living with the disease. The incident is described fully as the fifth trigger incident in chapter five. On this day, towards the end of the lecture, one student walked out of the lecture theatre.

> Today a student walked out of my lecture where a guest was making a presentation. That was very rude and inconsiderate. This person made a lot of

effort to prepare for this lecture and you just decide to walk out on this particular day. Was it boring? Did he feel it was a waste time? I am going to confront him to find out why he walked out

In some cases I used my own language Shona to express the **insights** from the lectures. My two collaboration friends were also Shona speaking so they would immediately understand what I had observed in my lectures. An example is given and explained below. I e-mailed California my critical friend immediately after the lecture in which the incident had occurred.

Dear California. In today's lecture, I was reminded of the Shona idiom which says 'Kunyarara hakusi kutaura here'?

The above idiom if literally translated is a question which goes: Is keeping quiet (or silence) not a form of talking? I wrote this entry in my journal and e-mailed it to my friend California with the description of the event that had happened. Note that the journal entry above was not a description of the actual event but a reflection on the event. Therefore, some journal entries were reconstructions of the events from reflecting and analysing the events. I described the event connected to the above journal entry as the second trigger incident in chapter five. Lastly, I also documented **comments and questions** from both students and colleagues at various points in my study. For example, I was posting on SAKAI (the university's e-learning system) video clips of my teaching for students to get a chance to watch and listen to my explanation of concepts after the lectures. A colleague who also had access to the site watched one of the video clips and came to me with some questions. I recorded that conversation in my journal. Part of the conversation is shown below:

Georgia: I watched the video clip that you posted on SAKAI because I wanted to compare the content with what I was observing at this other institution. When I watched it, I wondered why you didn't go to the next stage. The next stage Georgia was referring to is indicated by the blue structures in Figure 11 below. My explanation had focussed and ended on the white structures only. The blue structures were representing the same phenomena as the white structures; that is how and why DNA organises into chromatin then chromosomes. The purpose of the blue structures was to show students how they can play around with the resources they have at their disposal to create T/L aids for use in their classrooms. Georgia's question led into a discussion and some insights about my teaching.

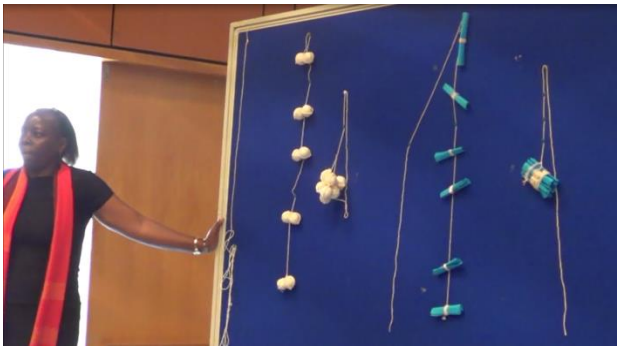


Figure 11: Visual aids showing how DNA organises itself into chromatin material then chromosome

In the journal I also recorded the **comments students made during lectures**:

Thank you ma'am for using those prompts, I now understand what chromatids are and their characteristics.

The prompts the student was referring to were the pool noodles shown in the picture in Figure 12.

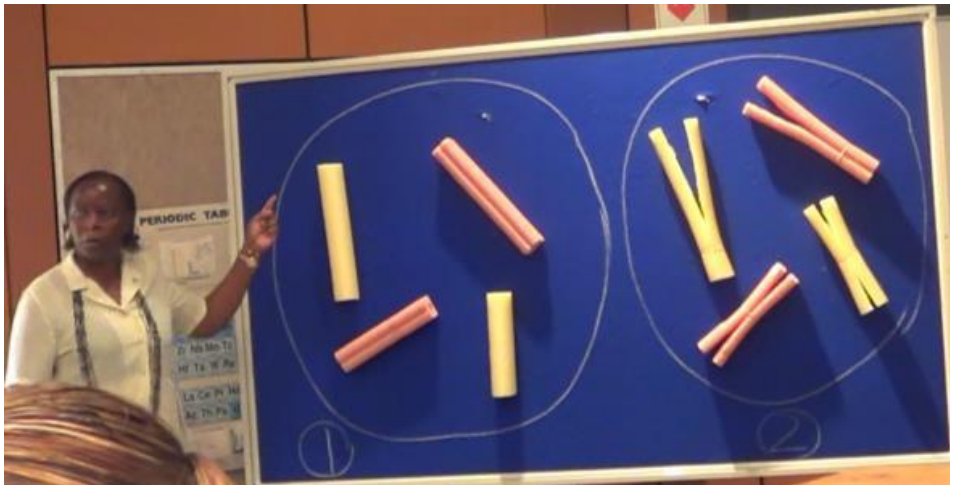


Figure 12: Using pool noodles to explain the events of prophase 1

I used Figure 12 again in chapter 4 to describe the pedagogical reasoning behind the choice and use of these noodles. In connection with the student's comment, I further wrote in my journal: *Students are appreciating my use of concrete concepts. It seems using concrete objects to represent the difficult genetics concepts is helping students to understand concepts better*.

In order to capture as much detail of the events as possible, I used the idea that I got from Garbett (2012), of recording the events as close as possible to the time each event happened.

3.9.2 Discussions with colleagues

On few occasions, I engaged colleagues who are biology teacher educators for inputs on how I could approach the teaching of certain topics and concepts in my course. On the first occasion I arranged a formal meeting with two colleagues. In the meeting we discussed how I could teach meiosis. I however realized that it was not easy to arrange these meetings as colleagues would be busy with their own workloads. It was more convenient for both me and my colleagues to just knock at their doors and ask informally about issues pertaining to my study including seeking teaching ideas. Therefore, that's what I did when I was preparing to teach about the topic genetics at molecular level, before and during the teaching of meiosis and also before teaching about inheritance. For example, I asked colleagues why chromatin network folds into chromosomes, how to teach meiosis conceptually and how to introduce the topic of inheritance.

3.9.3 Interaction with critical friends

Interaction with critical friends started right from the beginning of my study. As mentioned in section 3.8.3, I asked four colleagues in the Science Division responsible for teaching Life Science to pre-service teachers to be my critical friends. The reason why I approached all of them was also explained in section 3.8.3. The critical friends were involved at specific points in my study. These points are described next.

The first point that I involved critical friends was after writing the practice focused autobiographical account of my experiences as a novice teacher educator (I presented my autobiography in chapter one). In the autobiography I had expressed my personal views about my experiences and I needed a critical friend to provide feedback on my views. The second point that I involved critical friends was after outlining in the form of a concept map, the content of genetics that I considered to be appropriate for pre-service teachers' genetics course. In this instance I sent the concept map to all four Life Sciences teacher educators. I did this so that I could get a wide range of views on the appropriateness or inappropriateness of the content that I was planning to teach to pre-service teachers. The third point where I involved critical friends was after redesigning the genetics course. As with the concept map, I sent the course outline to all four colleagues as I again felt that it was important to get a wide range of feedback on the suitability of my course outline. The fourth point was after describing in detail how I was going to teach three of the five topics that made up the genetics course. At all these four points, I sent the documents to my critical

friends by email. They would read the documents and then we would meet to discuss their feedback.

Critical friends were also involved in the analysis of my journal entries, analysis of video-recorded lectures and analysis of students' interviews. I audio-recorded all the formal discussions that I had with my critical friends. In some cases however, I made entries of the questions that my critical friend would ask and my responses in my journal. One critical friend Belinda was able to read full drafts of chapters 1 and 4. Another friend California read a complete draft of chapter 5, and Virginia and Nico read complete drafts of chapters 6 and 7. After the critique from critical friends, my supervisor would then read the chapters and give his own feedback. Chapter 2 is the literature review so it did not need to be critiqued by critical friends. Chapter 3 is on my research design. This chapter contains the descriptions of everything that I did in this study which was critiqued at various platforms during the course of the study. Hence, I did not think it was necessary to present the completed chapter to critical friends as it was now a presentation of the critiqued work. Chapter 8 is my final chapter which summarises all the work hence it was only read and critiqued by my supervisor.

The role that was played by my supervisor

In many PhD studies, the feedback from the supervisor is not made explicit. In this study however, I treated feedback from my supervisor as feedback from a critical friend. The reasons why I decided to treat him as a critical friend are that we discussed my work in a similar manner to the way I did with other critical friends. In addition, just as with feedback from critical friends, I would reflect on his feedback at various stages of my study and document any insights that I would get from my reflections. My supervisor is also my colleague. Therefore, he was also involved in the various discussions that I had with colleagues on my teaching.

3.9.4 Video-recording of lectures

Preparing for video-recording of lectures

I enlisted the services of a fellow PhD student to record my lectures. Before the beginning of the course, we visited the lecture room where I was going to do the teaching of the course. We tried various possible camera positions until we had identified an appropriate one that would capture most of my teaching without drawing my attention as I was going to be the focus of the recording not the students. In addition to capturing everything that I did in the

lectures, the video also recorded the audio signals from me and from students during the lecture proceedings.

The video recording: The video cameraman would be at the lecture venue about five minutes before the lecture, set-up and position himself for the recording. He would record the physical happenings of the lecture from the beginning to the end of the lecture. I would then collect the video camera after the lecture and immediately upload the video to my personal computer. I would also transfer the video-recording to data storage devices; an external hard drive and two compact discs (CDs) as a safety measure. One CD was for the transcriber. After every lecture, I would watch the video of the lecture for reflection on what had transpired and for insights in preparation for the next lectures. I would make screen print outs of the videos and some brief notes on those print outs.

Transcription of video recordings: To minimize the length of time that I had to spend transcribing the videos, I hired a professional transcriber. I would send the video recordings to the transcriber at the end of each week. After receiving the transcriptions, I watched and listened to all the videos correcting the transcripts and filling in the gaps. I also added screen shots to the transcript of the physical happenings of my lectures.

3.9.5 The interviews

I used a semi-structured interview schedule for the interviews. I did not construct the interview schedule from scratch. I adapted the schedule from a practice-based research project that was running in the institution at the time of which I was a member. I had become a member of the research project because self-study is a practice-based study and therefore it fitted well into the project. The focus of the project was the scholarship of teaching which looks at teaching as a field of study and at teaching and learning as a knowledge base where expertise can be developed. The aim of this practice-based project was to study our practice with the aim of improving it which was also the aim of my study. Using a similar interview schedule was therefore going to help me to fulfil my purpose and that of the bigger project. So I adapted the interview schedule then piloted it to ensure its suitability for my study. The original interview schedule which was generic for the practice-based project is shown in Box 1 below. The schedule was made up of 6 questions. I adapted the schedule in box 1 by separating the two questions making up question one and adding another question which was going to focus students directly on my teaching and their learning experiences. The separated questions became questions 1 and 2. I added the name of my course

(genetics) to question 1. The question that I added became question 4. The adapted interview schedule is shown in Box 2 below.

Box 1: The interview schedule

1. Describe a 'typical' lecture session. Have you encountered formats other than a 'lecture'?
2. What sorts of content and skills have you encountered so far?
3. How would you describe the 'level' of the work you have encountered so far?
4. Can you describe any experiences of 'new' learning on the course so far?
5. To what extent would you say you have enjoyed the course so far?
6. To what extent have you found the course useful so far?

Box 2: The adapted interview schedule

1. Describe a 'typical' genetics lecture session.
2. Have you encountered formats other than a 'lecture'?
3. What sorts of content and skills have you encountered so far?
4. What messages about teaching and learning did you understand from genetics classes
5. How would you describe the 'level' of the work you have encountered so far?
6. Can you describe any experiences of 'new' learning on the course so far?
7. To what extent would you say you have enjoyed the course so far?
8. To what extent have vou found the course useful so far?

Piloting of the interview process.

I asked three of my 2012 students for permission to interview them about their experiences of my teaching of a method course. This was the first time for me to do interviews. One important attribute an interviewer of unstructured or semi-structured interviews should have is the ability to elicit ideas from an interviewee (Trumbull, 2012), otherwise the interview may not yield as much information as one would want. My first interview did not yield as much information as I would have wanted. It sounded unnatural as most of the students' answers were brief. Both the student and myself were not relaxed. Although, a semi-structured interview allows for probing, I found it very difficult to probe as it felt like I was looking for certain responses from the students and the student at some point seemed to have held back some responses because she felt that I knew what I was asking her. For example when I asked the student the first interview question, the student's response was:

Student: The lecture starts with a short PowerPoint presentation followed by some activities.

To probe further, I asked: What kind of activities?

Student: Like planning.

I then asked: What were you planning?

Student: Ha ma'am, like the grade planning where we had to plan grade level teaching for the whole year

The way the interviewing was proceeding seemed like I was putting the student on the spot, interrogating her to see if she could remember what we had done. I was failing to avoid what Trumbull (2012), described as turning the interview into a session of teaching and testing as the student's last response felt like she was saying 'why are you asking that when you know what we did'. In the second interview, I decided to interview two students at the same time. The atmosphere was more relaxed. A response from one student would seem to trigger or remind the other of the events pertaining to the question asked. Every now and then however, the students would respond in a way which implied that I was asking what I knew. Therefore, at the end of the two pilot interviews, I made the decision that it would be better for the interviews to be group interviews and that they should be done by a person who does not know what happened in the lectures so that students would see the need to give detailed responses. There is reference to this approach of group interviewing in qualitative research literature (Cohen et al., 2000) but I have not come across any self-studies in which this approach was used. I discussed the results of my pilot interviews with Virginia. Virginia then suggested that I needed to problematize the issue of self as the researcher against using someone else to collect the data. I have already highlighted above why it was problematic for me to carry out the interviews. In the light of Virginia's suggestion, I described below the steps that I took as the researcher to minimize the possible problems that someone else and not the researcher was collecting data.

What literature says about group interviews

Group interviews are a type of interview where there is a backward and forward interaction between the interviewer and the group. The interviewer asks questions to the group members who in turn respond to the questions (Cohen et al., 2000). I chose to use group interviews because as discovered in the pilot exercise, interviewing two students together had helped the students to relax and their responses acted as reminders of the lecture events for each other. Literature also highlights a number of advantages for doing group interviews. According to Bogdan and Biklen (2007), group interviews can generate a wider range of responses than in individual interviews. Group interviews can also bring together people who hold varied opinions or maybe "representatives of different collectives" (Cohen

et al., 2000, p. 287). In my case, group interviews were going to bring together students who were representative of the diverse groups in my classroom. On a practical note, group interviews were going to be quick as they allowed the interviewing of many students simultaneously. I was aware of the disadvantages of group interviews which included the need for skilful interviewing, difficulties that may arise if personal matters emerge and problems of coding (Cohen et al., 2000). I however felt that the advantages outweighed the disadvantages because firstly, I had made a decision that I was going to seek the services of an interviewer who was experienced in doing group interviews and therefore was competent enough to effectively execute the job. Secondly, I did not anticipate personal matters to arise as the interviews were not about personal matters. The interviews were on a phenomenon that the students had all participated in which was my teaching of the genetics course. As far as coding was concerned, I had read literature that had given me ideas on how I could go about coding group interviews (e.g. Rabiee, 2004).

Organizing the interviews

To get unbiased insights into students' experiences, consent for doing the interviews was sought from the whole class of 91 students. I then made a list of all the students who had consented to be interviewed. I hired a research assistant (Dorothy) to conduct the interviews. Purposeful sampling of interviewees was done. I chose to have purposeful sampling done so that I would have participants who were representative of the diversity of students in the course in terms of gender, race and ability. Students' marks in the course were used to determine the ability levels. For purposes of anonymity, Dorothy did all the steps that I have described above. A total of 33 students were picked up from the list. Of these 33 students, 13 were eventually interviewed. Twelve of the students were interviewed in groups. One student was interviewed alone. The student was interviewed alone because she was not available at the times that other students had indicated their availability. (See Appendix B for details of the interview participants). To keep up-to-date with the planning of the interviews, Dorothy updated me on every step.

The interviews

After having sampled participants who would be representative of the diversity in the genetics class from the initial list, Dorothy then set-up the dates and the times for the interviews and carried out the interviews (See Appendix B for the dates and times of the interviews). The interviews were audio-recorded. To uphold student anonymity as I had promised, I also asked Dorothy to do the transcription of the interviews for me. Therefore,

what I got from Dorothy were the interview transcripts. I have no idea of who the 13 students were who were eventually interviewed. (See appendix B for students' pseudonyms).

3.10 Validity and reliability

According to Cohen et al. (2000), validity and reliability are multifaceted concepts. In addition, there are many different types of both validity and reliability making it difficult to define the concepts. For example, Cohen et al. (2000); Cohen, Manion, and Morrison (2007), identified 18 types of validity and Samaras (2011) listed a dozen types of validity. Below I discuss the concepts of validity and reliability in qualitative research and in self-study research.

Validity

Validity is a key aspect in research and therefore an important requirement in both quantitative and qualitative research. This is because if a piece of research is considered invalid, it is worthless (Cohen et al., 2007). As said earlier, the concept of validity is difficult to define. While earlier definitions of validity in the literature looked at validity as a demonstration that a research instrument measures what it purports to measure (Cohen et al., 2007; Opie, 2004b), Scaife (2004), argued that validity should be seen as the *relationship* between a claim and the result of a data-gathering process rather than looking at it in terms of the measuring instrument, the results or the claims in isolation (emphasis original). How Scaife views validity is similar to how it is viewed in self-study research in which validity refers to the 'trustworthiness' and 'usefulness' of the claims made based on the scope of the collected data. According to Cohen et al. (2007), research can not be 100 percent valid. This is because opinions, perspectives, attitudes and subjectivity of respondents in qualitative research, all contribute bias to the research. Validity should therefore be viewed at as a matter of degree rather than an absolute state and what we should strive for is to minimize invalidity and maximize validity (Cohen et al., 2007). In self-study validation is achieved when the results of a study come to be viewed as sufficiently trustworthy for other researchers to rely upon in their own work (LaBoskey, 2004). While in qualitative research, validity can be addressed " through honest, depth, richness and scope of the data achieved, the participants approached, the extent of triangulation and the disinterestedness or objectivity of the researcher" (Cohen et al., 2000, p. 105; 2007), in self-study, validity rests on the presentation of the actual practices, the data gathering methods, the observations and the interpretations in enough detail that the relevant community can

judge trustworthiness and usefulness (LaBoskey, 2004). LaBoskey asserts exemplar-based validation whereby concrete documents and examples of practice are presented as exhibits for evaluation of validity.

Samaras (2011), suggested practicing what she called **dialogical** and **public** validity as one way of addressing the issue of validity in self-study. According to Samaras, dialogical and public validity is when you work with your critical friend as is required in self-study then get another dyad of critical friends as a validation group. The critical friends get to be involved in the research as a validation group when you present the steps that you have taken as a researcher to address issues of validity. In this study, I considered suggestions by both Samaras and La Boskey to address the issue of validity including presenting my research process to the relevant community at intervals using the checklist in Samaras (2011, p. 220), as a guide. Below is a description of how I established trustworthiness in my study.

Processes of validation for my study

There are a number of platforms that are organized by my institution to promote interaction between PhD students, supervisors and other senior researchers from the school, from other institutions within South Africa and internationally. I made use of these platforms to address issues of validity in my study. I describe these platforms in some detail below.

PhD weekends: At my institution, there is a programme that is called *PhD weekends* that run from Friday afternoon to Saturday afternoon. The PhD weekends are organised quarterly to allow PhD students to present their work to fellow PhD students and to supervisors for critical feedback. As a PhD student, it is also a requirement to present first your proposal, then your ongoing work at least once a year throughout the duration of your study. One can present more than once according to need and interest. The Wits University's School of Education also has in place a requirement that a supervisor appoints two senior researchers to read a candidate's proposal for critical feedback before the proposal can be submitted for candidature. I made use of this platform to practice dialogical and public validation of my research. For example, two critical readers appointed by my supervisor read my proposal which outlined my whole research design. I then presented the proposal to an audience at a PhD weekend. The feedback was quite extensive and useful. One critical suggestion from critical readers was that I should interview students to find out their views of my teaching as a way of triangulating my data sources instead of relying on just my analysis of video-recordings. I therefore, incorporated that interview suggestion in my research design.

Discussion with renowned researchers: At every PhD weekend, there is an invited guest, a visiting scholar who is a renowned researcher. The visiting scholar is invited to do a plenary session and a workshop based on his or her work and to interact with PhD students. I was able to present my work to four of these researchers for critical feedback two of whom are in the field of both PCK and self-study. I got subtantial feedback through this process. The meeting with the first researcher was at the proposal stage, the meeting with the second researcher was during the data collection phase and two meetings were during data analysis and writing of my thesis.

Southern African Association of Research in Maths, Science and Technology Education (SAARMSTE) Research School: Research schools are one week long events that are organised by SAARMSTE once every year for PhD students in the fields of Maths, Science and Technology education from universities in Southern Africa. At these events each PhD student is assigned a Mentor who reads his/her work and gives critical feedback during the week. The PhD students also present their studies in the form of posters which are displayed throughout the week. Time slots are allocated for fellow PhD students and other mentors to give feedback on the work presented on the posters. I presented my work for validation at these annual Research Schools from 2011 to 2014.

Conferences: In addition to presenting my work at PhD weekends, and at Research Schools, I also presented a paper at SAARMSTE conference on my research design in 2012 and on learning to become a teacher educator at the American Educational Research Association (AERA) conference in 2013.

Writing retreats: The faculty of Humanities organises a number of writing retreats that run from Monday to Friday on scheduled periods. These writing retreats are organised for members of staff who are working on journal articles or book chapters and for PhD students. During the writing retreats PhD students are assigned mentors who are senior researchers in the faculty to read their work and to provide feedback. I attended three of these writing retreats in 2014 as I was busy with my analysis and writing of my thesis. The mentors acted as the 'other' validation group of critical friends (see section 3.10.1 above).

The platforms above provided ideal spaces for dialogic and public validation of my work. I present a summary of these dialogic and public validation processes in Table 4 below.

Table 4: Catalogue for the public validation process

Stage of my research	Validation platform (At the University of Wits unless otherwise stated)
Planning the research	Research school June 2011 (Tshwane University of Technology)
Writing my proposal	SAARMSTE conference (University of the Western Cape) January 2012
Proposal presentation	PhD weekend (March 2012. Meeting with a renowned researcher
Presentation of the revised proposal	Research School June 2012 (University of Kwazulu-Natal)
Piloting methods of data collection and validation process	Practice-based research seminar at Stellenbosch university (Oct 2012)
Data collection and preliminary analysis	PhD weekend (March 2013)
Preliminary data analysis and presentation of findings	American Educational Research Association (AERA) conference April 2013 (San Francisco)
Discussion on the different forms of data that I collected	Research school June 2013 (Cape Peninsula University of Technology)
Code checking and discussion of interview data	Research school June 2014 (Central University of Technology)
Writing retreat with a senior researcher as a mentor	September and October 2014

Dialogical validation with critical friends: Dialogue with critical friends was a continuous process throughout my study. We discussed my planning of the course and of my lectures. We discussed my observations during my teaching and my reflections. We discussed my actual teaching, students' interviews and my data analysis and findings.

I have listed all the people who critiqued my work in Appendix A.

Triangulation

Triangulation is a way of addressing validity issues in qualitative research and was defined by Cohen et al. (2007, p. 141), as "the use of two or more methods of data collection in the study of some aspect of human behaviour". Denzin (1970) referred to the use of two or more methods of data collection as methodological triangulation and went further to identify other types of triangulation such a time, space, investigator and theoretical triangulations. In this study, I employed two types of triangulation, namely, time triangulation and methodological triangulation. Explanations of the other forms of triangulation are beyond the scope of this study. Just as in qualitative research, triangulation of data collection methods is also a way of addressing validity issues or trustworthiness in self-study research.

Methodological triangulation: In self-study, methodological triangulation is the use of multiple and varied data sources (Samaras, 2011). The multiple sources of data that I used were described in section 3.8 above. There was data in the form of journal entries, video and audio-recordings, discussions with colleagues and with critical friends. Methodological triangulation was done to increase the trustworthiness of my claims. I considered that similarities in the descriptions of students' experiences of my teaching to what would be observed in the video-recordings of my lectures would increase the trustworthiness of my claims. If for example students would make references to the use of T/L aids, the video-recordings should show evidence of the use of T/L aids. To further increase the trustworthiness of my findings, the data from the multiple sources was also exposed to critical friends for scrutiny and validation. I exposed my data to critical friends because in self-study multiple perspectives are a strong validator of the findings (Samaras & Freese, 2006). I also provided exemplars of audio transcripts in my study as evidence for the validation of the claims that I was making. I also described in detail everything that I did and why so as to bring to light the complexity and context of the situation under study.

Time triangulation: Time triangulation is when data is collected within a short space of time and over time to check similarity of data gathered in the same time and the stability of observations overtime respectively. I want to acknowledge here that it was not in my initial plan to do time triangulation. It was an opportunity that presented itself and I used it. The opportunity for time triangulation came when Dorothy was organising times for the interviews. As can be seen in Appendix B, three groups of students were available for interviewing on the same day 22 April 2013. The fourth group was only available two weeks later on May 6, 2013 and the last group a month after the fourth group on 3 June 2013. Instead of negotiating with the students for an earlier date, I saw this as an opportunity for time triangulation because if there was similarity in students' responses to the semi-structured interview questions in the same time (22 April 2013) and over time (6 May and 3 June 2013), then that was going to increase the trustworthiness of my claims. For example, the first interview question was: Describe a 'typical' genetics lecture session. All students attended the same lectures. Therefore, I would expect their descriptions to include similar aspects in the same time and over time. The second interview question was: Have you encountered formats other than a 'lecture'? I again would expect students in the different groups to identify and name same formats in the same time and over time (see section 7.2 for the results of this time triangulation).

3.10.2 Reliability

Reliability is defined by Scaife (2004) as "the extent to which a data-gathering process produces similar results in similar conditions" (p.68.). In self-study however, the concept of reliability is not considered separately from validity as the focus is to ensure that the claims from a study are trustworthy and useful and the measures that are taken to ensure trustworthiness of claims include reliability checks such as collaboration, dialogue and critique. As part of collaboration, dialogue and critique, I did check coding of my videos with Georgia and interview transcripts with California and Virginia. Check coding is the coding of same data sets by two researchers after which the two researchers discuss initial difficulties and any other issues arising from the coding process (Miles & Huberman, 1994). I did check coding when I was analysing video transcripts of my teaching and interview transcripts.

3.11 Generalizability of my research

Generalizability refers to the extent to which the findings from one's study can be applied to other contexts (Maxwell, 2005). In self-study, conditions for generalization include collaborative inquiry where the research is reviewed with critical friends and making the knowledge that is generated public through presentation and publication (Samaras, 2011). Presentations allow wider interaction with colleagues and the relevant community. This wider interaction does not only allow validation of the research process and findings but also provides a platform where colleagues are able to link the researcher's experiences and ideas with their own. The ability by colleagues to link the researcher's experiences and ideas with their own is a form of generalization in self-study research. Therefore, the validation processes that I carried out in my study as described in section 3.10.1 above allow for claims to generalizability of the research findings.

3.12 Data analysis

In self-study, data collection and data analysis are not linear processes whereby you collect data first then do data analysis after, rather preliminary data analysis occur concurrent with data collection. Samaras (2011, p. 197) described this characteristic of self-study as a hermeneutic process: *a dance of data collection and data analysis.* In this study therefore, data collection and preliminary data analysis happened concurrently and as a result the data was embedded in the descriptions and explanations of my findings which are presented in chapters 4-7. In the next sub-section, I describe briefly the different forms of data that were collected in this study and the analysis process. Detailed forms of the data and the analysis

processes are presented in chapters 4-7. The different forms of data include narrative texts, video and audio transcripts.

3.12.1 The narrative texts

The narrative texts contained descriptions and explanations of my planning, my observations during lectures and my experiences. Data was embedded in these descriptions and explanations of my experiences. To analyse my planning texts, I used three of the four components of my conceptual framework as explained in section 2.10 i.e. teacher educator's beliefs, teacher educator's domains of knowledge and teacher educator's pedagogical reasoning and action. The details of my planning texts are presented in chapter 4.

The narrative texts also include some observations and experiences of my teaching which I have described as **trigger incidents**[7] (TIs). The observations that I describe as TIs are events that activated something in me such as thoughts, feelings and emotions that initiated a response and also prompted me to reflect on what was happening during my teaching of the genetics course. Some of the incidents happened during lectures and others outside the classroom as I was interacting with the students. I have coined the term **trigger incidents** to bring out the idea that the events activated something in me that initiated a response. The analysis of the TIs included the following steps:

Step one: Description of the TI. The first step was to describe each incident in enough detail and as impartially as possible. Impartially means without offering an explanation, a justification and without using emotive terms (Mason, 2002). Describing the TIs in detail and impartially was necessary to help my critical friends first to understand the incident as it happened and second for them to be in a position to analyse it without due influence from my description.

Step two: Documentation of my reflection. The second step was a documentation of my reflection on each incident. My reflections were descriptions of my experiences of the incident (feelings, thoughts and evaluations).

[7] Garbett (2012, p. 34) used the word triggering incidents. She did not however explain what she was referring to as a triggering incident and what it was triggering. Therefore, my meaning of trigger incident is likely to be different to that of Garbett.

Step three: Presentation of the incident to a critical friend. The third step was a presentation of each incident to a critical friend followed by a discussion of the friend's comments and my reflections on the incidents.

Step four: Documentation of the results of the discussion with the critical friend. The last step was a documentation of my thoughts in response to the critical friend's comments on each incident.

I presented these TIs and the findings from the analysis of the TIs in chapter 5. Because the journaling and the analysis of the TIs happened concurrently, I implemented in the course a number of changes that were influenced by the findings from the preliminary data analysis. For example, after TI two, I stopped focusing on discussion only during my lectures and allowed students to think in silence or to draw as a way of assessing and consolidating their understanding. After incident three, I introduced flash cards and so on.

3.12.2 The analysis of lecture transcripts

The purpose of video-recording my lectures was so that I could present with evidence what happened in my lectures to my critical friends and to the relevant community. Video-recording my lectures also served to triangulate my data sources. The analysis of the video-recordings happened in four stages. I describe these stages next.

Stage one: Transfer of the video-recordings to other media devices for safe-keeping and for back-up. The first stage involved me downloading the recording to my personal computer, to an external hard drive and to two compact discs (CD) for safety and backup and to free the video camera memory. One CD was for the transcriber and the other one for back-up storage purposes.

Stage two: Familiarisation with the data (Rabiee, 2004). Familiarisation was achieved by watching the videos of my lectures soon after or as near as possible to the recorded lecture. I watched most of the videos on my own and on two occasions with a critical friend. Due to time constraints, my critical friend was only able to watch the shorter 1h video lectures. I want to acknowledge here that watching the videos with my critical friend was not an easy thing for me to do. I remember telling California how uncomfortable I was after inviting her to watch the videos of my teaching with me. California then said, *I am not interested in what was good or bad because that kind of critique is what makes us not to like other people to*

look at our own teaching. What is important is; what were the reasons behind what you did? What were you thinking when you did what you did?

Watching the videos allowed me to see if I had been able to follow through my thinking and planning as described in chapter four. In addition watching my own teaching helped me to evaluate the teaching and to make informed decisions on how to proceed in the following lectures in a way that would improve my teaching. I described one decision and change that I made in trigger incident four in chapter five where I had to rework on my response to a student's question in a previous lecture by responding to the question again in the next lecture using some visual aids.

Stage three: Transcription. All videos of my lectures were transcribed by an independent transcriber. The transcriber only transcribed the audio not the video. I watched the videos myself and noted important incidents. I would send the CDs with the recordings of the weekly lectures to the transcriber at the end of the week, Lectures on the following topics were recorded and transcribed: Genetics at molecular level, meiosis, genetic diseases and genetic inheritance. These topics were taught in four of the six weeks of the course. The topic of genetic testing and counselling involved mainly student activities such as group work, poster and oral presentations and was therefore not video-recorded as I had not sought consent for video-recording students. In total 12 hours of lectures were recorded and transcribed. The transcriber was not a biology person. Therefore, I supplied her with the PowerPoint presentations of every lecture so that she could familiarise herself with the vocabulary of the audio texts that she was transcribing. After receiving the transcripts back, I would go through each transcript and concurrently watch the video to fill in the gaps and to add screen shots to bring the transcripts to life.

Stage four: Coding of the lecture transcripts. To code the lecture transcripts, I started off with what Berry and van Driel (2013) described as a priori system of codes or categories about teaching from the literature and from my conceptual framework. The codes and categories are shown in Table 5 below and are described in detail in chapter 6.

Table 5: My initial coding scheme for analysing my teaching

Knowledge of context	Knowledge of students	General pedagogical knowledge	Content Knowledge
-**My context**-Anything in my teaching that points to my awareness of context e.g knowing that the university has e-learning or knowing the acoustics of big venues like a big lecture theatre. -**My students' context**-anything in my teaching that points to my awareness of my students' future teaching contexts	-Any reference to **misunderstandings** that students are known to bring to class about genetic phenomena. -Any reference to **misconceptions** that my students and my students' students are likely to bring to class Evidence of awareness of students' -**learning styles** -**linguistic abilities** -**cultural backgrounds** -**schooling backgrounds**	-**Teaching strategies (TS)** **-Teaching procedures (TP)** **-Teaching activities (TA)** **-Teaching and learning activities (TLA)** e.g. drawing, discussing **-Teaching and Learning Aids (T/L aids)**	**-Specialized content knowledge (SCK)** **-Common content knowledge (CCK)**

I struggled to code the audio transcript because I found the audio transcripts to be too bulky. A whole page could be taken up by just one teaching and learning activity and therefore one code such as a question & answer (Q & A) discussion. Sometimes one aspect of my teaching was intermingled with other teaching aspects. For example, I had cases where within a Q & A discussion, I would explain a concept or show and describe an analogy. I therefore decided to reduce the bulkiness of the audio transcripts by doing a step by step description of my lectures using both the audio transcripts and the videos. Therefore, instead of having a whole page of a Q & A discussion, I would just have one sentence saying whole class Q & A discussion taking place. Below is a section of the processed and coded transcript of lecture one.

An example of processed and coded transcript data

1. Lecturer put up some questions on the screen at the beginning of the lecture. **(Teaching Procedure-TP/TS)**
2. Lecturer explains the purpose of the questions (T**A)**
3. Lecturer gives instructions to students to discuss the questions (**TA**)
4. Students discuss the questions **(LA)**
5. Lecturer puts up a picture on the screen- **(T/L aid)**
6. Lecturer invites students to look at the picture and asks them to say what they can see-(**TLA/LSI)**
7. Lecturer takes responses from students and writes them on the chalk board-(**TLA/LSI)**
8. Lecturer repeats the question and waits for more responses-**(TLA/LSI)**
9. Lecturer moves on when no more responses are forthcoming-she **describes** in detail what the picture is showing-reproduction, meiosis, mitosis etc (**TA)**

10. Lecturer **explains** how what is happening in the picture including what students said is linked to the genetics that will be done in the course- (**TA)**
11. Lecturer introduces a concepts biological inheritance through a question that she puts up on the screen **(TP)**
12. Whole class Q and A discussion (**TLA/LSI)**
13. After the discussion, the lecturer explains the answer to the question **(TA)**
14. In her explanation, lecturer points out one of the things that makes genetics difficult to teach and to learn- terminology **(SCK)** and emphasises the importance of students as future teachers to understand that terminology- (**Knowledge of context)**
15. Lecturer spells out one of the aims of the lecture-**TA**
16. Lecturer puts up on the screen an outline of the structure of the science of inheritance **TA**
17. Lecturer goes through the slide explaining the structure of the science of inheritance **(TA)**. In her explanation, she points out the content that was covered in the previous course that the students did, the content that will be covered in future courses and spells out the content that will be covered in the genetics course- (**Curricular saliency-CS)**
18. Lecturer introduces an **analogy** of loose string and a ball of similar string-**T/L aids, TA**

The lecture one transcript section above shows how I eventually processed and coded my video transcripts of the lectures. The processing of video data was a time consuming process. I finished the video-recording of my lectures at the end of April 2013 but eight months later (end of 2013), I was still processing the data. After video processing, I coded the transcripts. Although the coding was guided by the codes in Table 5 above, I was open to new codes making the coding process both deductive and inductive. As part of the validation process, I asked Georgia to read through the transcripts of two lectures and to comment. I gave her only two transcripts as my plan was that, I would ask her to look at more transcripts only if there were disagreements that required further checking. After she had coded and commented on my teaching of the two lectures, we then met and discussed her observations and the analysis.

3.12.3 Analysis of interview transcripts

As explained in section 3.9.5, what I received from Dorothy the research assistant who did the interviews were the audio transcripts of the interviews and the details of the interviewees excluding their real names. To analyse the interview transcripts, just as with the analysis of video transcripts, I started off my analysis of students' interviews with a system of codes and categories that I had developed in chapter six from the analysis of my teaching transcripts. The codes and categories were however not aligned to the interview data. Therefore, I abandoned the codes and categories from chapter six and did inductive coding. Just as with the analysis of my teaching, I did the analysis of interviews in steps. The first step was familiarisation with the data. The second step was the coding process and formation of the categories. The last step was the interpretation and discussion of the findings. As part of the

validation process, I asked California to also code the five interview transcripts. She managed to code only three of them due to time constraints. We then met and discussed our coding to iron out any difficulties. The detailed description of the analysis of students' interviews and the presentation of the findings is in chapter seven.

3.13 Ethical issues

Educational research is by people, with people and for people (Sikes, 2004). Therefore, there are issues of ethics that need to be considered when one is doing educational research in order to protect and respect all those who are likely to be impacted by the research. My research was a self-study. Being a self-study, I was both the researcher and the teacher responsible for making the decisions of what was going to be enacted in the classroom. As argued by Mitchell (2004), teaching involves doing that which aims to improve students' learning. To improve students' learning one need to be aware of what is happening in one's classroom, evaluate it and make necessary changes. Being aware of what is happening in your classroom is a form of data collection and evaluation and making decisions to implement some changes involves an interpretation of what is happening. Therefore, doing a self-study is about studying what happens in one's daily life as a teacher or teacher educator. That being the case, there is little or no risk that is anticipated in many self-study projects. I was also not anticipating any risks of harming others (students, colleagues or the institution) in my self-study as I was studying what was happening or not happening in my teaching with the aim of improving my teaching of pre-service teachers. However, as insisted by Mitchell, I still needed to demonstrate that I was aware of and had considered in my planning of the research, the ethics related to my study.

The ethical issues related to my study that I could identify were at every stage from design to implementation and to reporting. I therefore needed to demonstrate the ethical responsibility of protecting and respecting all those people who were going to be involved throughout the study (Samaras, 2011; Sikes, 2004). To demonstrate this ethical responsibility, I sent my proposal to the University's ethics committee for ethics clearance with a full description of the ethical responsibilities that were associated with my study. However, as noted by Cohen et al. (2007) it was not possible for me to provide full information on all the aspects of my study to the ethics committee at the time of application or to the participants at the beginning of my study as I did not know everything about my investigation then. For example, I did not know what would be the dates, the times and the venues for the interviews. In such cases therefore, I was applying ideas from literature that offer participants protection and respect.

Therefore, some of the steps that I describe below are the steps that I eventually took during the course of the study but were not included in my ethics application or consent forms. The study got ethics approval shown in Appendix H. The topics that I considered in my ethics application were:

Informed consent - I shared my intention with my colleagues, the students and critical friends then requested their informed consent for participating in the research. My intention was to investigate my own teaching and students' learning with the aim of improving my teaching and their learning. I invited colleagues to critique my teaching documents like course outlines and to come and observe and critique my lectures. Critical friends were involved in critiquing my study from designing to data collection and data analysis (See Appendix K for the information sheet and the informed consent forms). The dilemma that I faced here was that the teaching of the genetics course was the field of study. Therefore, all the students who were registered for this course were by default participants in the research. I protected those students who did not give their consent by not involving them in the data collection processes such as the journal entries of my observations and interviews. What I was not able to do was not to capture their audio responses in the video-recordings of my lectures. To protect these students, all students' responses remained anonymous in the audio transcripts.

Confidentiality - I took all the necessary measures to ensure that the sources of information in the study were not disclosed without the permission of the participants. Therefore, although students were interviewed, I did not disclose the identities of the interviewees.

Sensitivity to established policies and activities - I made an undertaking in my application to adhere to the institution's policies and guidelines for conducting the research which included seeking permission to do the research during the normal teaching of my course from the Head of school (See Appendix J).

Participant withdrawal - I made it clear to participants in both the information sheets and the informed consent forms that the students had the right to withdraw from the research at any time.

Anonymity - I used pseudonyms to uphold the participants' right to remain anonymous. The video-recording focussed on myself the practitioner only and not the students to protect students' identity. I disclosed to the students that those who were going to be interviewed were going to remain completely anonymous.

The interview process - As part of respecting participants, it is important to consider the amount of time that a research procedure will take (Samaras, 2011). I therefore only asked students for their consent to participate in the interviews close to the time of the interviews when I had full information about the approximate amount of time that the interviews were going to take.

Appreciation and gratitude - As a sign of respect and appreciation, I expressed my gratitude to the students at the end of the course.

Dialogue with critical friends - To be considerate to my critical friends, I factored in time constraints in my research plan so that my critical friends would be able to accommodate my feedback needs without impacting their heavy workloads. For example, I was sending meeting request well in advance of the time for the feedback meetings.

Dialogue with colleagues - As said earlier, I involved colleagues in critiquing my work and also in my search for teaching ideas. In order to respect their busy schedules, I had to first find out what would work with individual colleagues when I was in search of teaching ideas. What eventually worked was to go to their offices and just ask them for a few minutes. As for Georgia who critiqued my teaching, I provided her with CDs of my lectures so that she could observe and critique them in her own time.

Writing up - According to Sikes (2004), traditional research reporting has a tendency of making the process to be neat and unproblematic but research is rarely like that. Therefore, I described in detail all the stages of my study as an ethical responsibility to researchers who are going to follow after me so that they can see and appreciate the complexity and problematic nature of research.

Communicate - As stated earlier, research is done by people for the people. Therefore, as a responsible educational researcher I was going to communicate my findings to relevant research populations and other stakeholders through conference presentations and publications.

3.14 Conclusion

In this chapter, I have described my research design and the research approaches that have influenced the methodology of self-study. I have also described in detail, the methods of data collection that I employed in the study. I described in brief the data analysis process as I

described it in detail in my results chapters. I could not separate data analysis from the presentation of the findings as I needed to embed the data in the findings as much as I could as part of the validation steps. In chapters 4-7, I present my data and findings from the study.

Chapter 4: Planning my teaching: A basis for professional development

4.1 Introduction

According to the PCK literature that I reviewed in chapter two, a teacher must possess four domains of knowledge as a basis for effective teaching. These knowledge domains are knowledge of context, knowledge of students, pedagogical knowledge (PK) and knowledge of content. In line with what I had come to understand about teaching pre-service teachers, a teacher educator must have the four domains of teacher knowledge at two levels, that is for knowledge of context, I needed to have knowledge of my context and of my students' future context. For knowledge of students, I needed to have knowledge of my students and knowledge of my students' students. For knowledge of pedagogy, I needed to have the pedagogy for teaching pre-service teachers and for teaching in schools and lastly for knowledge of content, I needed the knowledge of content for teaching pre-service and the knowledge of content that pre-service teachers will need for teaching in schools. Therefore, it was important for me to make sure that I had adequate knowledge of each of the four domains of knowledge at the two levels prior to my teaching as possession of that knowledge was going to influence what was going to happen in my classroom and in my study.

In this chapter, I describe the planning that I did for my teaching which was a process that I undertook to develop my knowledge for teaching pre-service teachers. I used the four domains of teacher knowledge to guide my planning. I will therefore use these domains as a structure to describe what I did to improve my knowledge for teaching pre-service teachers. Throughout the planning process, I would reflect on my current practice in the light of the knowledge I was gaining so that I could learn from what I was doing. In this chapter therefore, I also present my reflections and what came out of those reflections. What I present in this chapter will help me to answer my first research question: *What knowledge should I have as a teacher educator in order to effectively teach genetics, a content course to pre-service teachers?*

The steps that I took to improve my knowledge for teaching pre-service teachers resulted in me gaining more knowledge about my practice as a teacher educator. I therefore see what I did as a form of professional development (PD).

4.2 Knowledge of context

The two knowledge levels under knowledge of context that I needed as a teacher educator are knowledge of **my** context which in my case was the Wits school of education and its programmes and the knowledge of **my students'** context which are the schools. Below I describe how I gained and improved my knowledge of each of these contexts.

4.2.1 My context

As described in chapter one, my context was Wits University's School of Education where we train pre-service teachers through a four year Bachelor of Education (BEd) degree programme. What did I need to know about this context in order to effectively teach?

I envisaged that I needed to know the aims and objectives of our BEd programme. I therefore asked the Head of the BEd programme for a document that outlines the aims and objectives of the programme. This was in August 2012. The document that I was given was titled: *A Vision for a B.Ed Graduate: what kind of teachers for South Africa do we want to produce at Wits?* It was the first time I had seen this document. From the document I gained knowledge about our BEd curriculum; both the lateral curriculum and the vertical curriculum structures (see section 2.3.2 for definitions of lateral and vertical curricular). Knowledge of the BEd curriculum was important for my teaching and for my study as it gave me ideas of the knowledge that my third and fourth year students would bring to the genetics class about science and about teaching. From the same document, I also got to know about the kind of teacher that we want to produce from our programme. This information was very insightful for me and it became a reference point in all my teaching. The information was insightful in the sense that it gave ideas on some aspects of teaching and learning that I needed to consider in my own teaching. For example the document says that at Wits we would want to produce teachers who understand the history and contexts of the communities in which they work. To me, the implication of this statement was that as teacher educators at Wits University, we were expected to have the knowledge of our students' future contexts and to teach them and make them aware of their future communities. I therefore needed to consider this information in my own teaching if I had to contribute to the achievement of the university's aims.

My reflection: *For me, a description of the kind of teacher that we want to produce should be the goal of everything that we do in the BEd programme and should guide us in all our teaching. The goal therefore, should be known by all stakeholders and should be one of the things that new staff members are made aware of as part of their induction. I only got to know about the goals of our BEd programme through this planning which I did as part of my study. In this regard therefore, this planning which was part of my self-study became a form of my own induction and professional development.*

4.2.2 My students' context

The second context that I needed to have knowledge of was my students' future contexts i.e. the schools. The bulk of the background knowledge of schools that I had was obtained in Zimbabwe where I come from. In the five years that I had been a teacher educator in South Africa, I had also gained knowledge of South African school contexts through visits to the schools during teaching experience practicals, through the media and informally through discussions with colleagues and with students. The knowledge of South African schools that I gained from these sources had shown me that the South African school contexts were not very different to the Zimbabwean schools. For example, in Zimbabwe there are rural schools, urban schools and private schools (both urban and rural) and township schools. Schools can also be grouped into well-resourced and poorly resourced categories. This is also the case with the South African schools context. I therefore used my experiences of being a high school teacher, to visualize the future contexts of my students which were basically the schools where they would teach after qualification. I describe these contexts in terms of location and resource availability. The school contexts in terms of location can be urban or rural. In terms of resources, the schools can be well-resourced or poorly resourced. Knowledge of these contexts was important for me as a teacher educator. This is because as teacher educators, we should anticipate that our students are going to teach in any one of these contexts after qualification and make it our goal to develop in our students, competencies and skills for teaching in any of these different contexts.

My reflection: *When I reflected on the knowledge of school contexts that I have described above, I realized that it was not going to be a challenge for me to consider all these contexts in my teaching. This is because as narrated in my autobiography in chapter 1, I have experienced all these contexts in my life as a child, as a learner and as a teacher. I however wondered about teacher educators who have never been exposed to some of these contexts; for example teacher educators who have never been to a rural school. Where*

would they gain the knowledge of these school contexts which is important for effective teaching of pre-service teachers?[8] *Can PD for teacher educators be a solution in this case? Can literature help?*

4.3 Knowledge of students

According to Rollnick et al. (2008), knowledge of students includes knowledge of students' prior knowledge, their learning styles, linguistic abilities and interests and aspirations. I also think that knowledge of students' sociocultural and schooling backgrounds is also important. My life experiences and my experiences of teaching a multicultural[9] class which is characteristic of our classes at Wits University have shown me that a teaching activity that you may think will promote understanding of a concept may actually hinder meaningful learning in some students. The problem would be due to different levels of content knowledge and in some cases due to cultural differences and poor proficiency in English. The above list of what we need to know about our students for us to teach effectively is not exhaustive. Below I discuss some of the examples in the list above to show what I did to improve my knowledge of students and of my students' students.

I first looked at students' prior knowledge. I considered that the first type of prior knowledge that my students and my students' students would bring to class would be the ideas that they would have built up from their environment about the topic; what Shulman described as *the* "conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons" (1987, p. 8). So I went back to research literature on the teaching and learning of genetics to identify some of the conceptions and preconceptions that students have been seen to bring to class about genetic phenomena. The ideas that students bring to class that I identified from literature will be described in the section under knowledge of content. I decided to describe them together with content knowledge because knowledge of these ideas influences the content knowledge that I need to know and emphasize in my teaching.

[8] I posed a number of questions as part of my reflections in this chapter and elsewhere. I will re-visit these questions in my concluding chapter

[9] I am using the word multicultural to mean diverse student population in terms of gender, social class, schooling background, ethnicity, race, language or culture.

The second type of prior knowledge that I thought my students would bring to class is the knowledge that they would have gained through high school teaching. Some of that knowledge would be scientifically acceptable and some of it would be scientifically wrong. I read through the Curriculum and Assessment Policy Statement (CAPS) document which is South Africa's national syllabus and the Independent Examinations Board (IEB) which is the syllabus that is used by private schools in South Africa. This was to familiarise myself with the content knowledge of genetics that the students are likely to have from their high school learning. I was aware that some of the students who choose to do Life Sciences as their major or sub-major would not have done Life Sciences in high school. I considered that these students would not have any formal knowledge of genetics from their high school learning.

Having knowledge of students also means knowing their learning styles. The third year life sciences group is a relatively big group of about a hundred students. Therefore, knowing each student's learning style is a big challenge. I therefore decided that what I needed to know were the different learning styles that are described in the literature. Then in my lectures I would use teaching styles that cater for a variety of these learning styles (see section 2.12 for a detailed description of teaching styles).

Students' linguistic challenges were something I was already aware of. English is the official language of instruction at Wits University but it is not the home language for the majority of the students. From my previous experiences, I was aware that inability to speak English was hindering some students' full participation in discussions during lectures and tutorials and that lack of proficiency in the language of instruction was negatively impacting their academic success in tests and examinations. Some students would neither ask nor answer questions during lectures or tutorials for fear of being laughed at because of their poor English proficiency. I therefore had to think of ways of helping students to overcome that challenge in my lectures. In addition to English language challenges, there is also a huge amount of terminology that students of genetics need to know and understand in order to understand genetics. Bahar, Johnstone & Hansell (1999) found out in their study that terminology was as a source of difficulty for first year university students learning genetics. Through reading the literature on genetics teaching and learning, I became aware of the possible topic specific language difficulties that my students including English first language speakers could face.

My reflection: *When I look at the types of students' prior knowledge that I needed to know of, I can see that through my experiences of teaching genetics, I had knowledge of some of the ideas about genetic phenomena that students bring to class. I however gained a lot more of these prior ideas and their possible sources from literature. Therefore, research literature can be a source of important knowledge for teaching such as students' prior knowledge.*

4.4 Knowledge of content

Just as with the other knowledge domains that I have discussed above, I needed to have knowledge of content at two levels; knowledge of content that is taught in schools and knowledge of the content that I was going to teach in the university's genetics course. I needed knowledge of the genetics that is taught in schools so that when I prepare the content to teach in the course, I will know if the content would enable my students to teach the genetics that is taught in schools after qualification.

To gain the knowledge of the genetics that is taught in schools, I read through the CAPS and the (IEB) documents. To gain some knowledge on the genetics that is taught in schools internationally, I read through the "O" and "A" Cambridge Examination Syndicate syllabuses and the US Atlas of Science Literacy which is a collection of conceptual strand map and commentary that show how students' understanding of the ideas and skills that lead to literacy in science, mathematics, and technology might develop from kindergarten through 12th grade. Familiarising myself with school genetics was important so that I could be in a position to adequately prepare the students to teach that content.

As for the content that I needed to cover in the genetics course, I decided to start by looking at what was in the University's rules and syllabuses booklet. This was the first time I had found out what the university syllabus says about the content that I need to teach in my course.

My reflection: *By making reference to the syllabus, I came to realise that the syllabus is a very important document as it describes the curriculum. It is therefore one of the documents that new members of staff should be given or should ask for as part of their induction. Through my planning therefore I was actually carrying out induction and PD of self.*

When I read through the syllabus description, I found it to be very broad. Unlike the school syllabuses in which topics and the objectives for teaching that topic are clearly outlined, our university syllabuses are not like that. Initially, I did not know why the syllabus descriptions

were done in such an all-encompassing way. Through a conversation with a senior colleague I learnt that the syllabus descriptions were made broad for flexibility purposes. A broad description allows for implementation of minor changes within course outlines without having to amend what is in the University's Rules and Syllabuses booklet. Below is a syllabus description for the Life Sciences for which the genetics course was a component.

Study of biological topics and principles including introductory microbiology and pathogenic forms; methodology of biology and natural sciences teaching with respect to safety; genetics and principles of genetic engineering; introduction to theories of evolution; teaching of controversial biological issues.

As can be seen in that description, there is only the word genetics in the syllabus description and nothing else. When I reflected on this discovery, I postulated that it could have been the reason why at the beginning of my career as a teacher educator I was given a list of topics to use to produce a course outline instead of the syllabus. The fact that I struggled to produce a course outline with topics given meant that it was going to be even more difficult for me as a beginning teacher educator (BTE) to come up with topics to teach and to produce a course outline from the above syllabus description. I however, began to ask myself questions such as: How do you determine the topics to teach from such a syllabus description. What are the guidelines for the process of selecting the topics and who validates the selected topics and the whole course outline? When I asked around, I did not get a satisfactory answer. My colleagues as well were using course outlines that they had adopted from those who had taught the courses before. I then realized that this area of course outline development was actually a grey area. It was not clear who was responsible for producing the course outline and there were no guidelines for carrying out such an activity. I even searched for literature but I could not find any that describes how to develop a course outline. As the course presenter for the genetics course and for the purposes of my study, I decided to develop a new course outline for the genetics course in which I would describe in detail and outline the content for the course. How I developed the new genetics course outline is the subject of the next section.

To start off the development of my course outline, I produced a document that I called the genetics course breakdown. In this course breakdown, I described and explained how I unpacked the University's third year BEd Life Sciences syllabus to come up with the content (in the form of topics) that I was going to teach in the genetics course. In the document, I articulated the thinking that informed my choice of content and the way I sequenced that

content. The purpose of putting down on paper, my thoughts and reasons behind the choice of content and the structure of the course was for my research and for my PD. I wanted the reader to be aware of the content that I was going to teach and to understand how I had decided on that content knowledge. For my own PD, I wanted to be able to justify at any given time in my practice, why I was teaching the content that I was teaching. Feedback was sought from colleagues during the design process.

4.4.1 Background to the course breakdown

When I started teaching genetics at the beginning of my career as a teacher educator in 2007, I was given a list of topics which I organized into the genetics course outline. Figure 13 below is a section of my first course outline which shows the topics that made up the genetics course.

- Meiosis
- Chromosome and gene mutations
- Mendelian inheritance
- Codominance/Incomplete dominance
- Multiple alleles
- Sex-linkage
- Dihybrid inheritance

Figure 13: Genetics topics in my 2007 genetics course outline

I used my background of teaching genetics to high school learners to produce this sequence and I followed this sequence in my teaching of the course. As a new person (in 2007) I was not familiar with the B Ed Life Sciences programme. Therefore, I did not know what the students had covered in the courses that preceded the genetics course or what they were going to cover after the course (the vertical curriculum). What I find surprising now when I look back is that I just organized the topics into a course without finding out what it is that the students had covered in their previous courses so that I could make appropriate links to the content that I was going to teach. I did not even ask for the institution's syllabus to find out what it says about the content of genetics that I was going to teach. I just used what I had been given and my knowledge from high school teaching to produce the course outline. That

is why when I embarked on this study, I decided that I needed to start from the beginning by finding out what the university syllabus says about the content that must be taught in the genetics course. What motivated me was my wish to be in a position to justify the topics and the content that I was going to teach in the genetics course. The development of a new course was therefore a form of PD that I think BTE would benefit from if it is done as part of their induction.

4.4.2 The course breakdown process

To effectively unpack the syllabus, I decided to first put together a summary of what I had come to understand as the core knowledge of genetics from the review of the literature on the teaching and learning of genetics that I had done and then use the summary as a guide in unpacking the syllabus. The summary that I produced is presented below.

The core knowledge of genetics

From a review of literature on the teaching and learning of genetics (e.g.Lewis & Kattmann, 2004; Lewis et al., 2000a; Stewart, Cartier, & Passmore, 2005) the core knowledge of genetics includes:

1. The knowledge of genetic information molecules (DNA, nucleotides, genes, RNA)
2. The mechanisms that link genes to traits (transcription, translation).
3. The knowledge of meiosis i.e. the ability to transmit genetic information to future generations
4. The knowledge of classical or transmission genetics which looks at patterns of inheritance that are observed when organisms reproduce sexually

Duncan, Rogat, and Yarden (2009) described this core knowledge in terms of models. They termed the knowledge of genetic information molecules (DNA, nucleotides, genes, RNA) the **molecular model**, the knowledge of meiosis as **the meiotic model** and the knowledge of transmission genetics as **the inheritance model**. They argued that for one to reason adequately about and to account for genetic phenomena one needs to understand all the three models. Their description however, left out the mechanism that links genes to traits which I have decided to call the **gene expression model.** I am calling this mechanism the gene expression model because it is the information that is carried by the genes that is responsible for the formation of proteins and the proteins that are formed in turn lead to the development of the traits that we observe in organism. Although there is nothing in the literature about the need for an adequate knowledge of the cell and of mitosis for one to understand genetics, I thought that students would need this knowledge if they are to

adequately understand genetics. This is because most[10] living organisms are composed of cells and it is inside the cell that genetic information is located. In addition, the events of meiosis and protein synthesis occur inside the cell. It is important to know about mitosis because in multicellular organisms, genetic information is passed on from cell to cell through the process of mitosis. I have called the knowledge about the cell and about mitosis **the cellular model** and **the mitotic model** respectively. For me then, the core knowledge of genetics, includes the following: the molecular model, the gene expression model, the meiotic model, the inheritance model, the cellular model and the mitotic model. After putting together into a summary, the core knowledge of genetics that students need to know, I then used this summary to rework on my course outline.

Determining the content to include in the course outline and validation of that content

In order to come up with the topics for my genetics course, I first listed what I considered to be the main concepts in genetics based on the summary above. I also considered the genetics content in the documents that I had read namely: The CAPS document, the IEB syllabus, the 'O' and 'A' Level Cambridge syllabi and the US Atlas of Science Literacy. After listing the main genetics concepts, I constructed a concept map to reflect my understanding of the genetics that I would need for teaching (See Figure 13 below). I then gave copies of the concept map to three high school Life Sciences teachers and to four Life Sciences lecturers in our Science Division for their comments and input. Giving the concept map to Life Sciences lecturers and high school teachers was a necessary step as their comments would be useful in drawing my attention to possible gaps in my content knowledge and/or inconsistencies. I gave them the map whose final form became that shown in Figure 14 with the following guidelines: *The concept map represents my understanding of genetics concepts for teaching and the relationships between them. Please comment on the following*:

- The concepts chosen
- The links that explain the connections or relationships between the concepts
- The information that the whole map conveys

[10] Other organisms like bacteria are single celled and their genetic material is organized differently.

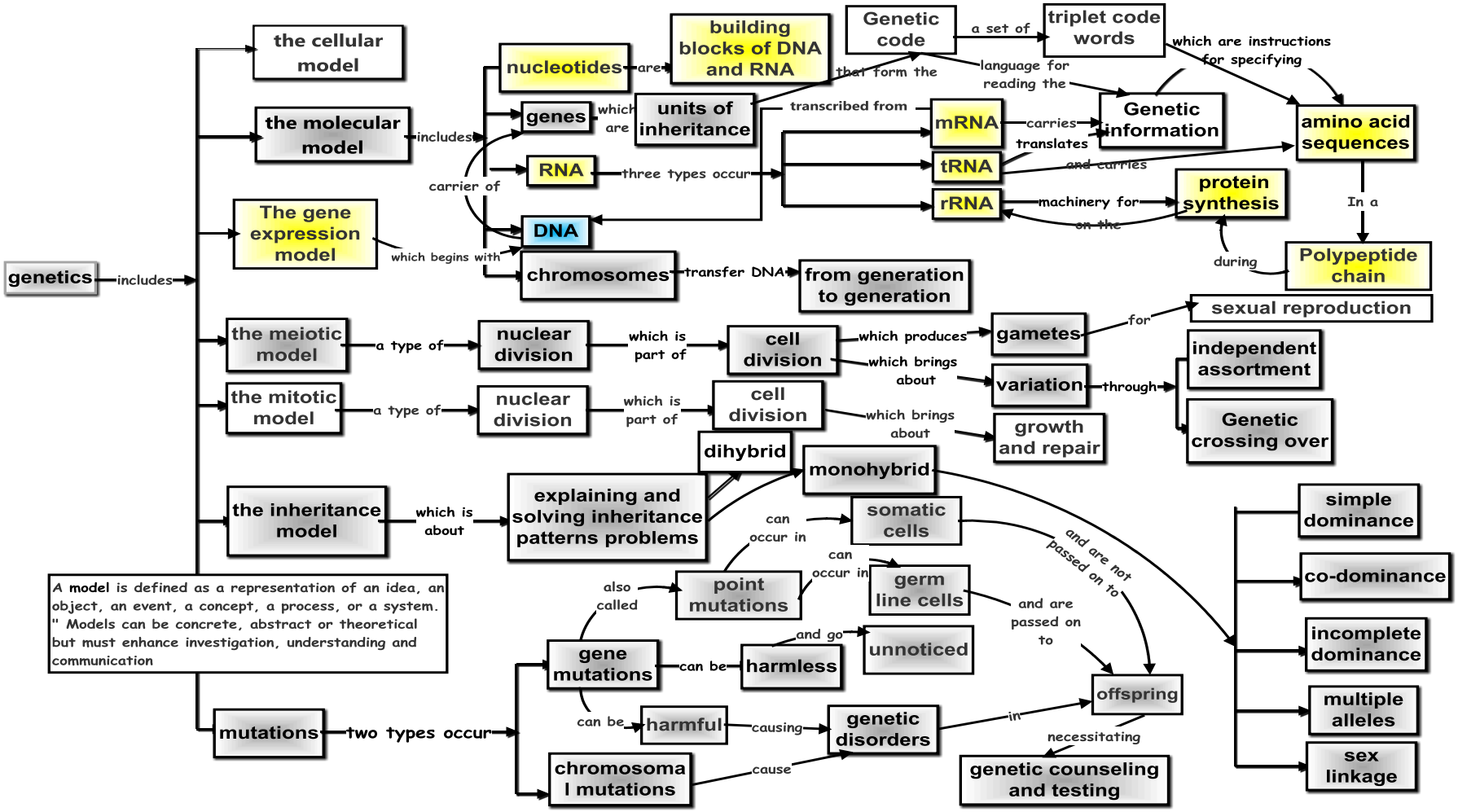


Figure 14: The genetics concept map

Two of the three high school teachers were happy with the map as it was. The third high school teacher was of the idea that the map should also show links to applications of genetics like biotechnology concepts (cloning, genetic engineering, DNA finger printing). These biology topics are found in the CAPS document. I had however, deliberately left out the biotechnology concepts because in our Life Sciences programme, biotechnology is done as a standalone course. The four Life Sciences colleagues that I asked to comment on the map were also happy with the genetics content that I had presented in the map. One colleague added that I should include a link between *unit of inheritance* and *genetic code* which was missing. The link was added. Another colleague was of the idea that the concept of gene should be presented as a model as I had done with other concepts like meiosis. This is because her experience of teaching about genes has shown her that students treat a gene as a physical entity that can be seen and be isolated. While I could represent a gene as a model, this suggestion was not added to the map as in the map genes fall under the molecular model. Secondly, a gene is a single concept whilst other models in the core knowledge of genetics all included a number of concepts and/or processes. Furthermore, with advances in biotechnology, single genes can now be cut and separated from DNA in some organisms using restriction enzymes. The third colleague was of the idea that the concepts of codominance, incomplete dominance and multiple alleles were monohybrid crosses and hence must be put under monohybrid inheritance. This was done. Figure 14 shows the final map. The yellow blocks show content that is covered in the course that precedes the genetics course. The blue block shows content that is covered in the previous course but which I also revise in some detail in my course. The grey blocks show the content that I teach. The white blocks show content that was not being covered anywhere in the Life Sciences programme at the time of doing my course breakdown.

After the concept map exercise, I revisited my list of topics in the original course outline and made a number of changes. The course outline with changes is shown in Figure 15 below.

Week 1: An exploration of students' prior knowledge of genetics. Basic structures of genetics (nucleotides, DNA, genes and chromosomes)
Week 2: Meiosis
Week 3: Mutations, genetic disorders, genetic testing and counseling
Week 4: Mendel, monohybrid inheritance, genetic diagrams, Punnett squares
Week 5: Co-dominance, Incomplete dominance and Multiple alleles
Week 6: Sex determination and sex-linkage
Week 7: Dihybrid inheritance?

Figure 15: The proposed list of genetics topics for the new genetics course outline

4.4.3 An explanation of the choice and sequencing of the genetics topics

Below I explain my choice and sequencing of topics in the genetics course outline that I developed as part of my study: a week by week course breakdown. In the explanation, I also include the ideas from literature and from my own experiences of teaching the genetics course, ideas that students have been seen to bring to class about genetic phenomena.

Week 1: An exploration of students' prior knowledge of genetics. Basic structures in genetics (nucleotides, DNA, genes, chromosomes)

In week one, I explore students' knowledge of genetics and I teach about the basic structures of genetics. My first course outline did not have these aspects. This was because as explained earlier, at the time that I did my first course outline, I was given a list of topics that I was expected to teach. I did not question or change anything in the original list of the topics because as someone coming straight from a high school classroom I saw the list as something that could not be questioned or changed. Even after observing that there was nothing about DNA, chromosomes and genes on the list, I did not find out if this content was being covered elsewhere. I just assumed that the molecular model content was being covered in the courses that preceded the genetics course. Then, the literature review that I did in 2009 in preparation for the Life Sciences subject advisors' workshop (see section 1.3.4) awakened me as it was reporting that students of genetics lack an understanding of the structures of genetic phenomena; DNA, genes, chromosomes (e.g. Duncan & Tseng,

2011; Lewis & Wood-Robinson, 2000). Therefore, in 2010, after the 2009 workshop, I decided that it was important to find out what the students knew about the structures of genetics at the beginning of the course so as to know where to start from and how fast to go. I prepared a number of exercises to establish the students' knowledge of the nature of genetic information and how that information is interpreted. Students' responses to these exercises revealed that the students knew very little about the nature of genetic information, and gene expression. I therefore considered these observations in my planning of the new genetics course and made a decision that in the new course, I would start the genetics course by finding out the knowledge of genetics that students bring to class.

From my experience as a teacher educator of genetics at Wits University's School of Education, I have realized that every year, there is a sizeable number of students who enrol for the genetics course who have never done genetics before. This observation made me decide that after finding out what students know about genetics, I will start the course with the topic **basic structures of genetics:** DNA, chromosome, gene, RNA and genetic information and the relationships among them (The molecular model). I was however worried that there is no mention anywhere in the Life Sciences syllabus or in the Life Sciences course outline, or in my previous genetics course outline of the teaching of the cell (structure and function) and protein synthesis. I wondered whether there was an assumption by those who had unpacked the syllabus for Life Sciences that students should, by the time they finish Matric (High School), have a good knowledge of the concept of a cell, its structure and functions and hence, there was no need of teaching these concepts at university level or was it just an oversight. Many students of genetics that I have taught in the past could not draw or label correctly, a diagram of an animal or a plant cell. They also could not explain how an organism ends up with different types of cells in its body. Students lack the knowledge of the cell which is fundamental to the understanding of genetics. This observation highlighted the need to incorporate this topic in my teaching. I therefore decided that I would use the first practical session to teach about cell structure and function. Each practical session is three periods long. This is enough time to teach about cells and for students to do practical activities based on the cell. So although the topic cell structure and function does not appear in my course outline, I cover this content in the first practical.

The omission of protein synthesis in the syllabus was also a cause for concern for me. Firstly, because it is a section of the South African grade 12 syllabus and hence our students as teachers of tomorrow should know this content. Secondly, research shows that one common misunderstanding that is exhibited by students is the belief that genes are directly

responsible for the traits (Lewis & Kattmann, 2004; Lewis, Leach, & Wood-Robinson, 2000b; Marbach & Stavy, 2000). Students do not understand that the products of genes are proteins and in a few cases RNA and that it is the interaction of proteins that determine an organism's phenotype (the traits). Therefore, if students are not formally taught about the mechanism of protein synthesis, they will lack the knowledge of this important link. Due to time constraints, I could not include this concept in my new course outline. I therefore discussed this with a colleague who is responsible for teaching the chemical background to Life Sciences in the Science Division. This background includes nucleic acids. I asked her to include the content from gene to protein so that when I take over from her to teach the genetics course, the students would have the knowledge about the gene expression model.

In my course outline, the teaching of the molecular model is followed by the meiotic model in week two.

Week 2: Meiosis

When teaching meiosis, I will look at the following:

- **purposes** of meiosis
- **process** of meiosis
- **products** of meiosis

When I teach about meiosis, I make explicit the link between the behaviour of chromosomes and the purposes and products of meiosis. I decided to teach meiosis after the basic structures of genetics because meiosis has to do with the transmission of genes and chromosomes which I would have covered in the teaching of basic structures of genetics. I decided to teach meiosis before teaching transmission genetics because meiosis is a mechanism which gives meaning to problem solving (Stewart, Hafner, & Dale, 1990) as it explains the inheritance patterns evident in traits in our everyday life.

At the time of developing my genetics course outline, mitosis was not being taught in the genetics course or anywhere in our Life Sciences programme. This omission was again a cause for concern as mitosis is an important process that students need to know. There is unity in function and purposes of different processes of genetics and for students to gain a robust understanding of genetic phenomena; they need to be able to make the necessary links between the various processes and structures. A good example is the link between meiosis, mitosis and sexual reproduction in the transfer of genetic information. Leaving out mitosis creates a content gap that will make it difficult for students to understand transfer of genetic material from cell to cell within an organism. I therefore brought to the attention of my colleagues in the science division, the absence of mitosis in the Life Sciences programme

and the teaching and learning difficulties that it creates. It was then agreed that in future both the topics cell structure and function and mitosis would be incorporated into the First Year biology course.

My reflection: *This was the first time I had identified important omissions in our curriculum and to bring them to the attention of my Life Sciences colleagues. This was because previously, I had focused on teaching the topics that had been given to me only without giving much thought to the coherence of these topics to other sections in the Life Sciences programme. I had also looked at the list of topics as something that could not be questioned. I never took time to look at the whole Life Sciences syllabus and evaluate how the topics link to other topics in the syllabus. Through developing the genetics course outline, I was able to not only identify problematic issues in our curriculum but to also think of ways of overcoming those problems to help improve the teaching and learning of genetics. My own professional development was implicitly taking place through the process of designing a new course outline. By identifying problematic issues within the Life Sciences curriculum and bringing those to the attention of my colleagues impacted the way my colleagues also viewed their roles and responsibilities. One senior colleague suggested that we needed to conduct regular meetings as Life Sciences lecturers in which we would discuss issues pertaining to our Life Sciences curriculum. The suggestion was agreed upon. We began our monthly meetings in 2013 which culminated in the revision of our Life Sciences curriculum.*

After meiosis I teach about mutations.

Week 3: Mutations

There are two types of mutations namely **gene** and **chromosome** mutations. Chromosome mutations are also referred to as chromosome aberrations. I decided that the best stage to teach about mutations is after having looked at genes, chromosomes and meiosis as knowledge of these concepts is necessary if students are to understand what mutations are, how they occur and how they cause genetic disorders. The focus would be on mutations that cause genetic disorders in humans as these directly affect us as human beings. Under the topic mutations, I would include a look at genetic **disorders** and **genetic counselling** and **testing**.

Week 4, 5 and 6: The inheritance model: Mendel, monohybrid inheritance, genetic diagrams, Punnett squares, co-dominance, incomplete dominance, multiple alleles, sex determination and sex-linkage

The next topic in my course outline is **the inheritance model.** I need three weeks to teach about this model. The inheritance model involves a look at how genetic information is transmitted from parents to offspring and at inheritance patterns. An inheritance pattern defines the basic relationship between genotypes and phenotypes (Collins & Stewart, 1989). The content includes solving problems of inheritance. Typical genetics problems can be grouped into four classes. These four classes are simple dominance, co-dominance, multiple alleles and sex linkage problems. These classes of problems differ in the number of variations. Therefore, under the topic of inheritance, I teach about:

- Simple dominance
- Co-dominance
- Multiple alleles
- Sex determination and sex linkage.

I also teach the concept of incomplete or partial dominance. This I regard as a fifth class of genetics problems. The main focus in this section is interpretation and solving of genetics problems in the five classes of genetics problems. At the end of the course, students must be able to explain the patterns they see in given data using the above inheritance pattern models. Inheritance patterns models explain how genes interact to produce variations that are observed in the traits. To teach the inheritance model, I first look at the history of **Mendel** who is regarded as the Father of genetics. When looking at Mendel, I also want my students to appreciate some aspects of the nature of science. So we will look at how people failed to understand Mendel's findings during Mendel's time and how scientists now understand and can explain them. I believe the History of Science is an important inclusion in that it helps students understand that science is a human activity. Using Mendel's experiments, I introduce the terminology of genetics followed by simple **monohybrid** inheritance problems. When I introduce monohybrid inheritance, I also introduce the use of **genetic diagrams** and **Punnett squares** when solving genetic problems. Research has shown that students are able to use genetic diagrams and Punnett squares to correctly solve genetic problems without understanding the concepts behind each step that they take in solving the problems (M. U. Smith & Kindfield, 1999). I will therefore make explicit in my teaching the links between **inheritance**, **meiosis**, **independent assortment**, and **random fertilisation** as represented in genetic diagrams and Punnett squares.

Note that I have put down dihybrid inheritance as a topic to be taught in week seven. What this means is that I will require a seventh week to be added to the duration of the genetics course if I am to teach dihybrid inheritance.

4.4.4 Feedback from colleagues on my genetics course breakdown

After completing my planning and designing of the genetics course I gave the document to four colleagues for their feedback. A critique by colleagues was necessary as it would help to validate my course outline and also to see if the process of designing the course that I had undertaken was a useful exercise to do. Three of the four colleagues were biology lecturers in our Science Division and the fourth one was picked up from outside the Wits School of Education. The idea was to get views of a person who is external to the teaching profession. The following pseudonyms were used in the discussion that follows:

Georgia (G) - Biology teacher educator

Alaska (A) - Biology teacher educator

Michigan (M) - Biology teacher educator

Kansas (K) - Lecturer in the faculty of Engineering. He has no teacher education background.

These colleagues were invited to read the course breakdown document focussing on the appropriateness of the content that I was planning to teach and the sequencing of the topics after which we would meet and discuss. I was not able to meet with Michigan. She however wrote some comments for me.

Michigan's comments

Michigan said it was a 'lovely' document. She agreed with me that the unpacking of the syllabus is an important exercise and was happy with my suggestion that it be done for all courses at Division level as a collective exercise involving all lecturers in the Division.

I managed to meet with Georgia, Alaska and Kansas. During the discussion with the three colleagues, I took down notes, some of them verbatim. Below is a discussion of what transpired during the discussions.

Georgia's comments (G)

G: *The course breakdown together with the concept map is invaluable as they both clarify the content and the sequencing of that content to whoever will teach it in future. You know, after reading this (meaning my course breakdown document), I am of the opinion that we should have something like this for every course but ah-ah only after my retirement.*

Eunice (author): Why?

G: This is a lot of work so ah-ah after my retirement

According to Georgia, my course breakdown clarifies the content to be taught and its sequencing for whoever will teach the genetics course in future. Georgia's comments show that the course breakdown document is of value and wishes that the same be produced for every course. She can however also see the amount of work that went into its production and therefore doesn't wish to see this exercise being implemented during her time because it will mean a lot of work for her too.

Alaska's comments (A)

Alaska's comments focused on the content part of the document. She was of the opinion that the topic mutations should be taught at the end instead of the middle where I had put it. She saw the content about genetic disorders and genetic counselling as content in which the knowledge of genetics is being applied. She therefore felt that it is more appropriate to teach it at the end after everything else. Her argument made sense so after the discussion with her; I took her comments into consideration and shifted the topic mutations to the end (see appendix C for the final course outline). I however needed more feedback from her so I asked her the following question:

Eunice: Do you see this course breakdown as of any value?
A: I do. If I had taught this course before seeing this document, my teaching would have involved me just stating my understanding of genetics without thinking pedagogically, not thinking about why. This document provides structure to the course and moves your thinking beyond content. If we had time, it would be good to do this for other courses.

What I could pick from Alaska's comments are issues of content and pedagogy; that it was important that I had considered both content and pedagogy in my planning of the course. Alaska just like Georgia could also see value in the document that I had produced. She also wished that it could be done for other courses.

Kansas' comments

Kansas' comments were given in point form:

- *Your document is saying: don't make assumptions about what students know. Find out.*
- *What you did is partly curriculum development and partly evaluation of the courses and this is part of your responsibilities.*
- *A course outline is a living document that needs continuous evaluation. It is like a steering thing of a ship.*

- *A course syllabus is very broad and if unpacking of that syllabus into a course outline is done by individuals may result in misalignments according to the lecturer's preferences, competence and interest. Course outlines should therefore be treated in the same way that we deal with internal exam reviews.*

When I discussed the comments above with Kansas, he said this was a summary of what he could pick from my course breakdown document. His first comment concerns students' prior knowledge that we should not make assumptions about what students know about a topic. This comment came as a result of what I said in one section of the course breakdown document where I said '*Over the years, I have realized that a big number of students who enrol for the genetics course have never done genetics before. Even for those who have done genetics, it is important to find out what they know about genetics so as to know where to start from and how fast to go'.* Kansas said that by saying this, I showed an awareness of the importance of the knowledge that learners in this case students bring to class. Kansas also saw the document as partly curriculum development and partly curriculum evaluation because he could see that the syllabus entry from which the syllabus breakdown was produced was not a straight forward piece of text and that the production of the course breakdown document led me to identify some gaps in our Life Sciences programme.

In addition to seeing the production of the course breakdown document as curriculum evaluation, Kansas was of the view that the unpacking of the syllabus into course outlines should go through an internal review process just like what is done with examination papers for quality control and assurance purposes. This suggestion came from a concern that if the unpacking of the syllabus entry is left to individuals only, there is a possibility that those individuals may choose the content that interest them and/or are comfortable to teach. The individuals may also overlook and leave out important content. Hence the comment: *if unpacking of that syllabus into a course outline is done by individuals may result in misalignments according to the lecturer's preferences, competence and interest*. Kansas' suggestion never crossed my mind when I was developing my course outline. I am however happy to say that some of the steps that I took when I was planning the genetics course catered for such biases thereby helping to make the course breakdown authentic and free from my own preferences. For example, I read literature to put together the core knowledge of genetics. I also involved high school teachers and colleagues to validate the content of genetics that I was proposing to teach.

My reflection: *When I reflected on the process that I had gone through to develop my genetics course outline and on the feedback from colleagues, I got a number of insights for my practice as a teacher educator. The first insight that I got is that a course outline is a very important document. While one person could be responsible for the preparation of a course outline, members of the subject should have an input into its development for two important reasons: Firstly, to avoid situations where individuals would choose content that they are comfortable to teach or content that interests them and leave out important content. Secondly, to ensure continuity: if all members of a subject get involved in the preparation of course outlines at various levels, they will all be aware of the content that is taught in the courses before or after theirs; the vertical curriculum (see section 2.3.2). This will prevent situations where content is repeated or left out. The second insight is that syllabus documents and textbooks describe what is called common content knowledge (see section 2.3.4) about a topic. This is the content that teachers and teacher educators usually teach. There is however specialized content knowledge (section 2.3.4) that is necessary for the development of a better understanding of a concept or a topic that the above listed sources are silent about. It is our responsibility as teacher educators to be aware of this specialized content knowledge so that we can teach it to pre-service teachers. One source of specialized content knowledge is research literature. The third insight that I got is that our roles and responsibilities as teacher educators go beyond teaching to curriculum development and curriculum evaluation. The question is: Are teacher educators aware of these roles other than the teaching role? The last insight was the realisation that there is not enough time for us as teacher educators to fulfil our roles and responsibilities. My question then is: what are we going to do about it?*

After reflection on the development of my course outline and on colleagues' comments, I presented the course breakdown document together with my colleagues' comments to my critical friend for a critique. I wanted her to look at the significance of developing a course outline to my practice as a teacher educator and to my study. In the next section, I discuss what came out of my discussion with my critical friend.

4.5 Designing the genetics course outline: Significance and lessons learnt

In section 4.4 above, I described in detail how I put together the content that I was going to teach in the genetics course through designing a new genetics course outline. I also described what I learnt from producing the genetics course outline and discussing it with

colleagues. In this section I present and discuss what came out of a discussion of my course breakdown with California my critical friend. The presentation includes quotes from the discussion. The first significant aspect that California picked from my course breakdown was how I viewed myself as a teacher educator:

> Eunice, the first thing that caught my attention from your account of developing a course outline is that before doing this course outline, you viewed yourself as an implementer of the curriculum. One big problem that we have as teachers or teacher educators is that we see ourselves as implementers or rather delivery vans of the curriculum not designers. As a result, some of us do not think beyond the curriculum or the syllabus documents that we are given in our teaching.

My reflection: *The comment above by California of me seeing myself as an implementer of the curriculum was very profound because until then, I had not realized that that is exactly how I viewed myself. If one reads my autobiography about my teaching of the genetics course at the beginning of my career as a teacher educator, you would see me moaning about not being given a course outline when I joined the school. I had a narrow view of my roles and my responsibilities. I thought that my responsibilities were to implement the curriculum, to teach what is described in the syllabus. Kosnik and Beck (2009) identified this narrow view of teaching by teachers as a major problem in professional identity and I had carried it over to my teacher education practice. Now, through this study specifically by going through this process of designing a course outline, I have become aware that teaching is just one of my many responsibilities. There are many other roles and responsibilities beyond teaching: as a teacher educator I am also a curriculum designer, a curriculum evaluator and also a solver of curriculum problems. It is our responsibility as teacher educators, to continuously evaluate our courses to make sure that they are still serving the interests of our clients.*

The second aspect that California picked from my course design document was that I had clearly shown that there is a relationship between teaching and students' learning by indicating that I intended to find out students' prior knowledge about genetic phenomena. She said such an approach to teaching where one is aware of what students know already would help to build a better understanding of the content in the students.

> Your content description shows clearly that there is a relationship between students' learning and your teaching. You are interested in students' learning not just your teaching that's why you plan to explore students' prior knowledge. Such

> an approach would build a better understanding in students from what they already know.

With her comment above about the importance of knowing students' prior knowledge, I felt that California was endorsing my plan to find out students' prior knowledge at the beginning of course. The third aspect that California brought out about my document was the importance of using research literature in the development of my course outline. For her, finding out what literature says about the teaching and learning of specific content such as genetics in my case places my teaching and my students' learning in a global context.

> Your document shows that you do not look at your teaching and your students' learning in isolation. You situate your students' learning in a global context by taking into consideration what the literature says about the teaching and learning of genetics.

What I could pick up from California's comment above is the importance of considering what research literature says in our teaching and the implications of considering research literature when we plan our teaching.

My reflection: *Have we ever seriously considered what would happen if we apply what research says would improve our teaching for example what research says motivates students to stay on task or what research says improves the impact of formative assessment?*

The fourth aspect that California pointed out that she could see even in the comments by my colleagues was that teaching is a thinking job and that thinking starts before teaching is done.

> What I thought you are saying in your document is that teaching is not just about transmission of content, that teaching is a thinking job and the thinking starts before you teach. You are therefore saying to educators when you go out to teach, think before you start teaching. I am sure when you start analysing your teaching you will see your thinking going through as well but ---someone can actually see from the document that you are making us think content and think pedagogically.

The last aspect that California pointed out was that the document shows that I care about my students and their future students and that I care about my profession:

> Your document shows that you are worried about what students know, about students grasping content. You are actually taking steps and the steps show through in various ways in your document. Caring comes upfront in your document, caring for your subject, caring for your profession and your students. So for me the big thing in your document is caring.

In response to this last comment by my critical friend, I asked her the question: What does it mean to care in science teacher education? She said "*your caring attitude is seen in your focus which is all round: focus on your present students, their future students and on our profession as a whole"*. If students do read that I care about them and about their future as teachers as you said, would that impact their learning of genetics? I asked my friend. California's answer was "*Let's wait and see what they are going to say after teaching them*". This comment ended my discussion with California.

The last knowledge domain that I needed to develop for my teaching was the general pedagogical knowledge (PK) domain. The definition of PK that I am using in this study was discussed in section 2.4. The definition encompasses the different aspects of teaching such as teaching procedures and teaching activities and the relationship between the teaching actions and students' learning. In planning my pedagogy, my aim was to develop knowledge that would help me to achieve the dual role of a teacher educator: teaching content for understanding and for teaching. My planning of the pedagogy for teaching the genetics course was therefore going to be a form of professional development. Below I present the PK that I developed for teaching the genetics course. Please note that the order of the knowledge components that I will use is knowledge of context first, knowledge of students next, PK and lastly, knowledge of content. In this chapter however, I described knowledge of content first because the PK that I developed was not general PK but topic specific PK. Therefore, I could not describe topic specific PK without describing the content associated with it.

4.6 Pedagogical knowledge (PK)

In this section, I narrate what I did in planning for my lectures with a focus on bringing out the PK that I developed as I was planning my teaching of the genetics course. I first describe how I gathered information on how to execute my teaching. I then describe the planning that I did for my introductory lecture and for teaching the following topics: genetics at molecular level, meiosis and inheritance. Although, the genetics course comprises of more other topics namely mutations and genetic disorders and then genetic counselling and testing, I

described the planning that I did for only three topics because the purpose of this section was not to describe my planning of each and every topic that I was going to teach in the genetics course, but to bring out my PK and the features that characterized the development of my PK for teaching genetics. In planning my teaching, I focused on how I would teach a whole topic not how I would teach one lecture. The planning was informed by the knowledge of the other three domains that I have described above and my experiences of teaching these topics. My planning also involved metacognition. I have used pictures in my narrative as evidence for my PK.

4.6.1 Guidelines for my planning to teach

At the time that I started planning my teaching, I had come to understand that as teacher educators, we had a dual purpose; teaching content and at the same time developing in pre-service teachers the competence for teaching that content (Garbett, 2012). This dual purpose was however a big challenge for me. What made it challenging was that I use a lecture theatre where my teaching approach had become what Bullock (2009, p. 294) described as "the traditional university lecture format" where I would only use a power-point presentation as my teaching tool to explain the subject matter. I didn't know what teaching approaches to use in a big lecture theatre to achieve that dual purpose. I turned to colleagues for ideas. Tony, my supervisor and colleague suggested that the best way to achieve that dual purpose would be by modelling good teaching practices in my teaching of the content. I was in agreement with Tony because I anticipated that by modelling good teaching during my teaching of the content, students would be learning the content and at the same time learning how to teach that content through experiencing the teaching practices that I would be modelling. The literature also gave me some direction. In the framework of a pedagogy of teacher education (2006), Loughran pointed out some of the behaviours that teacher educators need to enact as part of teaching about teaching. Those behaviours include modelling specific approaches to teaching and being explicit and analytic about one's own teaching. However, as had been acknowledged by Belinda, my other colleague, modelling good teaching is a challenge when teaching big groups in a lecture theatre. However, Tony had a useful suggestion that I could use to overcome any hindrance to modelling good teaching. Using materials as T/L aids that were big enough to be seen by all students even in a big lecture theatre:

If for example I want to model chromosomes, I would use pool noodles[11]. They are big enough to be seen by all students in a big classroom. Figure 21 shows the models of chromosomes that I made using pool noodles.

The message was clear. Even though I would be teaching in a bigger venue, I could still use visual aids such as models but I needed to go big in terms of the size of the visual aids so that even those at the back of the lecture theatre would be able to see. This gave me ideas on how I could deal with the challenge of modelling good teaching to pre-service teachers. With all these ideas in place, I began my planning for the lectures. In my planning I applied the pedagogical reasoning that is outlined in my conceptual framework. Therefore the narrative account below of my planning reflects some aspects of the pedagogical reasoning process.

4.6.2 My plan for encouraging students to come to lectures on time

One of the things that bother me is that many students come late for lectures. The students don't seem to appreciate the value of the five or ten minutes of lectures that they lose every time they are late. My biggest worry is that the students would take this attitude into their professional lives when they qualify. So when I was planning my lectures, I thought of a way that could encourage students to come to my lectures on time. I anticipated that one possible reason why they would not be motivated to come on time is because they would just sit idly until the lecture starts. I therefore decided that I would go to the lecture venue in time, at least 10 minutes before the lecture, then as a way of encouraging the students to also come on time, I would prepare a set of questions and put them up on the screen or on the chalk board so that those students who come early would be occupied with something constructive. The questions would focus them on the content covered in the previous lecture and/or content to be covered in that lecture. This was going to be an established routine. There was going to be 'today's questions' on the screen before the start of every lecture. In addition to trying to motivate students to come on time, I also wanted to instil in students the value of punctuality by being punctual myself.

[11] Pool noodles are cylindrical pieces of polyethylene form. They are used by people of all ages when swimming for floating when learning to swim, for water play, for aquatic exercise etc.

4.6.3 Preparing my introductory lecture to the course

Research has shown that students find genetics difficult to learn and one of the causes of student difficulties was identified as their lack of the overall picture of the inheritance process (Bahar et al., 1999). The other cause was identified as the fact that genetics concepts belong to different levels of biological organization; the macro, the micro and the symbolic which students need to transcend when learning genetics (Bahar et al., 1999; Marbach-Ad, 2001). The problem is not about the three levels per se. According to Bahar et al. the problem is that these levels are taught at different times and are not always integrated enough to make clear the processes underlying the genetic phenomena and the overall picture of the inheritance process. These insights from literature informed the planning of my introduction to the genetics course. As outlined in Appendix C the following topics were going to be covered in the course.

Week 1: An exploration of students' prior knowledge of genetics. Basic structures of genetics (nucleotides, DNA, genes and chromosomes)
Week 2: Meiosis
Week 3: Mendel, monohybrid inheritance, genetic diagrams, Punnett squares
Week 4: Co-dominance, Incomplete dominance and Multiple alleles
Week 5: Sex determination and sex-linkage
Week 6: Mutations, genetic disorders, genetic testing and counseling

These topics cover content at all levels of biological organisation and are linked to other topics like sexual reproduction, mitosis and growth and development. Therefore, my plan was to start the genetics course by making students aware of these different levels of biological organisation and of how the topics of genetics we were going to cover are linked to other biology topics. I decided to use a picture shown in Figure 16 below to introduce genetics. The picture shows a population of people, then a couple coming out of the population, then arrows from the reproductive organs of the couple to show where meiosis takes place which produces a sperm and an egg, then fertilisation to produce a zygote which divides by mitosis to form an embryo which develops into a child.

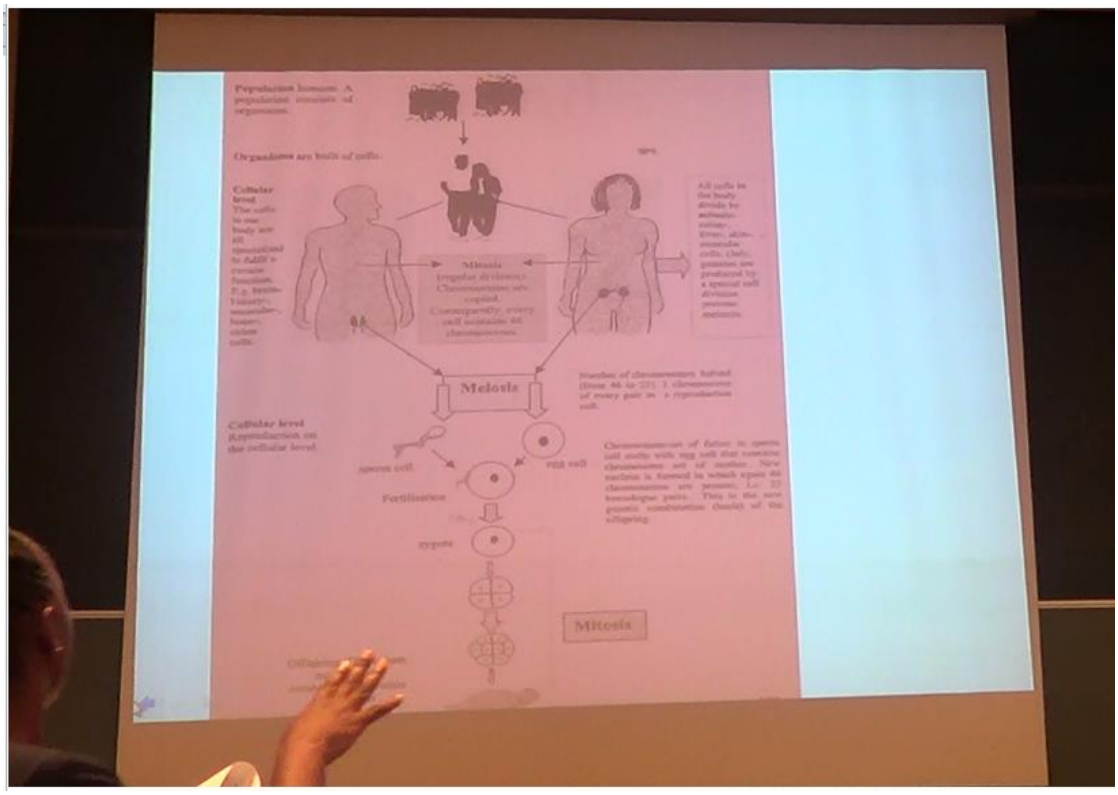


Figure 16: Picture used to introduce genetics (Source unknown)

I chose this image because in my opinion it represents the bigger picture of genetics: the macro and the cellular levels and the links between genetics, sexual reproduction, meiosis and mitosis. By discussing with the students what the picture is showing, my hope was that the students would from the onset be clear about the bigger picture of genetics and the three levels of biological organisation that genetic phenomena operate at.

4.6.4 Planning the teaching of the topic genetics at molecular level

Under this topic genetics at molecular level, I was going to teach about DNA, genes, nucleotides, genetic information, chromosomes and RNA. From the literature review that I had done, I was **now** aware of the knowledge gaps that students exhibit after being taught about the various structures of genetics. These knowledge gaps are as described below:

- Many students would show a good general understanding that genes determine characteristics, however, the students would show a lack of a basic understanding of what a gene is (its basic function, where it is found and how it relates to other structures) (Lewis et al., 2000b).

- Some students would show an awareness that genes contain or provide information. However they would lack an understanding of the nature of this information and how it is used (Lewis et al., 2000b).
- Students would have the idea that the structures chromosome, gene and DNA play a role in determining the characteristics of an organism. However, they would show confusion regarding the respective roles of each of these molecules (Wood-Robinson, Lewis, & Leach, 2000).
- It was also seen that many students showed a limited understanding of the structure of and relationship between chromosomes and genes (Lewis & Wood-Robinson, 2000).

The above findings which were confirmed by many other researchers (e.g.Marbach-Ad, 2001; Quinn et al., 2009) helped me to be clear on the content that I was going to teach and how I was going to structure it. The content that I was going to teach under this topic is summarised below.

The nature of DNA, genes, chromosomes, chromatin and genetic information, the functions of DNA and genes, the specific roles of chromatin and chromosomes and the relationships between the genetic structures (DNA, genes, chromatin and chromosomes).

According to researchers, the knowledge summarised above is crucial for an understanding of genetics or the inheritance process. Therefore, I wanted to make sure that I was going to cover the **structure** and **function** of each entity, the **relationship** between them and the **role** of each in the inheritance process. During the planning, I found out that I could easily explain what these structures are and the relationships among them. My knowledge of why we had all those different forms was however scanty. I could see that I was not able to explain why we had all those different genetic structures. I had never thought about it and had never explicitly taught about it. This was a gap in my own knowledge of teaching genetics that I had just discovered that I needed to fill. The challenge now was for me to get this information. The research literature that I had reviewed didn't contain this information. The biology textbooks that I had read didn't have this explicit information. So I decided that I would start from what I knew about DNA, chromatin and chromosomes and engage in metacognitive activity as described in section 2.6.1. In the previous years I had used the diagram shown in Figure 17 below to explain how chromosomes form from DNA.

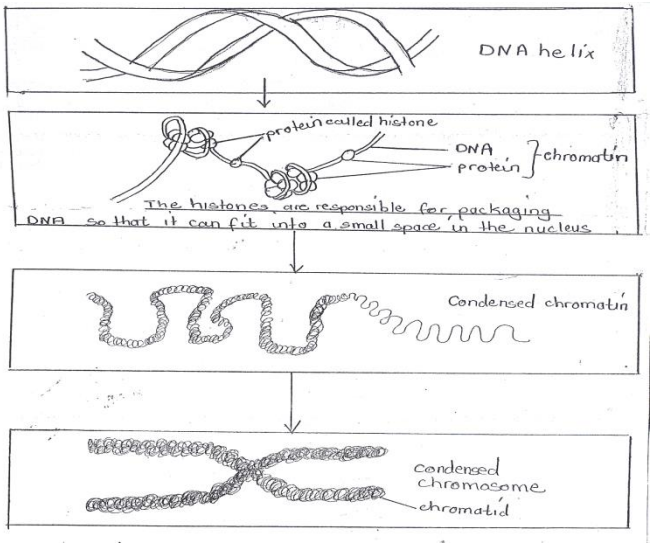


Figure 17: Levels of DNA packaging

I revisited this diagram and studied it carefully. I thought about the title of my slide *'Levels of DNA packaging'*. I thought about the word packaging. I looked up the word in the dictionary. According to the Cambridge Advanced Learner's Dictionary, packaging is a noun which describes 'the materials in which objects are wrapped before being sold' p 907. From this definition of the word packaging, the whole diagram became very clear to me: The DNA is the object of interest which is being wrapped around some material (histone proteins). The packaging produces more compact structures from DNA called chromatin and then a chromosome. Thinking about the long threadlike structure of DNA, I postulated that the purpose of organising DNA into a chromosome is for conservation of space within the nucleus of a cell and for efficiency: efficiency of storage of the DNA material and efficiency during the events of mitosis and meiosis. When I came to this understanding, I was convinced that the use of the idea of packaging for space conservation, and for efficiency, would form the basis of a conceptual understanding of the relationship between DNA molecules and chromosomes. The next question that I then asked myself was how best I should teach that concept. I then decided to use an analogy of string; how it is packaged after it has been manufactured for ease of storage, transportation and distribution (see Figure 18 below). The loose string represents a DNA molecule and the ball of string represents a chromosome.

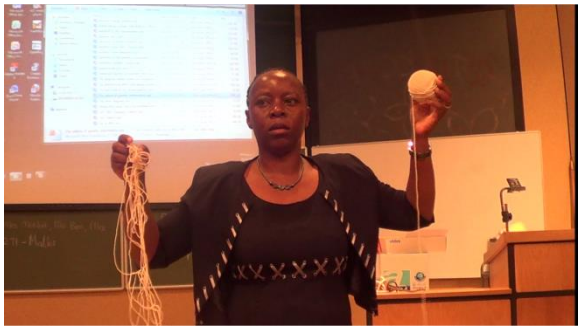


Figure 18: String analogy

After this metacognitive activity, I felt that I was ready to teach my first lecture. To support my teaching, I prepared the following visual aids:

- Pieces of coloured string tied one after another to explain what genes are and how they are related to DNA (Figure 19). The explanation would be that the long string made up of different coloured sections represents the DNA molecule, the coloured sections represents different genes on the DNA and the folded string represents DNA with its genes compacted into a chromosome.



Figure 19: Pieces of coloured string tied together

- Models of DNA to recap on the structure of DNA (Figure 20). I was going to use the model to discuss how the structure of DNA is suited to its functions; explain what genetic information is and the relationship between DNA, genes and genetic information.



Figure 20: Model of DNA

String rolled on paper and on balls of Formica to show how chromatin forms first and then coils into a chromosome (Figure 21)

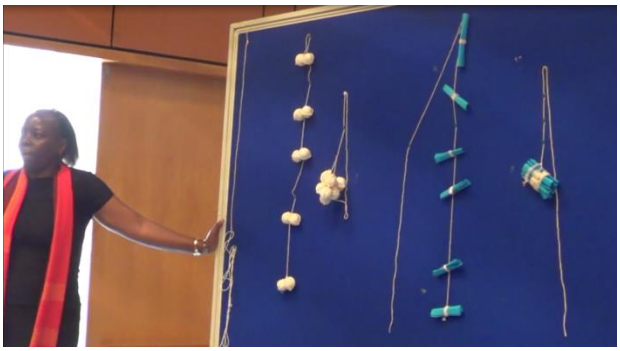


Figure 21: Visual objects to show how DNA organizes into chromatin then a chromosome

4.6.5 Planning the teaching of the topic meiosis

I started my planning for teaching meiosis by asking myself the following question: What are the issues that surround the teaching of meiosis? The first issue had to do with the ideas that students bring to class. From my previous teaching of the genetics course, I had found out that some students come to the genetics course without any prior formal learning of meiosis. In my planning, I was going to consider these students as not having 'any knowledge' about meiosis. Which means a detailed description of the process of meiosis and other subordinate concepts was required. Other students come to the genetics course having learnt about meiosis in high school. These students would have knowledge meiosis some of which would be scientifically correct and some incorrect. Some of the incorrect ideas about meiosis that students bring to class that I have come to know about from my previous teaching are discussed below.

Some students bring to class the following ideas: Firstly, t*hat meiosis is a type of cell division in which a cell divides in half twice to form four daughter cells.* This idea is wrong as meiosis is a mechanism of nuclear **not** cell division by which an organism ultimately produces daughter cells with half the number of chromosomes when compared to the parent cell. The second wrong idea that many students that I have taught in the previous years brought to class was that interphase is the first stage of meiosis during which DNA replicates. I had also observed from my previous teaching that students struggle to understand some concepts associated with meiosis for example chromatids, homologous chromosomes, synapsis and bivalent.

The second issue that I needed to consider was what research literature says about the teaching and learning of meiosis. Research has shown that some students show a poor understanding of the purposes, processes and products of cell division (Lewis et al., 2000b) Some students also show confusion with the use of terms like replicating, dividing, copying, splitting (Lewis et al., 2000a) and the concepts of duplicated chromosomes, chromatids and homologous chromosomes (Brown, 1990). Some students are of the idea that DNA replication is the source of homologous chromosomes and therefore sister chromatids are the homologs (M. U. Smith & Kindfield, 1999). These findings were supporting some of my own observations as outlined in the previous paragraph.

With all these issues in mind, the big question was 'How should I approach the teaching of meiosis? How should I explain the concepts of cell division and meiosis? I turned to colleagues for ideas. I met with two colleagues Tony and Alaska and explained to them that previously, I had taught meiosis by simply describing the process of meiosis in which I would describe meiosis 1 and its stages then go to meiosis II and its stages. There would then be a discussion at the end of the significance of the process of meiosis: source of variation and production of gametes. My question to my colleagues was:

How would you teach meiosis in a way that goes beyond just describing the phases?

Tony: *If I was teaching this ten years ago and I wasn't thinking in detail about it, I would have taught it in the way you have just described it but now because you are asking us about it and we know that you are doing this study, it's like we are metathinking about it. It's like metacognition. We are thinking deeply.*

I would suggest that you teach conceptually working out with them what would happen if for example ordinary cells of an organism with 4 chromosomes in each cell are used.

Alaska: *I have always taught meiosis the way you have described. So I have actually learnt something*

After this conversation with the two colleagues, I now had an idea as to how I could approach my teaching. Tony had suggested that I should teach conceptually by showing them what would happen if ordinary cells with a full complement of chromosomes were used as gametes; doubling of chromosomes would occur. While this was very helpful, it was going to cover only a small bit of what I felt students should understand about the process of meiosis. I reflected on my own understanding of meiosis; thinking about what I knew about meiosis. As I continued to think about it, I came to the understanding that meiosis is a causal mechanism which contributes to variation and brings about the formation of gametes (special cells containing half the number of chromosomes) for sexual reproduction. I considered that to be the conceptual understanding that the students will need to develop about meiosis. I then concluded that to teach meiosis conceptually would mean teaching in such a way that students will develop that conceptual understanding about meiosis that I had now developed. I then decided to focus on variation and reproduction to introduce the process of meiosis during which I would help students to understand what would happen if ordinary cells with a full complement of chromosomes were used as gametes through a question and answer (Q & A) discussion. In addition to the concepts of halving of the number of chromosomes and variation, there were still other issues that I needed to take care of in my teaching which included making clear

- what cell division involves
- that interphase is not a stage of meiosis
- the meanings of the various terms

Therefore, I decided that I was going to start off by making explicit what cell division is. My understanding of cell division is that it is the processes of nuclear division plus cytokinesis. Mitosis and meiosis are the two types of nuclear divisions that we know of. Therefore, there are two types of cell divisions which are mitosis plus cytokinesis (type 1) or meiosis plus cytokinesis (type 2). The teaching about what cell division is would be followed by explaining to students that interphase is not part of a nuclear division but that the events of the interphase stage prepare a cell for cell division. To help students to understand the concept, I decided that I would teach them about the cell cycle and the sexual cell cycle. While teaching students about the cell cycles, I would revisit the process of DNA replication. Since research has shown that some students exhibit the idea that DNA replication is the source of

homologous chromosomes, it would be important to revisit the process of DNA replication so that later on when describing the process of meiosis, I would link the products of DNA replication to chromatids.

After teaching about the cell cycles and DNA replication, I would then focus students on the process of meiosis. I would introduce meiosis by discussing with them, the purposes of meiosis; halving of the number of chromosomes in the production of gametes and genetic recombination which brings about variation in sexually reproducing organisms. This discussion would be followed by the description of phases starting with prophase 1.

When describing the events of prophase I, I would focus my teaching firstly, on the formation of chromosomes from chromatin at the beginning of prophase I. My aim would be to help students to understand why we now need chromosomes and not chromatin or DNA? The reason for bringing up this would be two-fold. The first reason would be to strengthen students' understanding of the relationship between chromatin and chromosomes. The second reason would be to help students to understand the role of chromosomes in the cellular events of meiosis. I would do this to establish the link between the genetic structures and the events of meiosis, lack of which has been sighted by researchers as one of the causes of the difficulties associated with the teaching and learning of genetics. While at prophase I, I would also focus on making students understand the confusing terms and processes that are encountered when teaching and learning about meiosis which include the terms double stranded or duplicated chromosome, chromatid, homologous chromosomes, chiasma and bivalent. The processes are crossing over, synapsis, independent assortment and segregation. An explicit description of the above terms and processes is key to understanding the purposes of meiosis and how those purposes are achieved. A lot of visuals are used to promote student understanding of the events of both meiosis I and Meiosis II. Figure 22 shows events of prophase one which I modelled using pool noodles. These are the pool noodles suggested in the conversation with Tony on how to model good teaching in a big lecture room described in section 4.6.1.

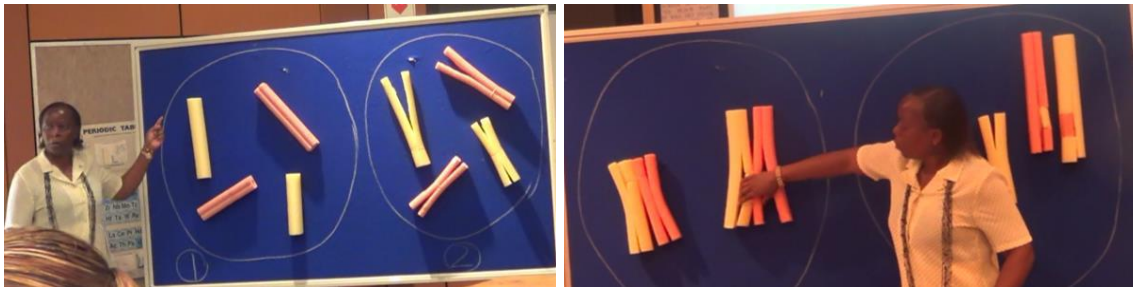


Figure 22: Model of the events of prophase 1

I used the visual structures in Figure 22 to explain the meanings of terms associated with meiosis such as chromatids, homologous chromosomes and chiasma and processes of synapse, and crossing over. At the end of the description of the process of meiosis, there would be a discussion of the significance or importance of the process of meiosis.

4.6.6 Planning for teaching inheritance or Mendelian genetics

Mendelian genetics is a set of rules about genetic inheritance. Genetic inheritance is how genes are passed on from parents to offspring and the variations of traits that we see in living organisms. Therefore, teaching about inheritance involves teaching students about the rules of genetic inheritance and how to use the knowledge of those rules to solve inheritance problems.

When I began my planning for teaching the topic inheritance, just as with my planning of the other topics, my first question was: What are the issues surrounding the teaching and learning of Mendelian inheritance? Research shows that there are some difficulties that are experienced by high school students when learning about Mendelian genetics. I decided that I wanted to be clear about these difficulties and any recommendations that were made then use this knowledge for planning my teaching. Most of the studies that focused on solving Mendelian inheritance problems such as monohybrid and dihybrid inheritance problems were done within the decade from 1980 to 1990 (e.g.Stewart, 1982, 1988; Tolman, 1982) These studies involved analysing misconceptions that students displayed during problem solving. Some of the findings from the studies are described below

- One major difficulty that was identified was the students' inability to relate meiotic events like segregation and independent assortment to Mendelian genetics when solving Mendelian genetics problems.
- Students failed to see the link between meiotic events and the Punnett squares they were drawing to solve the problems
- While some students showed an understanding of individual concepts like gene, trait, allele, dominant, recessive, homozygous and heterozygous others reflected a misunderstanding of these concepts. Many students in these studies were showing poor knowledge of the relationship between the above mentioned concepts.
- It was also observed that students could solve genetics problems successfully without the relevant conceptual knowledge related to the solutions of the solved problems

The main recommendation that came out of these studies was that teachers need to make **explicit** the meanings of and the relationships between concepts relating to genetic inheritance and the purpose of the steps that are involved in problem solving. I took into consideration these findings and recommendations when I was planning my teaching of inheritance.

The other issue that I considered in planning my teaching of inheritance had to do with the nature of science (NoS) as I see it in Mendel's work. You can't teach about inheritance without telling the story of Mendel and Mendel's story is a very good topic for teaching about the NoS. The ideas of Greek philosophers about the mechanism of inheritance and the history of Mendel have important lessons about the nature of science as they show some of the features about the NoS. These features include that:

- Scientific ideas are subject to change and some ideas maybe speculative hunches.
- Scientific knowledge is durable and accumulates over time to give us an increasingly better understanding of the natural world.
- Science is a social process. It is done by people and its procedures, results and analyses must be shared with the scientific community and the public where errors, oversights and fraud can be exposed and confirmation achieved

Previously, I have introduced the topic of genetic inheritance by narrating the story of Mendel. I have however found it to be a very long and unstimulating introduction. So, when I was planning my teaching of this topic, I needed ideas on how to introduce the work of Mendel in an interesting way. Belinda suggested that I organize some students to act out Mendel's story. I found it to be a great idea. However, the logistics of organizing the students to do the act before having taught the class about it meant that a small group of students would have to read beforehand about Mendel and prepare to act the story. This was going to be too involving and time consuming for both me and the students. I therefore decided to create a simple story from my childhood experiences and then use the story to introduce Mendelian inheritance. I used two pictures below of nuts called *nyimo*. Figure 23 below shows how nyimo seeds look like.



Figure 23: Nyimo nuts

My story would go like this: Nyimo are a type of nuts that are used as a source of food in my country. As you can see, nyimo seeds show a variety of interesting patterns which represent different varieties. I used to help my mother prepare nyimo seeds for planting. There is one variety of the seeds that fascinated me. As you can see from the picture above, all the seeds have a distinct white hilum. The seeds that I got interested in are cream in colour with two brown lines running from their hilum. These coloured lines appear like tears running from the seeds' eyes and this makes the seeds to appear as if they are crying. My mother calls them *misodzi* seeds which mean tears. During one season, while I was helping my mother to prepare the seeds, I asked her if I could separate all the misodzi seeds variety and then we would plant them separately. Figure 24 below shows how the misodzi seeds look like.

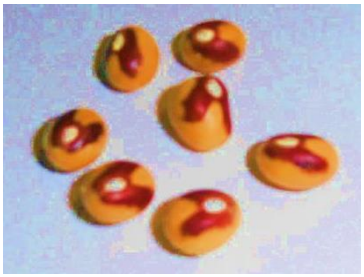


Figure 24: Misodzi (tears) seeds

My mother planted these seeds separately and harvested the plants from these seeds separately. However, when we processed the harvested seeds that is remove the covering, to my surprise and disappointment, the seeds contained other varieties that is seeds of other colorations like plain cream with no tears.

After telling this story, I would initiate a discussion by asking the students to provide possible explanations to my observations and what I could have done to verify their explanations. I

would then relate my story to Mendel's experiments and present his findings. When presenting Mendel's work, I would also highlight features of the NoS that are reflected in his work.

The knowledge and structure of Mendelian inheritance that I teach would be made up of the following: Genetic terms and their meanings and the different types of genetic problems that need to be solved. The genetic terms that students needed to understand included:

- Trait and variation
- Homozygous and heterozygous
- Dominant and recessive
- Phenotype and genotype
- Gene and allele

One major problem that is faced by students in the study of genetics is the extensive genetic terminology. An understanding of these genetic terms is important for successful problem solving. I therefore prepared a lot of visuals, analogies and examples to help the students to understand the terms. For the problem solving part, I was going to first introduce students to the different classes of genetics problems. Typical genetics problems that students should be able to solve can be grouped into five classes as described in an earlier section. These five classes are **simple dominance**, **codominance**, **multiple alleles, sex linkage and partial dominance problems**. I would teach students the procedures for problem solving that is the genetic diagram and the Punnett square. In my teaching, I would make explicit the purpose of every step of the genetic diagram and of the Punnett square. This would be followed by the use of the genetic diagram and Punnett squares in solving a variety of genetic problems from the different classes. I would put up problems on the screen, give students time to work out the solutions then show the solutions on the screen.

4.6.7 Planning for tutorials and practicals

In addition to planning for lectures, I also planned and prepared thoroughly for tutorials and practicals.

Tutorial work

My tutorials would take a number of formats; a list of questions that students would have to answer. The answers to the questions would be handed in for marking or would be discussed during the tutorial period. The questions would be based on the content that we

would have covered in class. I also planned group work in which students would model meiosis and do oral presentations. In the previous years, after teaching about meiosis, I used to divide students into groups. Each group would model one stage of the process of meiosis. At the end of the activity, the groups would put up their models on a board in the order of how the stages occur and the whole process of meiosis would be represented. The purpose of the activity was to encourage students to think about what I had taught them about meiosis as they were constructing their models. My assumption was that students' understanding would be enhanced through this modelling exercise. The students would however just copy from the textbooks without engaging with the events that the diagrams were showing. I therefore decided to add another dimension to what students were doing during this activity by asking groups to do an oral presentation of their models. Each group would, after modelling the stages, explain to the class the events that their model represented and they needed to link their stage to other stages of meiosis. Each member of the group had to say something during the presentations.

Practical activities

I planned a variety of practical activities. The activities included microscopy where students would prepare slides and view them under the microscope or would just view prepared slides showing stages of meiosis. Students would also do a modelling activity called the Reebop activity. In this activity, students would model a number of processes including sexual reproduction, meiosis, fertilization; growth and development (see Appendix D for the activity). The purpose of the Reebop activity would be to consolidate students' knowledge of the links between the above topics. Students would also do role-playing activities. In the role-playing activities, I would create case scenarios. Students would take up roles and do the role-playing. Below are descriptions of two such case scenarios.

Case scenario 1: *Role playing a family in which a happy young couple in a rural community gives birth to an albino child. Some family members think it's a curse for something this couple did. Others accuse the young mother of infidelity. The couple is devastated and they don't know what to do. A respected biology teacher at a local school offers to meet the family and explain how this could have happened.*

Case scenario 2*: Role playing a once happy and close family of six in which the father has developed Alzheimer's disease, a genetic disorder which is characterized by severe memory loss. In the play, the mother shares with her children the experiences of caring for their*

father and why she thinks that it may be a good idea for the children to know their status. Each child explains why they do or do not want to know their risk status.

4.7 Discussion: Planning to teach a course in pre-service teacher preparation, a basis for professional development

Professional development is about learning. PD describes opportunities for learning that are made available to educators to help them to develop or to improve their professional knowledge, competences, skills and effectiveness (Bruce & Calhoun, 2010). In education, PD takes a variety of form; workshops, conferences or degree programs. PD can also take a form of individual inquiry or action research (Bruce & Calhoun, 2010; McNiff, 2010). A variety of topics can be covered under PD such as PD for purposes of improving a teacher's content knowledge in a subject area (content knowledge) or PD for improving the teaching of specific content (pedagogical knowledge). In this discussion I use the term PD to refer to any activity that has the potential to improve a teacher educator's professional knowledge including knowledge of teaching as represented by the four domains of teacher knowledge in my conceptual framework; knowledge of context, knowledge of students, pedagogical knowledge and knowledge of content.

An analysis of what is reported in this chapter shows that after being a teacher educator for five years; I still didn't know my roles and responsibilities except that I was responsible for teaching pre-service teachers. This observation is supported by a vast amount of literature which shows that BTE need induction or training in order to know their roles and responsibilities and to develop knowledge and skills for those new roles and responsibilities (e.g. Chetty & Lubben, 2010; Murray & Male, 2005) . The question then is how should BTE be inducted? What is that new body of knowledge that BTE need? I will use my own experiences of planning to teach the genetics course to identify and suggest some of the knowledge and skills that BTE will need to be inducted into and how that induction can be done.

To plan my teaching of the genetics course, I used the four domains of a teacher educator's knowledge. The four domains of knowledge acted as a template to help me to identify the knowledge that I needed to have to effectively prepare and to teach my course. By taking steps to know about my context, I got to know the aims and objectives of our BEd programme. I also got to know the kind of teacher that we would want to produce. This knowledge became the reference point for everything that I did in my teaching including in

my design of the course. I was now constantly asking myself the questions; what do I need to do in my teaching in order to contribute towards the achievement of the overall aims of our BEd programme. I am therefore of the idea that BTE need the knowledge of the overall aims of the institution which they have become part of as such a document can act as the reference point in their practice as teacher educators.

As part of knowing my context, I also undertook to get to know the whole Life Sciences programme in terms of the content that is taught in each of the four years of the BEd programme so that I could see where the genetics course fits in. Knowing about the Life Sciences curriculum helped me to become aware of the knowledge that students were bringing to the genetics course which is taught at third year level and what they would learn afterwards. Such knowledge of the vertical curriculum is important for planning of one's own courses. I therefore would suggest that in addition to being exposed to documents that outline the overall aims of the BEd programme, BTE should also be exposed to the syllabus so that they become familiar with the whole curriculum for their discipline subjects.

When I read through the various syllabus descriptions for the life sciences programme, I realised that the descriptions were very vague. One cannot get to know the actual content that is taught in a particular course by reading the syllabus description. One needs a course outline as it is the document that has the details of the content to be covered in a particular course. A BTE would therefore, in addition to the syllabus booklet, also need access to course outlines of the courses that he/she would be teaching and of other courses in his/her subject area as part of the induction process. In addition to be familiarised with the syllabus and course outlines, BTEs need to be inducted on how to produce own course outlines. This is because, by developing own course outlines, teacher educators will be in a position to be able to explain what they do in their courses and why. Being able to say what you do and why is part of what it means to be a professional (McNiff, 2010).

Through planning the genetics course, I gained knowledge about the content that I teach and content knowledge is one of the domains of teacher knowledge. Therefore, designing or taking part in the design of the courses that you teach can help you to develop your content knowledge. An activity that develops a teacher/teacher educator's content knowledge is a form of professional development. As part of designing the genetics course, I constantly consulted colleagues regarding the content that I was planning to teach and also to get ideas on how to teach that content. Through these collegial practices, I gained teaching ideas from colleagues which I adapted for my own teaching thereby promoting the

development of my own PK. Knowledge of one's students which is one of the four knowledge domains can also be gained by consulting colleagues who have taught the students before.

Having used the four domains of knowledge to identify the knowledge that I had and to identify the knowledge that I needed as a teacher educator, I argue that these four domains of knowledge can be used in the induction and professional development of BTE to help them to identify the knowledge that they have and the knowledge that they need to have then use that information to plan induction and PD activities that will help the BTE to develop the new knowledge and skills. The planning of the induction and PD activities can be done as individual inquiry or action research. In this study, my own PD was promoted through a self-study.

4.8 Conclusion

In this chapter, I have described how I planned my teaching of the genetics course using the domains of teacher knowledge in my conceptual framework as a guide. By planning the genetics course using the four knowledge domains as a guide, I gained knowledge about teaching in terms of my context, my students, PK and genetics content and about making the planning process a PD exercise. I have also discussed how through the process of planning my course, I got to know about some of my roles and responsibilities as a teacher educator. I have therefore argued that the four domains of teacher knowledge can be used as a guiding framework in the induction and PD of BTE. In chapter five, I describe and discuss my observations as I implemented the teaching plan that I have described in this chapter.

Chapter five: My reflections on incidents that occurred during my teaching

Each act of teaching, of caring, of supporting is also an act of learning: learning about the students, learning about the situation and learning about oneself (Mason, 2002).

5.1 Introduction

In chapter four, I described in detail my in preparation for teaching the genetics course. In this chapter, I look at what happened during the teaching that followed that preparation. I describe some incidents that happened during my teaching of the course. I have used the term **trigger incidents** (TIs) to refer to these incidents as the incidents activated thoughts, feelings or emotions in me that prompted me to respond in one way or another. Reflecting on those incidents became a basis for powerful learning experiences about my teaching and students' learning. I presented the TIs to my critical friends (CFs) for feedback. In this chapter, I present both the TIs and my reflections on them. Where a critical friend commented on a TI, the comments immediately follow my reflections and my response to the critical friend's comments follows the comments. I support my responses with statements from literature about shared language. Below, I first explain the notion of shared language as explained by Loughran (2006). What I present in this chapter helps me to answer my second research question: *How is my practice as a teacher educator transformed as I examine and reflect on my teaching of genetics to pre-service teachers?*

5.2 The notion of shared language about teaching

The notion of a shared language as articulated by Loughran (2006, p. 63) describes ways that are used by teacher educators to articulate for oneself what one has come to know about oneself and about one's practice. At the same time, a shared language also offers a way of communicating and sharing that knowledge of practice with others thereby making professional knowledge of teaching accessible to others (Loughran, 2006). Northfield's shared language that he used to articulate his knowledge of practice was in the form of what he called *summary statements*. Berry's shared language was in the form of the concept of *tensions* and Loughran's was in the form of what he called *assertions* (Loughran, 2006).

Northfield developed summary statements after embarking on a sustained process of learning about teaching by going back to teach in a high school classroom for a year (Loughran, 2006). He developed 24 statements under the themes nature of learning, creating conditions for learning, students' perspectives on learning, process of teaching and learning and overall reactions. Berry (2004) formulated the construct of tensions after an extensive review of literature on teacher educators' learning about their own practice. Tensions capture the conflicting purposes of a teacher educator's work (Loughran, 2006). An assertion is a statement which describes what Loughran came to know about practice through taking a self-study stance. The motivation behind the development of assertions was a realization of the importance of making teacher educators' knowledge accessible to others (Loughran, 2006). Other ways of articulating expert knowledge that are found in literature include paradoxes *(P. J. Palmer, 1998),* program principles, and axioms (see Loughran, 2006, pp. 67, 72) respectively. In this chapter, I made use of this shared language to support what I have come to understand about my teaching from the trigger incidents.

5.3 Trigger incidents during my teaching of the genetics course

As described earlier in chapter 3 and briefly stated in the introduction above, the events that I describe as TIs are events that activated my thoughts, feelings or emotions, what Mason (2002), referred to as sensitivities and prompted me to reflect on what was happening during my teaching of the genetics course. Some of the incidents happened during lectures and others outside the classroom as I interacted with the students. I have coined the term **trigger incidents** to bring out the idea that the events may be commonplace occurrences but there were moments during those events that captured my attention. I am going to call those moments **trigger moments** (TMs). TMs prompted me to reflect on the TIs. When I reflected on the TIs, I was able to learn something different to my previous interpretation of the events. Below, I present the seven TIs which facilitated the transformation of my practice. I have underlined the parts of the description of the incidents which identify the incidents as trigger incidents.

The first TI was the **unexpected responses** that I got from students in my introductory lecture. The second TI was the **non-participation in discussions** of some students. The third TI was the **refusal by students to participate in whole class feedback sessions**. The fourth TI was **my failure to understand a student's question**. The fifth TI was when a **student walked out** during a presentation by a guest lecturer which I then perceived as rudeness. The sixth TI was **a comment by a student** which showed his thinking that as a

lecturer I no longer need to read in preparation for lectures as I now know the content. The last TI was about the students who earlier in the course had refused to participate in whole class feedback sessions but later in the course participated in the role-playing activities without a problem. These are some of the events that made an impression on me and prompted me to reflect. I present these TIs in detail below.

5.2.1 The first trigger incident: The unexpected responses from students which showed the influence of prior content knowledge on students' learning

In my first genetics lecture, I used the picture in Figure 25 below to explain the bigger picture of genetics.

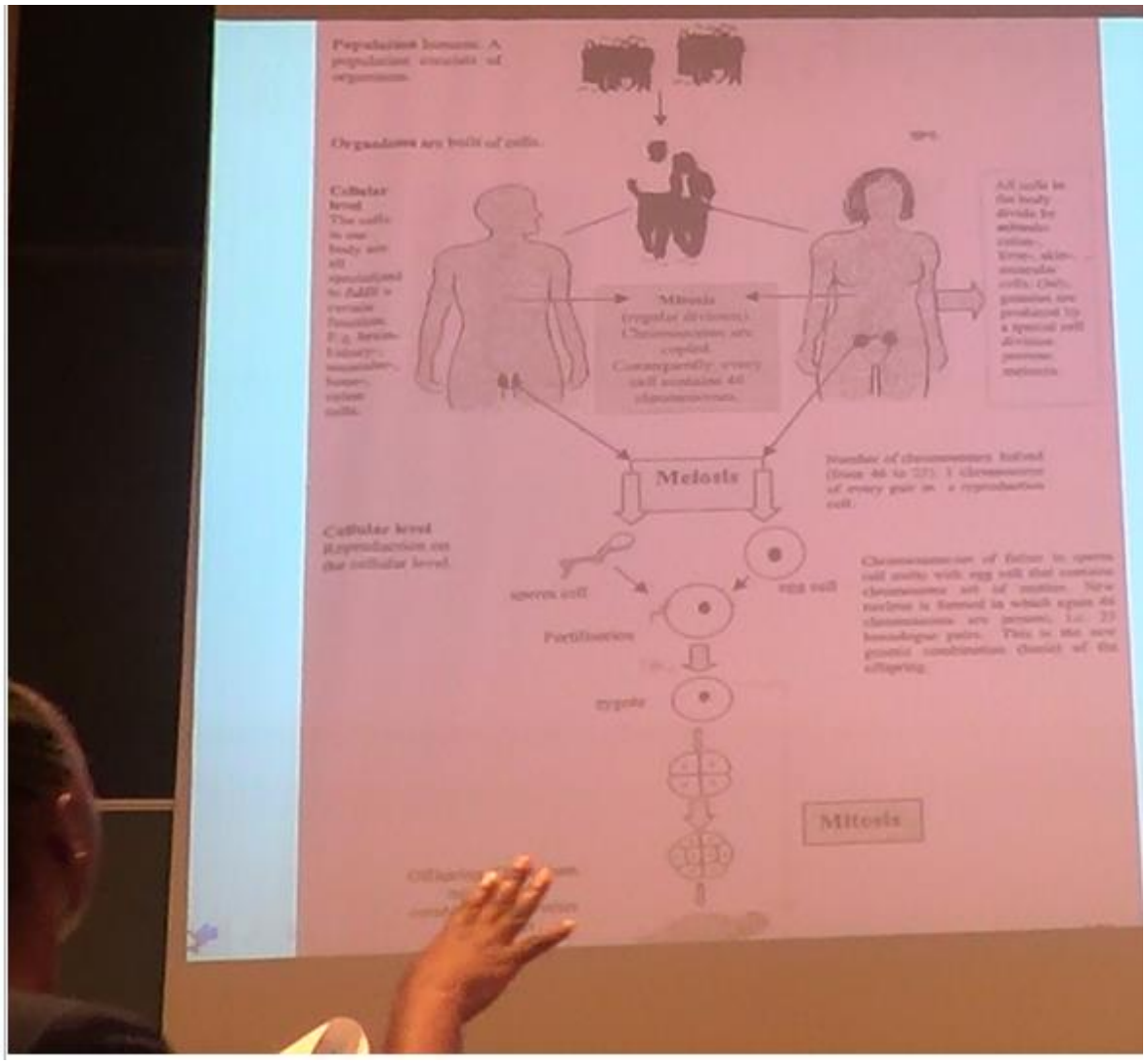


Figure 25: The bigger picture of genetics

When I asked students to tell me what they could see in the picture, I had expected certain answers from students. I had expected the students to say that they could see a group of people, a couple, a man, a woman, a child, a cell, a group of cells and so on. However, the answers that students gave were different to what I had expected. One student said she could see reproduction taking place. Another student said he could see the division of cells. Another student said she could see that the child was different to the parents. When I got the first answer, I felt the urge to say to the student "but you can't see that on the picture" but I decided to wait and hear all the answers from the students first. To my surprise, all the answers that the students gave were different to the answers I had expected. These unexpected answers marked a TM for reflection.

My reflection: *Students' answers were an interpretation of what the picture was showing not what the picture was showing*. *Students had prior knowledge of the processes that result in the production of a child and in the production of many cells; therefore, they used that knowledge to view and interpret what was on the picture. I could see students' prior knowledge in action influencing their thinking of what the picture was showing. I thought of the lessons that I could glean from the way students had responded to my questions. The first lesson that I thought of was what could happen had students' prior knowledge been wrong. In this case, students' prior knowledge was scientifically correct and therefore their interpretation of the picture was also correct. If their prior knowledge about the events shown in the picture was wrong, it could have resulted in the wrong interpretation. The incident therefore acted as a reminder that students' prior knowledge can impact their learning of new content hence I should constantly explore students' prior knowledge during my teaching in relation to what I will be teaching. Exploring students' prior knowledge will enable me to deal with any misconceptions and misunderstandings that students may display and also to highlight the links between their prior knowledge and new content. The incident was also a lesson on how prior knowledge of students can influence their learning.*

Tony: Isn't this a basic tenet of constructivism? Shouldn't you refer to that?

My response: As explained in section 2.6.3, constructivism is a theory of learning which postulates that individuals learn by constructing new knowledge from prior experiences and therefore in the teaching process finding out students' prior knowledge and working with that knowledge is key to successful teaching and learning (Novak, 1977). It was only when Tony asked me the question above that I realized that I had implicitly and 'successfully' applied the theory of constructivism as put forward by Ausubel (1968) in his theory of meaningful

learning in my first genetics lecture. I say successfully because, the picture that I used acted as an *advance organizer* which directed the students' attention to what was important by highlighting relationships between concepts involved and also the relevant prior knowledge. In the process of using the picture to introduce my lecture, I got to know the prior knowledge students had about the concepts linked to genetics such as reproduction and variation and because students had displayed that knowledge, instead of just using what the picture showed to describe to them the bigger picture of genetics I built on what students knew in my description of what genetics is all about and that is indeed constructivism. This is shown in the excerpt below.

Lecturer	You spoke of division of cells. Division of cells in meiosis, It can be mitosis. So under genetics then we are going to look at meiosis, and we are going to look at mitosis. These are two separate…different types of nuclear division and for different purposes. So we are also going to look at that. And someone said the offspring is different to the parents. And then we want to know why the offspring is different to the parents. And then if we look at the population and if you consider ourselves here to be a population, we are all human beings but we are all different. Why are we different? We want to look at that, and that's what genetics is all about. So those are the issues that we will be looking at in genetics. And when we look at genetics we can't separate that from reproduction, because from parent to offspring it's reproduction. That's how the genes are passed on from parent to offspring.

Tony's question also helped me to see a real example of constructivism in my own teaching. This observation then motivated me to go back to the video-recordings of my lectures to check if there were more cases of constructivism. I was amazed by the extent to which I use constructivism in my teaching. Every stage of my teaching reflects aspects of constructivism such as use of models, use of analogies and of authentic examples (Cimer, 2007) (see the analysis of my teaching later in chapter six). Getting to know that I use constructivism in my teaching was the beginning of an understanding of my teaching and that understanding had come through what Mason (2002) described as *noticing* and prompting from a critical friend. To notice is to perceive or to become aware of a change in one's environment or situation (which in my case is a teaching situation) that is captured by sensitivities which may be emotional, physical or cognitive (Mason, 2002). Talking about the incident with a friend helped me to see and to understand the salient aspects of my teaching thereby confirming

assertion 12 by Loughran (2006, p. 77) which says: *A shared experience with a valued other provides greater opportunity to reframe situations and confront one's assumptions about practice.*

When I look back at the above episode of my teaching, I see that by suppressing the urge to respond to students' answers on the basis of what I was expecting from my planning, which could have influenced other students' answers, I *acted* on students' unexpected answers instead of *reacting* to them and proceeded with my explanation in the light of the answers students had given. To act means that I first thought about what students' answers meant and then responded accordingly (Mason, 2002). The TI therefore, also helped me to see one example of Berry's tensions (2004) that may arise in a teaching situation that of whether to stick to plan or be responsive to learning opportunities as they arise in practice.

There are also other aspects about my teaching that are reflected in TI one; an aspect of caring for students and an aspect of having pedagogical knowledge. This is reflected in my use of the picture to introduce genetics. By looking for a visual aid in the form of a picture to help students to understand the content that I was going to teach is an act of caring for the students and evidence of pedagogical knowledge.

5.2.2 **The second trigger incident: Students' non-participation in discussions during lectures**

In my lecture on meiosis, after I had finished describing the events of prophase 1 (shortening and thickening of chromosomes, synapsis and crossing over) I asked students to describe the same events to those who were sitting next to them for them to see if they had understood what I had just described to them. (Note here that this pair discussion activity is a constructivist teaching and learning activity). When I give students an activity to do, I expect all students to participate in the activity as the activity will be part of the teaching and learning process. During that interval discussion, I observed that some students were not participating in the discussion. When I saw the students just sitting and not participating in the discussions, I immediately felt that these students were undermining the teaching and learning process by not doing what I had asked them to do. Under 'normal' circumstances, despite the disheartening feeling that the students were undermining the teaching and learning process, I would have ignored such behaviour as long as the students were not disrupting the lecture proceedings. This is because in my view, pre-service teachers at third year level of their BEd studies are mature adults who should know what they want from a lecture. However, because I was doing this study and I wanted to understand what happens

in my lectures, I did not ignore what I had observed. I went to the students to find out why they were not participating in the discussions.

On inquiry about their non-participation, one student (Regina) said, “Listening to you is enough for me ma’am and don’t worry because I have understood”. She even offered to describe the processes to me so that I could know that for sure she had understood. The other student (Dylan) said he did not do biology in Matric and what I had said was so much that he felt overwhelmed. He would rather go over it on his own in silence than describe it to someone else. Students’ reasons for not participating in the discussions marked a TM for reflection.

My reflection: *By going to find out why the two students did not participate in the discussions, that made me to immediately realize that my assumption that students were undermining the teaching and learning process turned out to be wrong pointing to the importance of inquiring or checking students’ behaviour before drawing conclusions. Students had ‘genuine’ reasons for their non-participation. I then wondered about what had made me think that students were not participating because they wanted to undermine the teaching and learning process? On reflection, I realized that my assumptions were based on my pre-conceived ideas that are influenced by my own lived experiences. I have had cases before even as a high school teacher when students or learners would just disregard what I wanted them to do as part of the teaching and learning process which in some cases ended up disrupting the flow of the lesson. By going to students, I managed to act on what I had noticed instead of reacting (Mason, 2002) and it helped to correct my assumptions. If I had ignored students’ behaviour, such a response would have conformed to Mason’s assertion that when supporting and caring for others as a teacher or in some other ways, common situations (like students’ behaviour in this case) can become habitual and when those situations arise, “instead of responding sensitively, we frequently react according to established patterns” (Mason, 2002, p. 8) which in this case was ignoring the students.*

On a different note, I used to think that allowing students to discuss their understanding of a concept that I would have just taught before moving to the next concept was an effective way of promoting learning and of affording students a chance to assess their own understanding during lectures. Like Mortimer and Scott (2003), I strongly believed that talk underpins the learning process. It never occurred to me that discussing may not be a preferred learning style for some students. Therefore I always included discussion time in my lectures to allow students to talk about their understanding of concepts and I expected

everyone to participate. From reflecting on what the students had said to me, I became aware of three pedagogical aspects. The first one is that discussion during teaching is a teaching style that caters for students who learn better by actively processing information (Felder & Silverman, 1988). Discussions would therefore not work for students like Regina and Dylan who prefer to process information silently through introspection, watching and listening. I therefore need to give students several options during my teaching in order to cater for a range of learning styles e.g. discuss, think about it in silence or write down or draw. The insight above confirms one of the paradoxes of teaching as identified by Palmer (1998) which says that one's teaching space should welcome both silence and speech and Northfield's summary statement number 12 under the theme creating conditions for learning which says that there is a need for teachers to respond to contextual factors and make intuitive decisions rather than always following the plan (Loughran & Northfield, 1996, p. 124).

In addition to bringing out the importance of investigating students' behavior instead of making assumptions and the importance of varying learning styles when teaching, what Dylan said also confirms what was explained by Bligh (1998), that the working memory of a learner (short memory) which is where information processing occurs is very small. Therefore, because the flow of information during a class is faster, the short memory is quickly overloaded. That information needs to be transferred to long term memory to create space again in the short memory. Before that can occur, no further learning takes place. Short breaks like the one that was taken by Dylan allows students to process new information according to Svinicki (1999) thereby recreating space in the working memory.

California: You were able to discover these things because you reached out to students. You wouldn't have known these things if you had not reached out to them. You do not see your position in front of the lecture room as your fixed position. You go to your students to find out, to try to know individual students at a much deeper level. This is student centredness.

My response: California's comments helped me to see what I had done above in a different light; that by going to students to find out what was happening; I had reached out to students. By reaching out to students, I had learnt about students' individual needs which helped me to respond to their needs appropriately. In addition, by reaching out to students, I had also reached out to my own perceptions of such student behavior. Note again that **noticing** what was happening in my classroom and acting on it by checking with students

concerned and discussing it with a friend helped me to understand one way of reaching out to students and the importance of reaching out to them which is that one gets to know the students at individual level. By reflecting on TI two I gained not only knowledge about my students, but also pedagogical knowledge.

5.2.3 The third trigger incident: Students' 'refusal' to participate in whole class feedback sessions

Every time when I give students work to discuss, this is followed by a whole class feedback session. On this day, which was a third lecture of my course, two students (Simba and Kuda) were discussing the questions that I had given them. As the discussion was continuing, Simba and Kuda put up their hands. I went to them and they said they wanted to tell me what they had discussed so that I could give them feedback. I then said to them that they should hold on to their answers. We were going to do as we normally do; one feedback session involving the whole class so that we can all learn from each other's answers. Kuda then said "No ma'am, they will laugh at our English". This utterance by the student immediately caught my attention and marked a TM for reflection. I then told Kuda that no one would laugh at him. I had strongly talked against ridiculing each other because of different English accents or poor English at the beginning of the course and therefore had assumed that every student would be comfortable enough to actively participate in any learning activity. Simba then said "What if our answers are wrong. Please ma'am". The students were actually now pleading with me. I listened to their answers and gave them feedback.

My reflection: As I reflected on the above incident, *I understood how the students were feeling because I have experienced the same as an English second language student (see my autobiography in chapter 1). I remember being laughed at during my high school days not once but several times for speaking grammatically wrong English in class and that completely silenced me. As narrated in my autobiography, those like me who could not speak English fluently were even given a name; SRBs meaning those with **s**trong **r**ural **b**ackgrounds. The ridicule that I experienced due to my poor English competence stopped me completely from actively participating in class during my high school days and as a result, I became what I would call a silent student. That's why at the beginning of the courses I teach, I always talk about this issue of English saying that those who are English First Language speakers should know that they are privileged because we use English as the language of instruction. I then try to encourage the rest by saying that they should never be*

silenced by the fear of speaking grammatically wrong English because it is not their home language. I had not witnessed any ridicule in my lectures but that did not mean that it was not happening. I therefore, realized that Simba and Kuda were not going to say a word during those feedback sessions for fear that they would be ridiculed. Regina and Dylan had not participated in discussions for some reasons and now Simba and Kuda were not going to participate in the feedback sessions for other reasons different to those for Regina and Dylan. I had to think of ways of getting Simba and Kuda and others like them involved during the formative assessment tasks by creating a less threatening environment for them. Listening to individual students or groups was not practical for me due to the size of the class which was big (91 students) and also the lecture room structure. This is what motivated me to start using flash cards for the quizzes that I was doing with them. The flash cards would enable the students to show their answers to me during feedback sessions without them worrying about their English or that others will see their answers in case the answers would be wrong (see section 6.4.3.6 for more information on the quiz)*. From this trigger incident, I could again see the reality of Northfield's summary statement number 12: there is a need for teachers to respond to contextual factors and make intuitive decisions rather than always following the plan.*

California: You are empathetic. The fact that you went to the students despite the structure of the lecture theatre and listened to them and were able to understand their position is empathy. I again see student centeredness. Most of the times we think of student centredness in terms of getting students to be actively involved but there are other levels of student centredness. Go and read a conference paper by Cliff Malcolm and Moira Keane. They described three levels of student centeredness and I am sure yours is one of them.

My response: As a follow up to California's recommendation, I read the conference paper by Malcolm and Keane (2001, p. 3) and found out that in their paper, they suggested that there are three levels of learner-centredness which are (1) caring for students (2) learner-centred pedagogy and (3) learner-centred outcomes respectively. What I did in incidents two and three above reflect the first level of learner centredness which is caring for the students. Level one learner centredness is when a teacher does what makes students feel that the teacher understands them, loves them and believes in them (Malcolm & Keane, 2001). According to Malcolm and Keane (2001), the classroom in which level one learner-centredness is practiced is characterized by respect, care, security and community. At this point I realized that the issue of caring for students was an aspect that was reflecting in all the three trigger incidents. The aspect that I care about students was also coming up for the

second time in this study. The excerpt below is from chapter four. The excerpt shows how the issue of caring first came up. It was in California's response to the genetics course breakdown document that I had produced:

Your document shows that you are worried about what students know, about students grasping content. You are actually taking steps and the steps show through in various ways in your document. Caring comes upfront in your document, caring for your subject, caring for your profession and your students. So for me the big thing in your document is caring.

In response to the above comment by California, I had asked her the question: What does it mean to care in science teacher education to which she had responded "your caring attitude is seen in your focus which is all round: focus on your present students, their future students and on our profession as a whole*"*. I had then further asked California: If students do notice that I care about them and about their future as teachers as you said, would that impact their learning of genetics. California's answer was "Let's wait and see what they are going to say after teaching them".

There is an aspect of caring in TI one as I highlighted earlier. My discussion of TIs two and three with California gave me another example of what it means to care. I had left the position in front of the lecture theatre to go and find out what was happening with the students. Going out to students and listening to them is a characteristic of level one learner-centredness which is caring for students. All of California's comments above helped me to understand student centredness in a different way. I got to understand that caring for students in one's teaching is a form of student centredness.

California also commented about me being empathetic. The empathetic stance was activated by my ability to notice which then activated my own experiences of being ridiculed because of my poor English. I could not stand the idea of exposing these two students to the humiliation that I suffered at the hands of my own peers during my high school days and at university. The way I responded to this incident shows that our ability to notice and whether we act or react to what we notice can be influenced by our own lived experiences. By noticing and responding to what was happening during the lectures, I was gaining knowledge about my students and having knowledge of one's students helps a teacher to create conditions that would promote the learning of all students.

5.2.4 The fourth trigger incident: Failure to understand a student's question

It was a lecture in which we looked at problem solving and we were analyzing the inheritance of ABO blood groups. I gave the following explanation about blood groups:

What do we mean when we say blood groups? These are proteins that are found on the membranes of red blood cells. Blood is made up of red blood cells. The red blood cells contain the red pigment and just like any cell, they have proteins on their cell membrane and those proteins are what we will be referring to when we say blood groups. So when a person is said to be blood group A, it means his red blood cells contain A proteins. If he is a blood group B person the proteins on the cell membranes of his red blood cells will be B proteins and Blood group O means there are no proteins on the red blood cells and then for the blood group AB person both proteins A and B are found on the cell membrane.

The explanation was accompanied by diagrams of red blood cells that I had made shown in the screen picture in Figure 26 below. Although I knew that red blood cells are biconcave in shape it was difficult for me to represent a biconcave shape. Therefore, the diagrams were flat circles filled in with red colour on which I had included letters A and B to represent the A and B proteins.

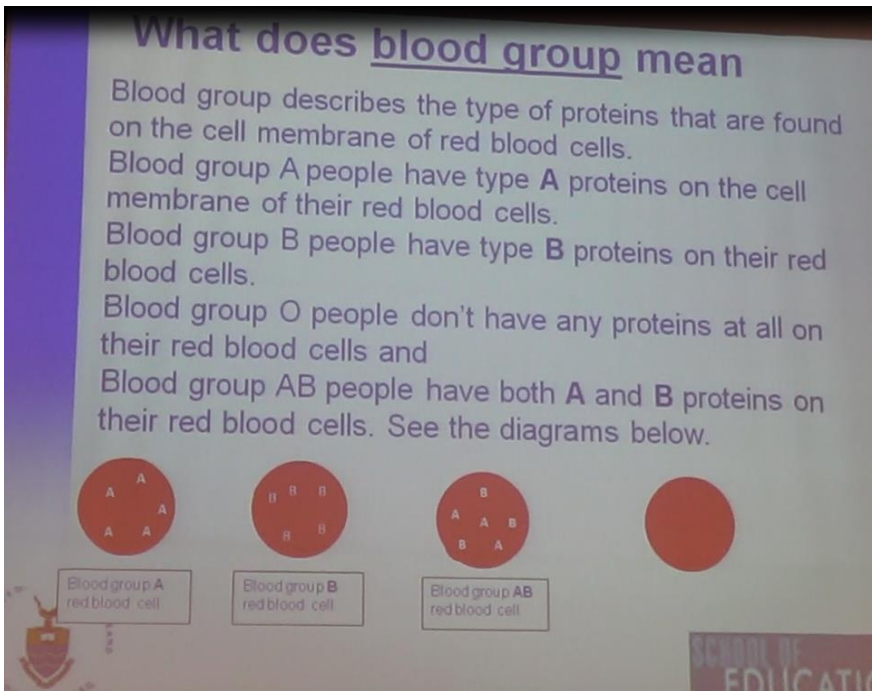
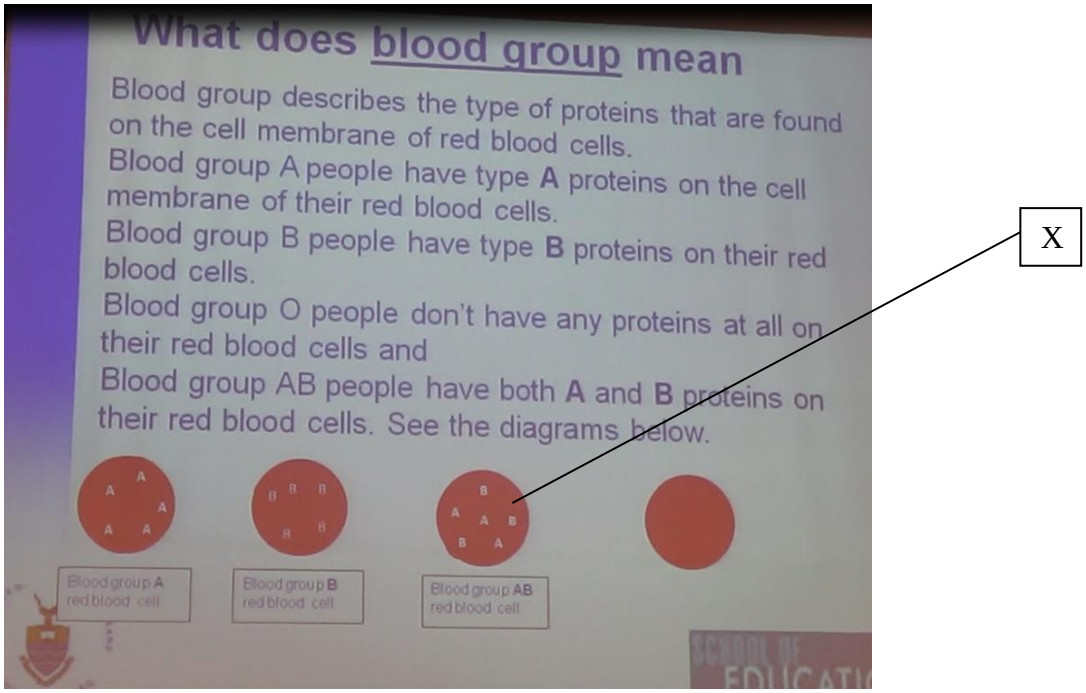


Figure 26: Explanation of blood groups

In response to my explanation above, a student (Fadzi) asked the question “For the blood group AB person, does it mean that a person will have an equal number of red blood cells with A proteins and red blood cells with B proteins?” I responded to the student by saying that both A and B proteins are found on each red blood cell of a blood group AB person as shown in the diagram. Her next question was “Do we have an equal number of A and B proteins on the cell membrane of the blood group AB person?” My answer was: No. I don’t think scientist can actually count how many of these proteins are present on the red blood cell. After this answer, the student did not ask any further questions.

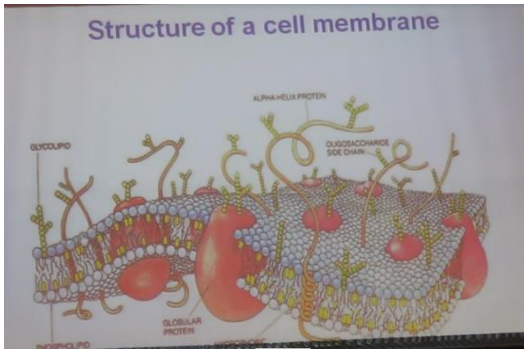
After the lecture, I played back the video and watched it with a friend. When we got to this episode of the exchanges between me and the students, my friend commented: “You did not answer the student’s question”. This marked a TM for reflection. I thought I had adequately answered the student but my friend helped me to see that I had not adequately answered it. I had failed to notice what was behind the student’s question and as a result had failed to give a satisfactory answer to her question. My friend had interpreted the diagrams in exactly the same way as the student and so he pointed out that my diagrams were actually the source of the student’s confusion. As can be seen on the diagram of the red blood cell labelled X showing blood group AB cell, I had put equal numbers of A and of B.

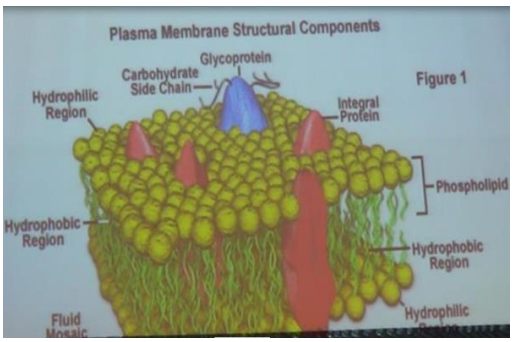


I then realized that my diagram could have sent a wrong message to the students. I then suspected that the source of the problem could be students’ lack of knowledge of the structure of cell membranes and decided that in the next lecture, I was going to use pictures

of cell membranes for the students to see how complex a cell membrane is and how proteins are arranged within a cell membrane. My hope was that if the student gets to know the structure of a cell membrane then the misunderstandings that had been created by my diagrams could be cleared. In my next lecture, I revisited the student's question and explained again using the diagrams shown in Figure 27 below. This was my explanation:

Yesterday there was a question on whether there will be the same number of blood group A, and blood group B proteins on the red blood cell of a blood group AB person. I didn't understand that question, then after the lecture the question was clarified. So I thought I'd show you the structure of a cell membrane for you to see that the proteins are not evenly distributed on cell membranes.





A B

Figure 27: Diagrams showing the structure of a cell membrane

The way I had drawn the red blood cells was as if the A and B proteins are evenly distributed but it will not be like that. So even on the second diagram (B) you can see that we have these different types of proteins, and in this case we have four red ones and just one blue one. There is more of one type that the other. So that's how the proteins occur on the cell membranes even of red blood cells.

At the end of the lecture Fadzi came to me and said: Ma'am, so you really take our questions seriously. You went back and researched on it? Wow Ma'am.

My reflection: *Firstly, the incident confirms assertion 12 by Loughran (2006, p. 77)* that :*A shared experience with a valued other provides greater opportunity to reframe situations and confront one's assumptions about practice*. Secondly, F*adzi's expression "*wow Ma'am*" which is an expression of wonder and awe was a TM. It seemed as if I had done something that Fadzi never expected. I wondered why she would not expect something like this from me. The student's comments imply that she used to see me as not giving enough attention*

to their questions but now she has just realized that I do take their questions seriously "Ma'am so you really take our questions seriously*". Fadzi seemed to not have been aware that when I do not answer their questions adequately, it is not because I do not take their questions seriously but I would actually be thinking that I have answered them. As a result students do not pursue their questions further. This incident confirms the importance of building a trust in students as suggested by Loughran (2006). Trust will build in students' confidence that any problems, concerns or issues that they will raise in the teaching and learning environment will be seriously considered. Without building that trust in students, they may not be motivated to speak up or in my case to take the risk of asking questions.*

If I was not doing this study in which I took time to look back at what was happening in each and every one of my lectures, I would not have picked up (through a friend) that I had not adequately answered the student's question. As teacher educators, it's not always possible to reflect at length on what happens in our lectures due to time constraints. However, we can learn to listen carefully to students' questions. It may also help to check with our students if we have understood the student's question by 1) repeating the student's question e.g. in this case, I could have said: Are you asking if the number of A and B proteins would be the same on each red blood cell? It would also help to probe the students further before answering the question for example, what do you think is the case and why? Having said this, the simple truth if we are to improve our teaching is to invest time for a careful review of our teaching practices one lecture at a time. This simple truth is captured in Northfield's summary statement number 22 Loughran and Northfield (1996, p. 124) which says that time and careful review are essential for professional development.

California: What I see here is that you assumed that students would have the knowledge of the structure of the cell membrane and therefore would not be confused with your diagrams in spite of one student who had told you in an earlier lecture that he had not done matric biology. You did not think beyond the previous incident to understand the implications of having students in your genetics class who had not done biology in Matric.

My response: California's comment above was crucial. The implications of having students who had not done biology at Matric level were huge. I was aware of the situation and had actually said in my planning that I was going to start from the basics to cater for such students. This incident showed that determining the basic knowledge to begin with is difficult. In this case I had thought that starting with the structure of the red blood cell was the basic knowledge that students would need in order to understand blood groups but unfortunately,

what was basic for me was not basic for students. TI number four confirms Northfield's summary statement number 24: *Understanding students' responses requires details of student and class context* (Loughran & Northfield, 1996, p. 124)**.** The incident above and the summary statement number 24 show that as a teacher educator, it is important to have knowledge of students which is one of the knowledge domains that teacher educators should have as indicated in my conceptual framework. That knowledge includes their prior knowledge about content to be taught.

From reflecting on TI number four above, I gained PK. The PK that I gained from this TI is the importance of listening carefully to students' answers, the importance of prompting students when they ask questions instead of rushing to give them correct answers and the importance of building trust in students. In addition, I also learnt that I really need to think through the teaching aids that I choose to use in my lectures and make sure that the T/L aids won't cause misunderstandings of content in students.

In addition to gaining PK, I again see the aspect of caring for the students in the fourth TI. Finding new ways of answering a student's question and admitting to the students that I had misunderstood the question are aspects of caring for the students. This caring aspect is what actually amazed Fadzi "Wow ma'am, you really take our questions seriously".

Georgia[12] in her critique of my lectures made the following comment: "Acknowledging to students that your teaching could have been a source of students' misunderstanding is commendable. I am sure that students appreciated it". Students did appreciate it as shown by Fadzi above. Even later during interviews, students made reference to these cases when I brought in new T/L aids to improve my explanations of the concepts that I had taught in the previous lectures. The utterance by Munya below illustrates this point:

Munya: Basically I would talk concerning the way in which she interacted with our questions that we had towards certain, about certain concepts. So basically she would come to class, if you ask a question, the following lecture she would make sure that she come to class having visual aids to further elaborate on whatever we had a question on.

[12] Georgia watched the video of my lectures and critiqued my teaching.

Munya's utterance shows that he eventually developed a trust that when they ask questions during lectures, I will do my best to answer them.

5.2.5 The fifth trigger incident: A student walks out during a presentation by a guest lecturer

On this day, I had invited a guest (Patronella) for my lecture on genetic diseases. Patronella suffers from cystic fibrosis. The aim of inviting her was for her to share with the class her experiences of living with the disease. Towards the end of Pat's presentation, one student (Walter) walked out of the lecture theatre. At that moment, I felt that what the student had done was very rude. The questions that came to my mind were: Did he feel that it was a waste of time? Was it boring? However, because of an earlier experience (see incident number two above), I did not want to speculate why he had walked out. I decided to find out the next time I would meet him. When I met him during the course of the week, I said to him, "You walked out before the end of the lecture, was everything ok"? The student's response was: "No ma'am. I will come to your office to explain". Walter came to my office and explained why he had walked out of the lecture theatre. Walter has chronic TB and has to use an inhaler twice a day for the rest of his life. His mother died of TB. He doesn't know his father. Walter doesn't understand why his TB cannot be cured. The presentation by Patronella of her own experiences of living with cystic fibrosis had aroused a whole lot of emotions in him that he could not take it anymore and hence he decided to leave the lecture theatre. Walter's account was a trigger for reflection.

My reflection: *I have never before asked students who walk out of my lectures their reasons for walking out although I always feel that it is not fair for them to do so because I invest a lot of time and thought in my lectures. A previous incident had helped me to notice the importance of following up on Walter. This trigger incident reinforces the importance to me as a teacher educator of acting on students' behavior by finding out why students engage in certain behaviours. Walter's reason for walking out during Patronella's presentation is not something I had anticipated which was an emotional arousal of what he was going through in his own life. The reason why I had invited Patronella to come and share her experiences with the students was for students to realize that the diseases that we had discussed in the course were not something theoretical but real. I also wanted the students to see that having such genetic diseases is not a death sentence. With advances in medical technology, it was now possible to live a normal life. What was important was to understand the diseases and*

manage them. When I organized the presentation, I did not realize that such a presentation could have an emotional impact on students something that I now need to consider in future.

When I reflected on this incident and on the previous incident when students did not participate in the discussions, I realized the importance of paying attention to both my own emotions that are triggered by certain students' behaviour and acting on students' behaviour. Being attentive to students' behaviour is one way of getting to know one's students. I also started to pay attention to students' performance. By paying attention to these aspects of students, I got to know many of my students at personal levels. Coming late for lectures, achieving low marks, achieving high marks were all opportunities that I started to notice and to act on to reach out to individual students which in turn allowed me to know students at personal level. I did not get to know all my students but I got to know many of them. I then started to notice a trend where more and more students would come for extra help during consultation times. I also had students who would call me to apologize in advance or would send their apologies through friends that they would be late for lectures. It appeared that by getting to know the students, I had opened a comfortable space where it was now easy and comfortable for the students to communicate and interact with me. There is an assumption described in the literature that when students perceive that their teachers care about them, those students will care about class and are likely to pay attention in class which may result in student learning (Teven & McCroskey, 1997). My observations above seem to support this assumption.

5.2.6 The sixth trigger incident: <u>Student's thinking</u> that I don't need to read anymore in preparation for my lectures because I know the content that I teach

A student (Nyasha) came to see me after a lecture one day and asked: "Ma'am where do you get this information that you teach us. I went to the library and there is nothing similar to what you are teaching us". I answered him jokingly saying this is PCK. I am transforming the content that is described in the textbooks for teaching you. Nyasha was however not convinced. He thought there was a book somewhere that I was using and I did not want him to know about it. I felt disappointed by what Nyasha had said because it implied that Nyasha would never understand and would not appreciate the effort that had gone into my preparation of the lectures and this triggered a reflection.

My reflection: *Nyasha was convinced that I was implementing in my lectures something that was described in a book or module and wanted access to this source of information. I thought it would be necessary at some point to explain to Nyasha what it had taken me to present the kind of lectures and the content that I was presenting. One day I saw him sitting in the concourse at break time. I called him so that I could explain what I had done in preparation for my lectures. He looked surprised when I called him. He walked to me and said "Ma'am you know my name". He then turned to the other student who was sitting with him and said "Ma'am knows my name". Nyasha's surprised response that I knew his name triggered another moment for reflection. We stood on the side of the concourse and I explained to him that as part of my preparation for teaching the genetics course, I had read research articles on the teaching and learning of genetics. I had consulted colleagues and I had done a great deal of thinking. Therefore, it had taken me a great deal of time and effort to put together the content that I was teaching and the teaching that I was doing. While he believed what I had said to him about my teaching, Nyasha was surprised firstly, that I had to read lots of material in preparation for my lectures and secondly, that this included research articles not only textbooks. Furthermore, that I think hard as part of my preparation for lectures. Ma'am why would you read, you know these things. For Nyasha, knowledge of what we teach is now in 'our heads' we do not need to read anymore. "*In research articles is where I get the information that you could not get in the library e.g. the concepts that students find difficult to understand and why. This then gives me ideas on how I should approach the teaching of these concepts" I said. *After this conversation with Nyasha, I told my critical friend how surprised Nyasha had been that I knew him by name and had this to say*

California*:* Knowing a student by name means that you don't see them as a group. There is personalized attention which makes a lot of difference in a student's life.

My response: The assertion by California above is supported by the findings from the study by Vallant and Neville (2006) in which they investigated the impact on student learning of the relationship between student nurses and nurse clinicians. In the study, student nurses described as 'frustrating', 'upsetting' and 'soul-destroying' situations when they felt that clinicians were only seeing them as students and not as individuals who had individual learning needs. Now I really make an effort to know students including their names. As explained earlier, I get to know my students by responding to their behaviours and performance during the course. I enjoy greeting them by name when I see them in the corridors and to call them by name during lectures because I know what it means to them.

California also commented about what the student had said in connection with me saying that I read a lot in preparation for my lectures.

California: The student's thinking that as a teacher you have the knowledge and therefore do not need to read anymore has serious implications. If that is the thinking that other students and qualified teachers have, it means they stopped reading on the day they qualified and as a result, their content knowledge is very limited.

My response: This comment by California helped me to see that as teacher educators, there was a need to respond to this mindset during our teaching as it has serious implications on the teaching practices of our pre-service teachers when they qualify (I elaborate on this thinking in my discussion later).

5.2.7 The seventh trigger incident: Students who refused to participate in whole class feedback sessions participated in a role-playing activity without showing any anxiety.

As described in chapter four, I planned case scenarios for students to role-play as part of the practical activities. On this day, the students were going to do their first role-playing activity of the course. The case to be role-played was about a family in which the father was suffering from Alzheimer's disease (see case scenario 2 described in sections 4.6.6 for details). As students were getting ready to act in their groups, I was watching Simba and Kuda, the students who in an earlier lecture had shown an unwillingness to participate in the whole class feedback sessions during lectures for fear of speaking 'wrong' English or contributing wrong answers. I had wondered how they were feeling and how well they were going to participate in the activity. To my surprise, the students did not show any anxiety at all. Simba actually volunteered his group to role-play first and I could see that he was actually looking forward to the activity and this marked a TM for reflection. I could not wait to find out why he did not seem to be afraid to participate in an activity which was to be done in English and involved others listening to him. When I asked him at the end of the practical session, this was his answer: "Ma'am, this is different. You gave us time to prepare. So I had the time to research and understand the disease. So I knew beforehand what I was going to say and that it was correct". Simba helped me to understand better his fears and how giving the students time to prepare for the role-playing activities had helped him to overcome his fears and to participate fully in the activity. In addition, I could see the reality of what literature says that when students see that group members treat them with respect and value

their ideas and thoughts when working in a group and actively get involved in the group's activities, they develop confidence and participate more (Cimer, 2007).

Simba's sentiments above were later echoed by Mufaro during interviews as she described what she had had to do in preparation for the role-play and in the process developed confidence.

Mufaro: Because, okay, most of us weren't really familiar with the disease but it made us to go out there and research more about the disease, and because we had to role-play, you had to master what really is Alzheimer's, you had to get your facts straight, rather, so ja, that's the kind of content I got and the skills of researching as well. And confidence, I really think most of the activities requires you to, you know, to, like Ngoni said, some of us hardly speak in class, hardly participate, but this year we were taken out of our comfort zones to say, "you know what, you are a teacher, you have to own your content".

Mufaro got a chance to research and get his facts straight about the disease and just like Simba developed confidence to participate in the teaching and learning activities. The role-playing activity actually forced Mufaro out of what she called "comfort zones" which are situations when students are not obliged to participate in the teaching and learning activity. It is not clear why Mufaro finds it 'comfortable' not to participate in teaching and learning activities. However, whatever Mufaro's reason is, if as teacher educators we do not incorporate in our teaching, activities that will involve and encourage such students to participate; they may pass through our systems in "silence". Ngoni actually confirmed during the interviews the possibility of some students going through our system in silence:

Ngoni: She was the first one for me, since I was here, from first year and second year; she was the first one to introduce presentation in science. Like, I haven't talked for two years in science, so like, everybody got the chance to say something about genetics, so if you didn't understand then there will be a platform to show that you don't understand and then the misconception you have will be corrected.

The irony about Ngoni's utterance above is that she is training to be a teacher and the greater part of a teacher's work involves oral explanation of concepts. Therefore, lack of oral

participation in our courses by our pre-service teachers is not a good teaching practice. As teacher educators, we need to incorporate activities in our teaching that create opportunities for students to orally articulate their understanding of concepts through and through.

Other trigger incidents were in the form of comments that I got from students. For example one day a student (Lenny) walked into the lecture room well before the lecture time, sat down and then asked with an expression of anticipation “Ma’am so what do you have in store for us today”*?* My interpretation of the student’s question was that the student had expectations. I could see a spark of anticipation in the student. What had happened in previous lectures had built some kind of anticipation in Lenny and it was clear that he was looking forward to the lecture*.* It is motivating to see that Lenny was looking forward to the lecture. I however wondered what it was that he looked forward to in my lectures.

These are some of the trigger incidents that occurred during my teaching of the genetics course which prompted me to reflect on my teaching.

5.4 Discussion

Reviewing my teaching with friends helped me to discover the salient aspects of my teaching practices. One of the aspects of my teaching that I discovered is that I use constructivism in my teaching. Ever since I discovered this aspect of my teaching and went back to watch the videos of my teaching, I feel like I have discovered my identity as a teacher educator because before then, I was not fully aware of what I do in my lectures and why. While some people may take for granted that as teacher educators we should be fully aware of the teaching and learning theories that direct our teaching, I was not. Therefore, getting to see that constructivism is the approach that I use in my teaching was a profound discovery which led to a better understanding of my teaching practices. Now when I watch the videos of my lectures, I am able to explain what I see myself doing and why I do it.

Prior knowledge of students is not only about the misconceptions and the misunderstandings that students bring to class about a topic. Scientifically correct prior content knowledge of biology topics that students bring to class is also important knowledge that I need to consider and work with when planning my lessons and when teaching. Students’ prior knowledge about reproduction and cell division helped students to recognize what the picture was about and according to Beyer (1991), recognition is an aspect that forms the basis of many thinking skills and together with comparison form the basis for learning in science and mathematics. Therefore as teacher educators, we can enhance our teaching by exploring

our students' prior content knowledge then use that knowledge to introduce new content. Such an approach reflects basic tenets of constructivism as expounded in Ausubel's theory which is about the importance of prior knowledge in learning. The theory postulates that meaningful learning occurs when the learner's appropriate existing knowledge interacts with the new learning (Novak, 1977). As a teacher educator, I also need to consider the prior knowledge that students should have from high school about a topic but may not have and put into place measures to help students to acquire that knowledge before introducing new content.

It is important for a teacher educator to have knowledge of students which was described by Rollnick et al. (2008) as including knowledge of students' prior knowledge, their learning styles, linguistic abilities and interests and aspirations. At one point, I thought a student was being rude when he walked out of my lecture where a guest lecturer was presenting only to find out that he had been emotionally affected by the presentation due to a condition that he had. At another point I thought students were undermining the teaching and learning process when they both had 'valid excuses' for not participating in the activity. All this happened because of not having adequate knowledge of these students.

In the study by Rollnick et al. (2008), the authors showed how the teachers in the study were able to take appropriate action during teaching because they had knowledge of students. The authors however, did not explain or suggest how a teacher can acquire the various aspects of the knowledge of students such as their learning styles and linguistic abilities. From reflecting on the trigger incidents above, I have learnt that as a teacher educator, I can gain knowledge about my students by reaching out to them during and even after lectures. By paying attention to students' behaviours and using those behaviours as opportunities to interact with them, I can get to know students at a much deeper level. Another way is to pay attention to students' performance by checking their marks periodically, and then make time to see those who seem to be struggling to find out why and those who are doing well to complement them. While I did not get to know all my students because of the size of the class (91 students), the students seem to have come to know that I am interested in their interests and wellbeing as indicated by an increase in the number of students who were coming to consult me. Therefore, by reaching out to as many students as one can, there is a possibility of creating an enabling environment for other students to also come to you for help. In addition, reaching out to students is also a type of learner centredness which develops in students a sense that I care about them. Such learner centredness creates an atmosphere of respect, care and security in the classroom.

My own lived experiences influence what I notice in teaching situations and may lead to wrong interpretations of what will be happening in the teaching and learning situations. Therefore, the ability to act instead of reacting when we notice 'things' happening in our classrooms for example certain behaviours by students has the potential of helping us as teacher educators confront our own assumptions about students which may be wrong and paying attention to our own cognitive and emotional perceptions of such students' behaviour is one potential way of understanding ourselves as teacher educators.

It is important for us as teacher educators to use teaching styles that cater for a variety of learning styles. Students disengaged and showed disinterest when I was using teaching styles that were not aligned to their learning styles thereby helping me to understand what may happen if I use teaching styles that only cater for a limited number of learning styles. Therefore, if I do not vary my teaching styles, some students will struggle to engage with my lectures which may demotivate them.

The visual aids that I used in my lecture on blood groups led to a misunderstanding of the content by some students. What I then learnt from this incident was that the T/L aids that I choose to use in my teaching may not always convey the message that I intend them to convey. In the same episode of teaching about blood groups, I misunderstood a student's question and as a result gave an unsatisfactory response. I just rushed to answer the question without taking time to think about it and as a result, I failed to notice the implications of the student's question which were that the student lacked knowledge of concepts that are important for understanding blood groups. It is therefore important that we learn to act on students' questions instead of reacting to them. This way, we may minimize the chances of misunderstanding students' questions. One way of achieving this is to desist from rushing to give students correct answers and instead prompt and facilitate a discussion that will lead to a correct answer.

Teaching students with different levels of content knowledge is a big challenge. For an adequate understanding of blood groups by students who did not do biology at Matric, I needed to start with the structure of a cell membrane. However, doing that had the potential to cause those students who already have knowledge of this content to lose interest as they will be expecting something new. One way of dealing with this situation would have been to be upfront with the students by explaining the contextual situation to them. I could also make use of the e-learning system by posting beforehand the content knowledge that students need to know before teaching a particular topic with some tasks that students can do in preparation for the topic.

There is a possibility of having students or their families with genetic diseases in my classes. Therefore, I need to treat my teaching of the section on genetic disease with sensitivity.

During the course, one student displayed the mindset that as teacher educators we don't need to read anymore in preparation for our lectures because the knowledge is now in our heads. While it was just one student's comment, it is important to look at the implications of such a mindset in case many other students have a similar mentality. Nyasha was the student who made the comment above. Nyasha displayed not only inadequate knowledge about the Nature of Science (NoS) but also that as a teacher you become a lifelong learner. The fact that science knowledge is not static but develops and changes with time (NoS) needs to be made explicit with examples in our teaching of all science subjects. As teacher educators, we also need to make our students aware that as a teacher, one needs to be continuously reading to keep up with any new developments in the various science fields.

In this chapter, I presented what I have described as trigger incidents that occurred in my teaching of the genetics course. Trigger incidents helped me to detect some of the challenging issues in my classroom. Detecting some of the challenges that were playing out in my classroom prompted me to reflect and to review these challenges with critical friends leading to powerful learning experiences. Shulman (1992) as cited by Loughran (2006) used the term cases to describe similar events. The only difference is that my trigger incidents are descriptions of the actual events while cases are events that are "structured around tensions and dilemmas that teachers experience in their own teaching" (Loughran, 2006, p. 33). Just like cases, the trigger events invite inquiry into the problematic situations that arise in teaching and learning and just as with cases, they create opportunities for questioning the taken for granted thereby highlighting the complexities that are inherent to teaching. In addition, trigger incidents also create opportunities for others to see into our teaching and learning situations thereby offering ways for the achievement of alternative interpretations from critical friends which can result in new learning.

This chapter is based on what I have termed trigger incidents. Two significant aspects are reflected in all the seven TIs. The first significant aspect that comes out of the descriptions of the TIs is what Mason (2002) described as **noticing**. The second significant aspect is that of **caring**. I describe each of these aspects next.

Noticing: Noticing has to do with recognizing and building on that which is problematic in practice (Mason, 2002). I have used the term trigger moments to point out in the TIs that

which helped me to notice. Examples of trigger moments which helped me to notice were the unexpected answers from students, the non-participation of students in discussions and a student's response when he found out that I knew his name. Noticing facilitated reflection. However, it is not just the facilitation of reflection that I found to be significant about noticing but how I was responding to that noticing. In some cases, I acted on what I was noticing and in other cases I reacted to it. For example, noticing happened when students gave me the answers that I did not expect. By acting on the answers and reflecting on them, I got to learn one way of how prior knowledge of students about a topic may impact their learning. Noticing also happened when students were not participating in the discussion. I acted on what I had noticed by checking with the students why they were not participating and in the process I got to learn that there was more to students' behavior than what I had assumed. Therefore, by checking what I was noticing or by taking some action and/or reflecting, I increased the range of meanings of what I was noticing. According to Mason (2002), a range of meanings of what one notices helps one to make informed decisions on how to act in a moment or to respond to situations as they emerge. Acting on what I was noticing also helped me to develop a better understanding of what was happening in my lectures which in turn helped me to think of teaching and assessment strategies that were suitable for my classroom context. Therefore, noticing is an important attribute that we need to develop as teacher educators as being able to notice and to act on teaching situations is a source of valuable information that can promote our professional development. However, noticing requires a sensitization which only develops with experience (Mason, 2002).

Caring: The notion of caring is a thread that runs through all the trigger incidents that I have described in this chapter. The aspect of caring is seen in my use of visual aids to try and promote students' learning and understanding of content. The aspect of caring is also seen in going to students to find out what was happening which led to a better understanding of students at individual level. The aspect of caring was further reflected in making an effort to know students' name and tracking the performance of both high and low performers in the course. This aspect of caring seemed to have created a conducive environment for fruitful interaction between me and the students as students started to respond to this caring atmosphere in various ways. Evidence that students were responding to this caring attitude was seen in an increase in the number of students who were coming to consult and in students who would apologies for missing or coming late for lectures. Therefore showing that you care for students can create an environment that encourages students' participation in teaching and learning activities and hence students' learning.

5.5 Conclusion

In this chapter I have presented the trigger incidents that occurred during my teaching of the genetics course. I have also presented my reflections and my critical friend's feedbacks on those trigger incidents. I have also discussed what I have come to understand about teaching and have made suggestion in some cases on how our teaching as teacher educators can be improved. I have articulated what can be achieved by being able to notice trigger events that occur in our practice and by showing our students that we care about them. The knowledge that I gained from reflecting on TIs is going to transform the way I plan my teaching, the way I teach and the way I interact with my students. In chapter six, I describe how I analyzed my teaching and present the findings from the analysis of my teaching. I then discuss what I have become aware of about my teaching from the analysis of my teaching.

Chapter six: What did I say and do? Analysis of my teaching and presentation of findings

6.1 Introduction

In chapter five, I described in detail the incidents that occurred during my teaching of the genetics course. In this chapter, I further analyze and describe my teaching as captured in the video-recordings of my lectures and bring to the fore the salient features of my teaching practices. I first describe how I analyzed my teaching using my conceptual framework as a lens and then present the findings. Although I was open to any interesting aspects that I could find about my teaching, my main focus was to find out if I was able to include in my teaching, the four domains of a teacher educator's knowledge namely knowledge of context, knowledge of students, PK and knowledge of content. I conclude the chapter by summarising and discussing the findings. Although I highlight the features of my teaching in the light of my conceptual framework, I also present detailed descriptions and explanations of what I did in my teaching to foreground what should be in students' experiences of my lectures which I present and discuss in chapter seven and will help me to answer research questions number three and four.

6.2 How I analyzed my teaching

I used the domains of a teacher educator's knowledge that form part of my conceptual framework as my initial categories and the various teaching aspects falling under these domains as the codes. I developed and discussed my conceptual framework in chapter 2. The analysis of my teaching was therefore deductive since I started with pre-defined codes and categories. I was however open to any other interesting aspects of my teaching that I could identify from my teaching.

My initial coding scheme

As explained above, the four domains of a teacher educator's knowledge were my initial categories. I then went back to my literature review to identify the possible codes for each of the four categories. Table 6 below shows my initial coding scheme. The lists of codes were

not exhaustive. I was open to any new codes that I could come across during the coding process.

Table 6: My initial coding scheme

Knowledge of context*	Knowledge of students	Pedagogical knowledge (PK)	Content Knowledge
-**My context**** - Anything in my teaching that points to my awareness of context e.g knowing that the university has e-learning or knowing the acoustics of big venues like a big lecture theatre. -**My students' context** - anything in my teaching that points to my awareness of my students' future teaching contexts.	-Any reference to **misunderstandings** that students are known to bring to class about genetic phenomena -Any reference to **misconceptions** that my students and my students' students are likely to bring to class -Evidence of awareness of students' -**learning styles** -**linguistic abilities** -**cultural backgrounds** -**schooling backgrounds**	-**Teaching strategies (TS)** **-Teaching procedures (TP)** **-Teaching activities (TA)** **-Teaching and learning activities (TLA)** e.g. drawing, discussing **-Teaching and Learning Aids (T/L aids)** **-Lecturer student interactions (LSI)**	**-Specialized content knowledge (SCK)** **-Common content knowledge (CCK)**

*All bolded words in the first row describe the categories. **All bolded words within the table indicate codes

Below is a list of definitions of my initial codes. Although the explanations of the meanings of some of the codes were obtained from literature, I have defined the codes here with reference to my study.

Definition of the codes

TP - Teaching procedure: Method of teaching that I used to bring about a teaching and/or a learning activity e.g. questioning and feedback

TA - Teaching activity: What I did as part of my teaching e.g. explaining a concept, describing a process

TS - Teaching strategy: Describes the development of an overall approach aimed at achieving a specific behaviour, attitude or lesson in students

TLA - Teaching and learning activity: An activity when both me and students are actively involved at the same time e.g. Q & A discussion. TLAs also show lecturer student interactions - **LSI**

T/L aid - Teaching and learning aid: device, object, material that I used to present information to students with the aim of promoting students' understanding of the content e.g. pictures, diagrams, models and charts

CCK - Common content knowledge: knowledge of the genetics content that is described in a curriculum and is presented in textbooks.

SCK - Specialized content knowledge: Knowledge of content which teachers use to make features of particular content visible to and learnable by students'

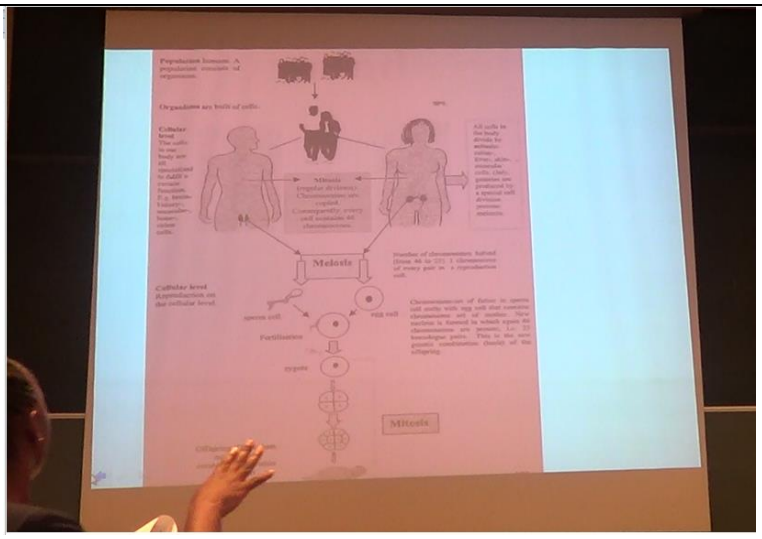
Misunderstanding - Incorrect meanings or explanations of concepts or phenomena that students hold, which they may have acquired from textbooks or from teachers during teaching.

Misconceptions - An idea or ideas that students strongly and persistently hold that are not scientifically acceptable that they would have constructed in response to their everyday experiences.

The initial coding process

After developing my coding scheme using information from the literature, I coded my transcripts starting with the audio transcripts for lecture one. Below is a section of the audio transcript of my teaching of lecture one showing how I did my coding.

Table 7: An example of my coding

	Lecture excerpt	Coding
Lecturer	Okay, for every lecture, before the lecture, for those who come in early, I will put questions, there are questions right now on the board so that you can start thinking about what we will be covering in the lesson. So you can always check for the questions on the screen and then you can start discussing those questions as they will be introducing you to the content of the lesson.	**A teaching procedure/A teaching strategy-** Questions at the beginning of every lecture
Lecturer	 Now, I want us to look at that picture. Don't worry about the words and the	**T/L aid**-Picture

	description, just look at the picture and tell me what you can see?	
Student	Reproduction is taking place.	
Lecturer	Reproduction is taking place. Okay. He says reproduction is taking place. What else can you see there? Yes?	
Student	The offspring	
Lecturer	The offspring is…?	
Student	…is different to the parent.	
Lecturer	The offspring is different from the parent. Okay. That's what she can see. Yes?	
Student	Division of cells.	
Lecturer	Division of cells. Yes?	**TLA-** Q & A session
Student	Multiplication of cells.	
Lecturer	Multiplication of cells. Yes, anything else? (*Some waiting takes place)* Okay, so let's look at the picture together. If you start from the top, that's a group of people there, and you can see it's a population. And then from that population we have two people, a couple there, and then something is happening between these two (*laughter*). What do you think is happening there?	**TLA** –Question and Answer (Q & A)

As explained in chapter 3, Initially, I struggled to code the audio transcript because I found the audio transcripts to be too bulky. I therefore decided to reduce the bulkiness of the audio transcripts by doing a step by step description of my lectures using both the audio transcripts and the videos. I gave an example of a video transcript in chapter three. I show the coded transcript again below to remind the reader on how I transcribed and coded my videos.

An example of processed and coded transcript data

1. Lecturer put up some questions on the screen at the beginning of the lecture. **(Teaching Procedure-TP/TS)**
2. Lecturer explains the purpose of the questions (T**A)**
3. Lecturer gives instructions to students to discuss the questions (**TA**)
4. Students discuss the questions **(LA)**
5. Lecturer puts up a picture on the screen- **(T/L aid)**
6. Lecturer invites students to look at the picture and asks them to say what they can see-(**TLA/LSI)**
7. Lecturer takes responses from students and writes them on the chalk board-(**TLA/LSI)**
8. Lecturer repeats the question and waits for more responses-**(TLA/LSI)**
9. Lecturer moves on when no more responses are forthcoming-she **describes** in detail what the picture is showing-reproduction, meiosis, mitosis etc (**TA)**
10. Lecturer **explains** how what is happening in the picture including what students said is linked to the genetics that will be done in the course- (**TA)**
11. Lecturer introduces a concepts biological inheritance through a question that she puts up on the screen **(TP)**

12. Whole class Q and A discussion (**TLA/LSI)**
13. After the discussion, the lecturer explains the answer to the question **(TA)**
14. In her explanation, lecturer points out one of the things that makes genetics difficult to teach and to learn-terminology **(SCK)** and emphasises the importance of students as future teachers to understand that terminology- (**Knowledge of context)**
15. Lecturer spells out one of the aims of the lecture-**TA**
16. Lecturer puts up on the screen an outline of the structure of the science of inheritance **TA**
17. Lecturer goes through the slide explaining the structure of the science of inheritance **(TA)**. In her explanation, she points out the content that was covered in the previous course that the students did, the content that will be covered in future courses and spells out the content that will be covered in the genetics course-(**Curricular saliency-CS)**
18. Lecturer introduces an **analogy** of loose string and a ball of similar string-**T/L aids, TA**

After coding my lectures, I assigned the codes that I had identified to the four categories as explained earlier. I could fit most of the coded information into the four categories of knowledge. I however had codes that I could not assign to any one of the four categories. An example of such a code is curricular saliency (CS). CS is the ability to analyze and organize a topic for teaching. It includes identification of the main concepts in a topic and subordinate concepts and deciding what is important for teaching and sequencing (Mavhunga & Rollnick, 2013). According to (Rollnick et al., 2008) curricular saliency is a manifestation of a teacher's PCK. Therefore, I could not fit CS in any one of the four knowledge categories. When I assigned codes to categories, I put aside all such codes that I could not assign to the four categories. A look at these codes at the end of the process of assigning the codes to categories, made me realise that all of them were what Rollnick et al. (2008) described as manifestations of a teacher's knowledge (which can be taken to be evidence of a teacher's PCK). Therefore, manifestations of a teacher's knowledge became my fifth category. The manifestations of a teacher's knowledge that I had identified were curricular saliency, lecturer-student interactions, student-student interactions and well-sequenced lectures. When I went back to Georgia my critical friend's video observation notes of my lectures, I found out that what she had classified as the key features of my teaching were the aspects that I had coded as the manifestations of my knowledge (evidence of my PCK). Her list of key features was however more elaborate than the one I had developed. Her list of the key features included how I used students' responses to effectively explain new content during discussions, the quality of interactions between me and the students, explicit stating of lesson outcomes to the class at the beginning of lectures, how I was consolidating the content of the whole lecture in the conclusion, the use of appropriate analogies, the co-construction of meanings of concepts through questioning and the way I modified

explanations using T/L aids to make sure students remained focused. My final coding scheme is shown in Table 8 below.

Table 8: My final coding scheme for analysing my teaching

	Knowledge of context	Knowledge of students	Pedagogical knowledge (PK)	Knowledge of content	Manifestations of my PCK
Identified teaching aspects	-Knowledge of my classroom context-awareness of the acoustics of a big lecture room. -Knowledge of my classroom context-the diversity in my classrooms-e.g. knowledge of students' different linguistic abilities and schooling backgrounds -Knowledge of my students' context-description of T/L aids appropriate for rural children and for urban children	-Knowledge of misunderstandings that students bring to class e.g. that interphase is part of meiosis -Knowledge of misconceptions that students bring to class e.g. that genes are directly responsible for our features -Knowledge of genetics concepts that students find difficult to learn about.	-Use of a variety of T/L aids (pictures on the screen, charts, models, concrete materials) -Teaching styles (visual/auditory/active/passive etc. -TA e.g. explaining and describing -TS e.g. today's questions -Individual work e.g. draw, quiz -Formative assessment activities e.g. quiz -TP-Questions and feedback -TLA e.g. whole class discussion, worked examples -Role-playing a family with a father who is suffering from Alzheimer's disease -Student to student interaction through small group discussions or discussions in pairs	-SCK-e.g. identification of aspects of content that makes genetics difficult to teach and learn -CCK-e.g. description of the structure of DNA -Knowledge of the vertical curriculum	-Curricular saliency -Step by step sequenced teaching -Lecturer-student interaction -Use of appropriate analogies

6.3 Background to the presentation of findings from the analysis of my teaching

I introduce this background section with a critique from one of my critical friends Nico. Nico read and critiqued a whole draft of this chapter. The purpose of asking Nico to read a complete draft of my chapter after I had already discussed it with critical friends was for further validation.

Nico's comments*: What you did in your teaching is not your "normal' teaching, but something that came with a lot of effort on your part; some kind of rehearsal, you may want to say. Yes, I know, in the process you developed yourself into a good teacher. But is this sustainable; or it is just for display?*

My comments: I remember when I first read the above comments from Nico. It was in the evening of Saturday the 16th of August 2014. I had given him a draft of this chapter in preparation for a presentation at one of the PhD weekends[13]. I had done the analysis of both my teaching and of students' interviews. I went to bed very early that evening sad and depressed. I could not sleep either. At 2:30am, I woke up and responded to his comments. By the time I went to church at 9: 30 in the morning, I was not sad anymore. When I revisited my response as I was writing my thesis, I realized that my response captured what would form a very informative foregrounding of the findings from the analysis of my teaching and of students' experiences of that teaching. Below I present my journal entry in response to Nico's comments

Nico you are right to say that the teaching that I did was not my normal teaching because for sure it wasn't. In my chapter 1, I described my 'normal' teaching and made it clear that my concern was that I was now dissatisfied with it and wanted to do a self-study in which I was going to search for better ways of teaching pre-service teachers. My aim when I embarked on this study was therefore neither to repeat my 'normal' teaching nor to stage 'good teaching' to pre-service teachers but rather to gather evidence of classroom practice that could inform my own and others' future teaching of a content course to pre-service teachers. Yes the teaching came with a lot of effort and that is why I developed into a better teacher educator as you said. Good teaching does not come easy Nico. It requires time and effort. Maybe the problems in teaching and in teacher education today are a result of that which you referred to as 'normal' teaching? You also said in your comments and I quote: "**You tend to oversimplify the issues here such that you force us to overstretch our imaginations so as to believe you**". *For sure, the accounts of my teaching sound as if it was very easy for me to think of an alternative activity every time I encountered problematic situations but that was not the case. It is very difficult for me to put on paper the details of the process (the thinking, the searching and the consultations) that I did as part of my study although I tried to do it in chapter 4 of this thesis. The advantage of my study was that it was a self-study and one of the powerful attributes of a self-study is that it allows you as a teacher or teacher educator to teach and at the same time to study your teaching and because your teaching is your fieldwork you find that you have some 'extra' time at your hands; time to think about your teaching, time to reflect on what is happening in your teaching and to do some extra reading because your research is linked to your teaching and*

[13] PhD weekends during which post-graduate students are given opportunities to present their work to their peers and members of staff for a critique of their weekend

in the process you get ideas that you can try out in a bid to solve pedagogical issues like the ones that arose in my teaching. Another attribute of a self-study is that it gives you the 'freedom' to try things out as part of the process of learning to teach. Therefore, my teaching became like an adventure where after every lecture, because my research focus was on my teaching, I would sit down and say to myself: this is what has happened so what's next. I would then search for new ideas from colleagues, from literature and from the Internet and carefully apply my mind because I would be thinking about my teaching and my research at the same time. I got many ideas from my searches that I thought through and adapted and used in my own teaching. Therefore, some of the teaching practices that I enacted were not original ideas. They are ideas from colleagues and from literature that I adapted to suit my own context. So as you said in your comments: **Would someone not do nearly the same with the same effort?** *Yes they can Nico. What I did is a form of what is called application research whereby a researcher gathers knowledge that is already there to address a significant societal issue (Boyer, 1990). In my case, I gathered knowledge to address a significant pre-service teacher education issue; how to effectively teach pre-service teachers content for understanding and for teaching. What my study shows is that the knowledge needed to improve our teaching may already be available in the literature and what we may need to do is to just apply some effort into translating that knowledge into practice to improve our teaching and to find ways of sustaining that effort.*

6.4 Presentation of findings

Below I present the findings from the analysis of my teaching. The findings are highlights of how I taught the genetics course. I present my findings using the five category headings in Table 8 as sub-headings. The five category headings are knowledge of context, knowledge of students, pedagogical knowledge, knowledge of content and manifestations of my PCK.

6.4.1 Knowledge of context

As described in my conceptual framework, knowledge of context encompasses knowledge of my own context (my institutional and classroom environment) and also knowledge of my students' context (schools). My knowledge of both contexts is described below.

Knowledge of my context

Awareness of the acoustics of big lecture rooms: I was aware of the acoustics of big lecture rooms which I consider to fall under knowledge of context. During the teaching process I would repeat students' responses before moving on to the next student.

Lecturer	Now, I want us to look at that picture. Don't worry about the words and the description, just look at the picture and tell me what you can see?
Student	Reproduction is taking place.
Lecturer	Reproduction is taking place. Okay. He says reproduction is taking place. What else can you see there? Yes?
Student	The offspring
Lecturer	The offspring is?
Student	Is different to the parent.
Lecturer	The offspring is different from the parent. Okay. That's what she can see. Yes?
Student	Division of cells.
Lecturer	Division of cells. Yes?

My comment: The reason why I repeated students' responses was to counter the effects of the acoustics of big lecture rooms. If students sitting in front of a big lecture room say something, I would hear them more clearly than their fellow students at the back of the lecture hall because of the directional propagation characteristics of sound. On the other hand, all students would be able to hear me clearly because of my front position in the lecture hall. Therefore, the reason why I repeated students' answers was to make sure that everyone heard what had been said. One of the features of a good lecture that was pointed out by students in Marris' study (1964) is that the lecturer must speak audibly. I however am of the opinion that it should not be the lecturer only who should be heard. If students are to benefit from the whole class discussions that take place in a lecture, it is important for them to also hear each other during contributions and questions. That is why I make sure that every student's contribution is heard by all students by repeating students' responses.

Awareness of the diversity in my classroom: An awareness of the nature and extent of the diversity in one's classrooms is knowledge of the classroom context or school context. An awareness of the diversity in terms of linguistic, cultural, socio-economic, and academic backgrounds of individual students is knowledge of students (Rollnick et al., 2008). Therefore, you will notice below that the description about my awareness of contextual factors in terms of the diversity in my classroom also reflects my knowledge of students.

I became aware that due to linguistic challenges and diverse schooling backgrounds, the lecture was a threatening environment for some students. Some students had clearly indicated that they would not participate in whole class discussions for fear of being laughed at if they spoke grammatically wrong English or for fear that their peers would think that they were stupid if they asked certain questions or gave certain answers (see trigger incident number three in chapter 5). Therefore, I always included work that would be done individually in silence within my PowerPoint presentation in addition to work that would be discussed by students in pairs or by the whole class. I was however in a dilemma in this situation because from my own experiences as an English second language learner, high school teacher and teacher educator, I knew that it was only through speaking English that the students would develop their English communicative competence. In addition, it was important for me to have students saying something through oral or written means for me to be able to assess their understanding. There would however not be enough time to assess students every time through written means due to the large classes that we now deal with. This dilemma was the motivation for introducing role playing activities and quiz as highlighted in section 6.4.3 (See section 4.6.6 for more details of the role-playing activities). While my initial motivation for introducing role-playing was to allow oral participation and was going to be a quick way of assessing students' understanding of content being role-played, I later found out from literature and also observed as the students role-played that role-playing promotes working in groups, generates high levels of motivation and enthusiasm and a platform for crediting personal initiative (Bonwell & James, 1991).

Knowledge of my students' contexts

My knowledge of students' contexts was shown in both implicit and explicit ways. Implicitly, I showed knowledge of students' context by modelling teaching practices that matched a variety of school contexts. The modelling involved deliberately using T/L aids that students

can also use in their future teaching. For example, instead of adopting the use of clickers[14], I decided to use flash cards in my classroom quizzes. Instead of using pictures[15] that I would just project on the screen, I prepared posters and pinned them on a board in the lecture hall as shown in Figure 28 below.

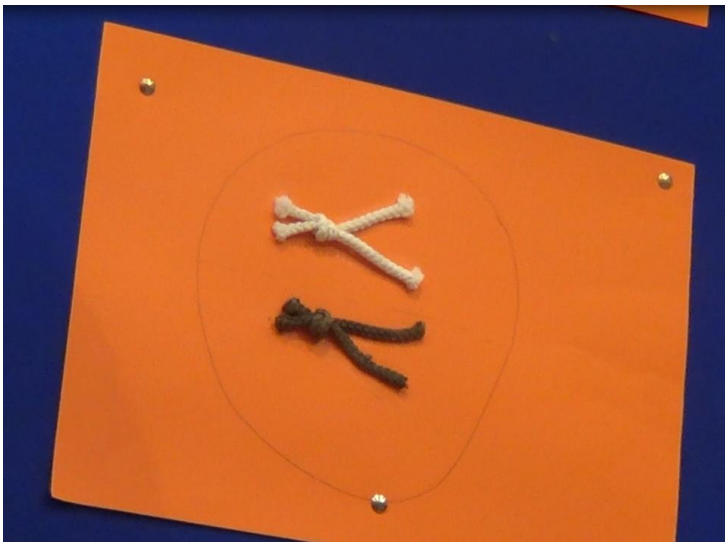


Figure 28: An example of a poster chart

Instead of solely using a PowerPoint presentation, I also made use of the chalkboard in some of my lectures where I would come in early and draw some diagrams on the chalkboard that I would make reference to during the lecture. During feedback sessions, I would also write students' responses on the chalkboard (see figure 29 below).

[14] A clicker is a type of an audience response system which is a portable handheld device that allows students in a classroom to instantly provide the instructor with feedback or answers to a question by pressing a button to make a choice. Students' responses are sent through radio waves and are collected by a receiver which is connected to a computer where the instructor is able to view. Clickers enable instructors immediate access to individual students' responses, to assess their understanding and to give immediate feedback.

[15] Here I am referring to pictures of organs or of flow diagrams from the internet. Therefore, instead of getting such pictures from the internet and inserting them in my PowerPoint presentation, I would also create posters using the pictures.

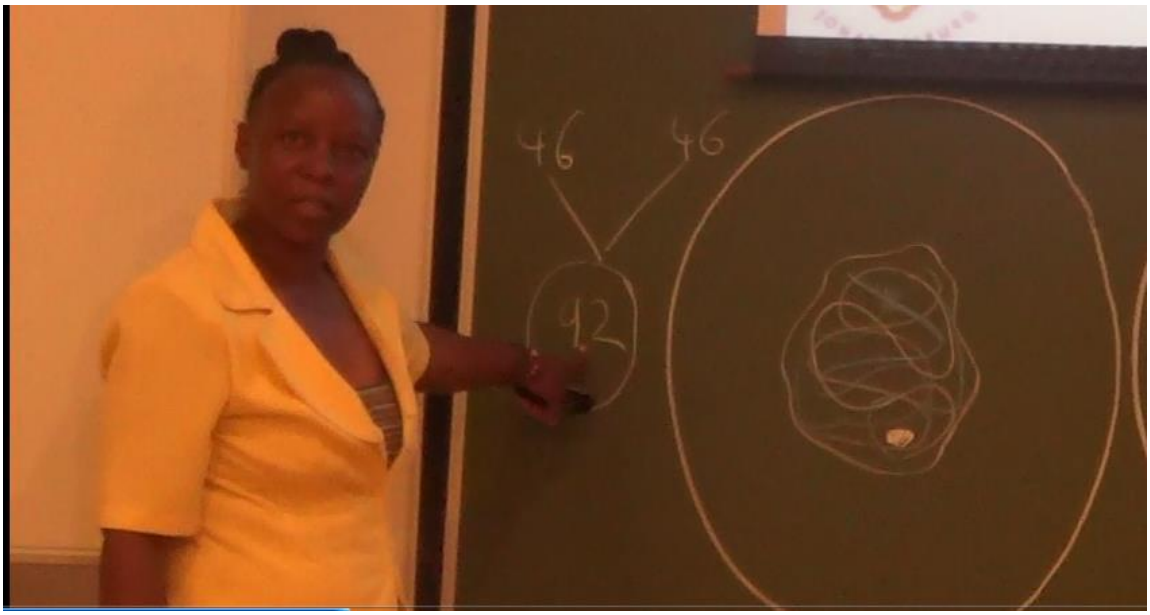
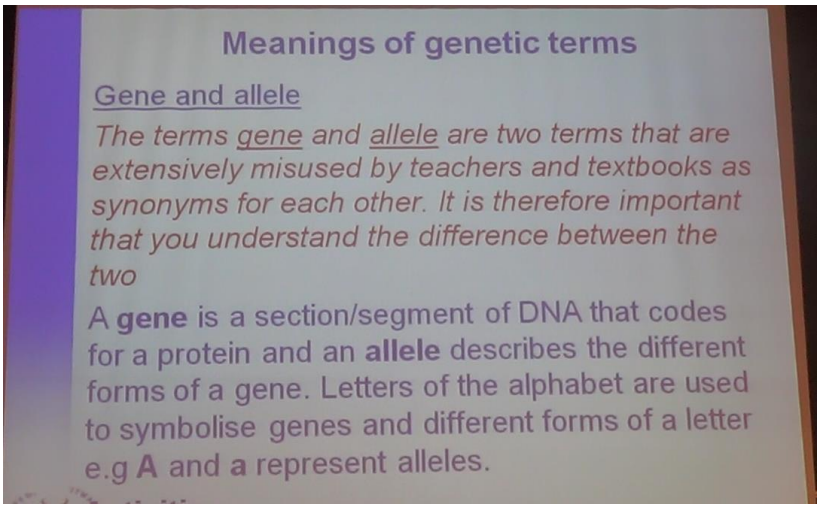


Figure 29: Making an illustration of a cell just before prophase 1 on the chalkboard

The reason for using charts and other T/L aids was because I had become aware that I was teaching pre-service teachers who in addition to knowing content, needed to learn about the kind of T/L aids and some of the formative assessment methods that they could potentially use in their future schools. The kind of modelling described above is that referred to by Loughran (2006, p. 6) as "traditional notion of modelling" teaching because I did not explain to students the thinking behind my choice of the T/L aids. According to Loughran (2006), modelling teaching about teaching should go beyond this traditional notion of modelling by including in one's teaching the unpacking of the teaching process so that students can access the pedagogical reasoning, uncertainties and dilemmas of practice. However, since the course was a content course, in which I was focusing on the content that the pre-service teachers would likely teach after qualification, I was of the idea that enacting pedagogical practices that would be relevant to students was a powerful way of teaching about teaching. After all how we teach is the message that students get from our teaching (Russell, 1997). In some cases however, I did model teaching about teaching as expounded by Loughran by explicitly making statements which clearly indicated the reasons behind my choice of T/L aids. Below is an episode of my teaching in which I not only unpacked my thinking regarding my choice of T/L aids but also made both implicit and explicit reference to my students' future contexts as school teachers:

Lecturer	Now that we know what trait is, trait is determined by a gene and the variation of that trait is determined by alleles. So now let's look at what we mean by gene and

	allele, because this one there is a huge misunderstanding.  Textbooks, teachers use these two terms as if they mean the same thing. So I was trying to figure out how best I can explain the difference. So the first thing I thought of was ice-cream. Right. Let's have the, different flavours of ice-cream.
Student	Strawberry
Lecturer	Strawberry
Student	Chocolate
Lecturer	So we have strawberry ice-cream, we have chocolate ice-cream, we have raspberry ice-cream, vanilla ice-cream. All those are ice-creams. So when we say ice-cream, we are referring to a gene. And then strawberry, vanilla, banana are alleles. Okay, so that's what you can use to explain, so ice-cream represents the gene and the flavours are the alleles. So it's still ice-cream but now we are seeing different flavours. But then I thought, I grew up in rural areas, and all I knew was ice-cream, I didn't know about flavours. So if my teacher had used that example it was not going to make sense to me. So being a rural child what would make sense to me is colour of hair of cattle. Because I knew a lot about cattle. And so depending on the context you need to use something that your learners can understand. So if we look at colour of cattle,

	we have black colour of fur, we have brown colour of fur, we have white. So there's a gene that determines that a cow or a bull should have colour in its fur. But then we have different alleles, different forms, so that we have brown, we have black.

As can be seen in the excerpt above, I first explicitly highlighted a very common problem about the content of genetics; the misunderstanding associated with the meanings of the terms gene and allele. I then made it explicit to students that I had to think seriously about how to explain the meanings of these two terms so that students could understand. I wanted students to appreciate that teaching is a thinking job. I then made it clear that the ice-cream analogy would not work in a rural context and explained why. I then provided another example which would work in a rural context. In the excerpt therefore, I showed **knowledge of students' possible future contexts** and what they would need to consider in their teaching in such contexts. I also showed **knowledge of CCK**; what is a gene and what is an allele, **knowledge of SCK**; how to explain these terms in a way that would potentially help students to understand the difference between the two terms and possible knowledge of students' prior knowledge as indicated in the literature; **a misunderstanding** that gene and allele are synonyms of each other.

When I presented the above account of my teaching to Tony, he posed this question: "If trying to anticipate your students' future contexts is so important, why do you use a PowerPoint? Why not just use the chalkboard instead?"

I found my CF's question very interesting because the question seemed to imply that the anticipated students' future contexts were just the poorly resourced and rural schools where there are no facilities for doing PowerPoint presentations but students' future contexts can also be well-resourced schools where there are facilities that allow the use of PowerPoint presentations and even smart boards. In fact, in Johannesburg even some poorly resourced schools have data projectors and students often use PowerPoint presentations during Teaching Experience practicals. So, in preparation for my teaching, I even surfed the internet for ideas on how to present effective PowerPoints. Therefore the use of PowerPoint presentations was also a chance to show pre-service teachers how to effectively use that technology for teaching purposes. In the interviews, Placki, a student, had this to say about my use of PowerPoint presentations:

Interviewer: What were the main messages about teaching and learning that you got from the genetics course even though it's not a methodology course?

Placki: Well you'd learn about the misconceptions because you'd end up having them and then in order, with like correction then you'd know, okay. So that's one strategy that I could take with me, and also her presentations are giving the information to us and you could learn from her skills.
Interviewer: Like what?
PLacki: How to present proper PowerPoints and still keep learners actively engaged

All aspects of teaching matter in pre-service teaching. As underscored by Russell (1997), how we teach is the message.

6.4.2 Knowledge of students

Just as with knowledge of context, knowledge of students encompasses knowledge of my own students and knowledge of my students' future students. As explained in section 6.3.1, in some cases, knowledge of students overlaps with what could be considered to be knowledge of context. Therefore, I have described my knowledge of students' different linguistic abilities and schooling backgrounds as part of my knowledge of the diversity in my classroom under knowledge of my context. Below I describe the other aspects of knowledge of students which include knowledge of the misunderstandings and misconceptions that genetics students bring to class.

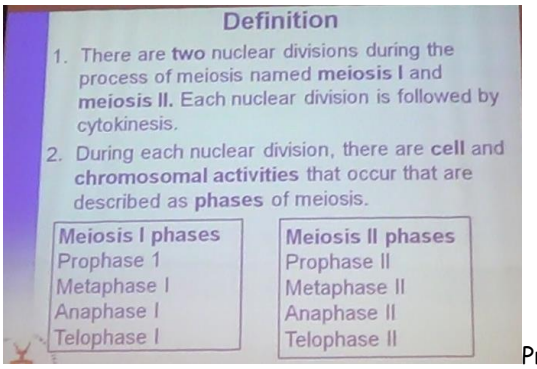
Knowledge of common misunderstandings my students bring to class about genetics content

I showed my knowledge of students by pointing out in my teaching, some common misunderstandings that some students bring to class. I described one of the misunderstandings in section 6.4.1 above. The other misunderstanding that I brought to the attention of the students is that meiosis is depicted in some textbooks as cell division and yet it is nuclear division.

Lecturer	So we defined meiosis as a type of nuclear division. Please note that I am saying <u>nuclear</u> division. Some textbooks that are used in high schools do not explicitly say nuclear division in their definitions of

	mitosis and meiosis. But when we go through the process you'll see that it's nuclear division. It's not cell division. For example in the textbook **Life Sciences For All**, cell division is defined as follows: *Cell division is the way new cells are made. A cell grows to a certain size then divides in half producing two small cells… This kind of cell division which results in growth is called mitosis. There is another kind of cell division that makes sex cells.* The underlined section is referring to meiosis as a kind of cell division.

A third misunderstanding that I brought to the attention of the students is that many students think that interphase is the first stage of meiosis. In the lecture on meiosis, just before I had highlighted this misunderstanding about interphase, some students in the class actually showed that they had this misunderstanding as shown in the lecture excerpt below

Lecturer	For meiosis I, those are the phases, meiosis II, those are the phases.  Prophase I, metaphase I, anaphase I, telophase I. And then it's II, II, II, II, for meiosis II. Yes?
Student	Where is interphase?
Lecturer	We are talking about that now. That's the next slide, you see? Okay. So let's go on to the next slide. Interphase. It's not part of meiosis. It's the preparation for meiosis.
Students	(in disbelief) Oh!
Lecturer	So that's the preparation for the process of meiosis. Unfortunately in textbooks, they will be saying cell division. And then meiosis. And then the first thing that they describe is interphase. Or they will be talking about mitosis and then they start with interphase as the first phase. But it's not. It's preparing for the process of meiosis.

	What happens…who knows what happens during interphase?

So when the student did not see the interphase stage on the slide above, he was quick to ask where interphase was and when I said interphase is not part of meiosis, a large number of students' response was that of disbelief.

California: It would have been nice to give students a chance (as a teaching and learning activity) to identify what was wrong with the above textbook statements instead of you just starting by telling them.

My response: California's comment helped me to see that I had taken for granted that students would fail to identify what was wrong with the text and as a result had failed to notice what could have been an effective way of clearing the misconception. I had fallen into the trap of 'telling' students the 'right' answers instead of helping them to find out for themselves (Berry, 2008). California helped me to see this pitfall in my teaching. Her comment highlights why regular observation of our teaching by colleagues (peer evaluation) is a necessary activity. The problem however is that institutions like ours use peer evaluation for promotional purposes instead of encouraging it for purposes of professional development. As lecturers we are therefore not keen to invite colleagues to observe our teaching.

Knowledge of misconceptions that students (both my students and my students' students) are likely to bring to class

I would highlight in my teaching some of the known misconceptions about genetics. An example of a common misconception that many people including students have about genetics is that genes are directly responsible for our features but the simple scientifically correct explanation is that genes are directly responsible for the production of proteins which are then built into various features of the body. The likelihood that my students also had this misconception was high. Therefore, in my teaching I emphasized the correct content as a way of making students aware of the misconception so that if they had that misconception, the highlighting of correct content might facilitate the development of a new and correct understanding.

Lecturer	If we look at a gene for eye colour protein, let's say it's found here (see A in Figure 30), so on the other chromosomes it's also found exactly on the same position (see B).

B

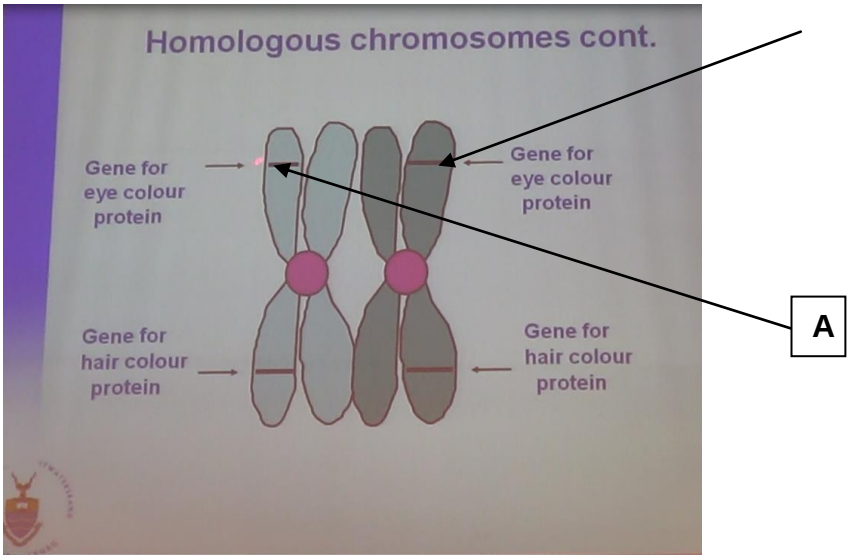


Figure 30: Illustrating position of a gene on homologous chromosomes

Lecturer	So the position where a gene is found is called the locus. And so in homologous chromosomes the position is the same. Please note that I'm saying gene for eye colour protein. There's no gene that produces colour blue. The gene is responsible for producing a protein which results in the blue colour of eyes. So it's gene for eye colour protein, gene for hair colour protein, gene for skin colour protein. Not gene for eye colour, gene for hair, gene for skin colour no.

Knowledge of difficulties that students (my students and my students' students) are likely to encounter when learning genetics

I highlighted in my teaching the content of genetics that students find difficult to understand according to literature (Bahar et al., 1999).

Lecturer	One of the major problems that are faced by students or learners is these terms. So it is very important for especially high school teachers here that you understand these terms if you are to teach the genetics effectively. Right, so the terms that we are going to look at, that we should understand and explain; the first pair is **trait** and **variation**. Then there is **homozygous** and **heterozygous**, **dominant** and **recessive**, **phenotype** and **genotype**, **gene** and **allele**.

How I explained gene and allele to help students to understand the two terms is shown in the excerpt in section 6.4.1.

6.4.3 Pedagogical knowledge

As indicated in chapter 5, the feedback from a critical friend on the first trigger incident sensitized me to my use of constructivist principles in my teaching. Therefore, when analysing the PK that is reflected in my teaching, I decided to put on the lens of constructivism to help me to notice and to understand my teaching. In simple terms, the theory of constructivism postulates that individuals learn by constructing new knowledge from prior experiences (Mintzes et al., 1998). The aspects of my teaching that fall under pedagogical knowledge include use of T/L aids, teaching styles, teaching activities, use of questions at the beginning of lectures (todays' questions) and discussions (whole class, small group or discussion in pairs). All these features are known and are common teaching practices. They can also be constructivist approaches depending on how they are used in the teaching and learning process. At the time of my teaching of the genetics course, I was not aware that they are constructivist teaching methods. Therefore, below I do not just present these teaching practices but also what I have found to be of importance in my use of these teaching practices when looking through a constructivist lens.

Use of T/L aids

Video-recordings of my lectures show that I used lots of pictures in my PowerPoint presentations. In addition, I also used a variety of concrete materials and objects such as strings, DNA models, charts, flowers and pool noodles as T/L aids. While it should be normal teaching practice to use T/L aids and is one teaching aspect that I encourage my students to practice in their own teaching when I am teaching them in methods courses, I had actually never used any tangible materials as T/L aids in my own teaching as a teacher educator and I had never linked their use to the theory of constructivism. Therefore, I found the use of tangible T/L aids to be a new and salient aspect of my teaching. What I had observed in my teaching is that the use of concrete objects to represent abstract ideas helped students to ask questions that would promote their understanding of concepts. A good example is when I presented to students a string with different coloured sections and explained to them that the whole string represented DNA and the different coloured sections represented genes (Figure 31).



Figure 31: Coloured string representing genes on DNA

A student (Gladys) then asked: “Are you saying that many different genes are found on a single DNA?” Gladys question was an indication of a developing understanding of the relationship between DNA and genes from simply showing students the string as a visual representation of DNA.

My reflection: *As I watched the videos of my teaching, I realised that this was the first time that I had used concrete T/L aids such as models in my teaching of pre-service teachers. All along, I had been telling my students about the importance of using T/L aids for effective teaching to occur but I had never used them in my own teaching of the same students. The nearest I had used T/L aids was by inserting pictures and diagrams in my PowerPoint presentations. Therefore, all along, I had been preaching what I was not practicing. I wondered why I had not been using T/L aids in my teaching of pre-service teachers. It struck me that when I moved from high school to university; I began to think that T/L aids were not necessary anymore. For whatever reasons, I seemed to have assumed that university students did not need the use of T/L aids. One possible source of this assumption could have been my own experiences as a student. My own lecturers during my time as a student at university never used T/L aids and I think that’s how I was viewing university teaching. The only reason why I decided to use T/L aids in this study was for purposes of modelling teaching as a way of teaching about teaching. However, when I watched my teaching, that mindset that T/L aids are not necessary at university level changed. The quality of my teaching, the extent of student engagement and interaction that subsequently occurred in my lectures, as a result of using T/L aids was a great experience. I had never experienced so much confidence and enjoyment in my teaching before. I had never seen students getting so much involved during my lectures. This was something new, something that I would want to experience again and again in every one of my lectures.*

The use of T/L aids is necessary for effective teaching to occur (Cimer, 2007). This is because they facilitate focussing students' attention on materials to be learnt thereby creating the necessary conditions for construction of new knowledge (Bligh, 1998) and that is what constructivism explains. T/L aids such as models help students to make sense of the world by making abstract or imagined concepts seem more real (Van Driel & Verloop, 1999). Just as with models, pictures are a form of multimedia that help to bring the real world to students and that also facilitates the construction of new knowledge. In addition, if the saying 'a picture is worth a thousand words' is anything to go by, then it means that through the use of pictures, I communicate a lot of information to my students which saves time and minimizes what Bligh (1998) warned against; short memory information overload.

Use of a variety of teaching styles

The other aspect of my teaching that I identified from watching the video-recordings of my lectures was that I used a variety of teaching styles in my teaching which corresponded to a variety of learning styles. As described in chapter two, students' learning styles can be described in terms of perception (sensory or intuitive), input (visual or auditory), organization (inductive or deductive), processing (active or passive) and understanding (sequential or global) (Felder & Silverman, 1988). In most of my lectures, in terms of perception, I catered for both intuitive and sensory students by explaining orally, the abstract concepts and then using concrete materials like the string and the DNA model. The presentation of content in my lectures was both visual (pictures, PowerPoint presentations, diagrams and concrete materials) and auditory (my explanations and class discussions). My presentation also catered for both active and passive students in that the question and answer discussions allowed active participation. However, students could also just listen if they did not want to participate actively. In most of my lectures, I started with the global perspective then narrowed the teaching to sequential steps thereby catering for both the students who understand better if they are given a global perspective and the students who understand better if they are given the information step by step. For example in my first lecture, I started off by explaining what genetics is all about then narrowed down the content to individual topics which I explained sequentially. Even in my teaching of individual topics, I began my lectures with a global perspective. For example in lecture two, I first described the purposes of meiosis with the students (global view) then narrowed the teaching to a step by step description of the process of meiosis. All these learning styles promote the construction of new knowledge in that they create attention in students and the creation of attention, be it through sensory, cognitive or affective stimulation helps students to retrieve from long term memory what they know about the concepts under discussion which then facilitates learning.

My reflection: *I was able to cater for a variety of learning styles in my teaching. As I see it now, a pure oral lecture without any use of T/L aids would cater for intuitive, auditory, and passive students. By making use of concrete materials such as T/L aids, I was able to cater for an increased range of learning styles i.e. sensory, visual and active thereby providing for a large variety of learning styles in my lectures. Therefore, while my reason for using T/L aids in my lectures was to model good teaching to students, I have now learnt that the use of T/L aids also exposes students to a wide range of teaching styles which in turn caters for many learning styles which is likely to promote learning.*

Teaching activities

The teaching activities that I used included **explaining** concepts and **describing** processes. These teaching activities were used together with other pedagogical activities such as the use of T/L aids, questioning and quiz. For example when I compared meiosis I and meiosis II, I put up a PowerPoint slide showing the stages of meiosis I and II side by side then used the diagram to describe the differences between the two processes after which I gave students time to discuss the differences amongst themselves or to just think of or look at the differences:

Lecturer	Now look at the two side by side. Interphase is outside the whole process. There is no other interphase after the end of meiosis I. So it's only one. Now look at prophase. This is very important and you should take note of it. In prophase I it is the homologous chromosomes that we are looking at. In prophase II we are looking at individual chromosomes. So when you get to metaphase, it is the homologous chromosomes that pair up one on one side…one whole chromosome on one side of the equator, and the other chromosome on the other side. Look now at metaphase II. It's an individual chromosome. One chromatid on one side, the other chromatid on the other side. So metaphase I, one whole chromosome on one side, one chromosome on the other side. Metaphase II, one chromatid on one side, and the other chromatid on the other side. So anaphase, it is the chromosomes that separate. In anaphase II it is the chromatids that separate. And then at the end, telophase I, we have two nuclei which results in two cells after cytokinesis, those are the products of meiosis I. At the end of meiosis II, we have four cells. So that is the process of meiosis. I'm giving you two minutes to think about, to look at it and state the difference between the two, to the person next to you. (*Students discuss)*.

In the excerpt above, I used the diagram on my PowerPoint to **describe** (teaching activity) the difference between meiosis I and meiosis II. My aim was to use what the picture showed to promote active learning and the use of higher order thinking skills. When I watched the video on which this excerpt is based however, I realized that I again fell into the trap of telling the students instead of giving them a chance to identify the differences between meiosis I and meiosis II on their own. Therefore, while it was a potentially good activity that could have helped students to construct knowledge on their own, I did not effectively make use of it. It is therefore one thing to know about good teaching activities and another thing to be able to effectively use them. This is where it helps for a teacher educator to be clear on his or her teaching philosophy that is, to be clear on what one believes helps the students to learn. Treating my teaching philosophy as a beacon would have helped me to constantly check in my planning and in my actual teaching if I was upholding my beliefs about how students should learn. Watching the videos of my teaching even on my own helped me to notice the salient aspects of my teaching both negative and positive cases. Such an exercise can therefore, sensitize one to notice and to work on one's weakness to improve one's teaching.

Teaching strategy: Use of "today's questions"

My lectures were characterized by a feature that I called "today's questions" that I put on the screen at the beginning of each lecture. My overall aim of introducing this feature of "today's questions" was to encourage students to come to lectures on time by getting them to know that they would be involved in a beneficial learning activity every time. That is why I chose to refer to the use of "today's question" as a strategy. The way I then used the questions to revise and to recap and to introduce new content makes it a teaching procedure too. I found the use of "today's questions" as a powerful teaching tool in two ways. Firstly, previously I used to wait uncomfortably for the students to come in and settle down before the start of my lectures. With the introduction of today's questions, that uncomfortable waiting became a thing of the past as I would discuss the questions with the students who came early while waiting for the lecture starting time. Secondly, students who came early for my lectures no longer had to wait idly for the lecture to start. They would be busy discussing the questions.

I used this new feature of today's questions to my lectures for a variety of purposes. For example, in the first lecture, the questions focused on the content that I was going to teach in that lecture. In the second lecture, the question was not related to the content of that lecture. It was based on a common misconception of genetics that different types of cells carry only the genetic information that they need to carry out their functions. The purpose of highlighting that misconception through a question was to try to correct the misconception

through a Q and A discussion. In the third lecture, the question was from a past exam paper based on the content that I was going to teach in that lecture. Therefore, through the today's questions feature of my teaching, I recapped on previous content, I introduced new content, I discussed common misconceptions and past exam questions with the students. (See Appendix E for examples of "Today's questions").

Considering that the use of questions in general helps teachers to determine the kind of knowledge a learner has, I was therefore using the principles of constructivism in my pre-lecture use of today's questions. Cimer (2007) asserts that for effective learning to occur, a teacher needs to identify learners' prior knowledge first, make students aware of them and in the light of these ideas, help students to construct their own understanding. The use of todays' questions helped me to practise this way of teaching.

The today's questions feature worked as a powerful 'ice-breaker' for my lectures which teacher educators can also adopt and use. What was good was that it was not a time consuming practice at all. I would formulate the questions based on a misconception or I would choose questions from previous exam papers that focused on content already covered or to be covered. Student participation in the discussion on today's question increased as the course progressed. What made the strategy effective was that the questions were appropriate to what we were doing in the course at the time and therefore meaningful to the students. Tendai had this to say about my use of today's questions:

Tendai: I think what was nice is that she always had those questions in the beginning, that was sort of a recap of what we'd done, so that we got a chance to see sort of how she would ask questions on what we'd learned, or, to remind us what we have done so that we can maybe relate it to what she's going to do in that time.

The fact that Tendai was able to describe what was achieved by my use of today's question feature shows that the questions had made a positive impact on her learning. *Reminding* students on what they know so that they can *relate* to what is to come is a feature of constructivism and according to Tendai, that's the purpose the questions were serving.

Individual work

Individual work was when I would put up some questions on the screen for students to respond to individually. The quiz show was one such activity. The excerpt in Appendix F and

pictures in the next section shows an example of a meiosis quiz where students had to answer questions individually.

Formative assessment

Initially, I used questions which I would ask students to discuss in pairs and then I would ask for feedback. Not everyone participated in these discussions or feedback sessions. I then decided to introduce a short quiz at the end of a lecture in the form of multiple choice questions and true and false statements. Students would write their answers down and then we would revise together. While the quiz allowed individual participation, it did not allow me to assess their performance during those quiz sessions. I then decided to use the idea that I got from a colleague of using flash cards. Each pack had five cards on which was written **True**, **False**, **A**, **B**, **C** and **D.** Figures 32 and 33 show pictures of a quiz session[16].



Figure 32: Students holding up cards to indicate the answers

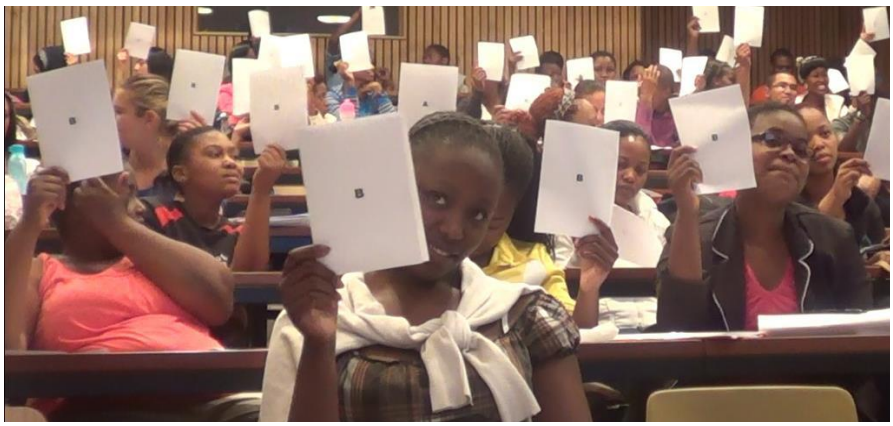


Figure 33: Students holding up cards to show their choice

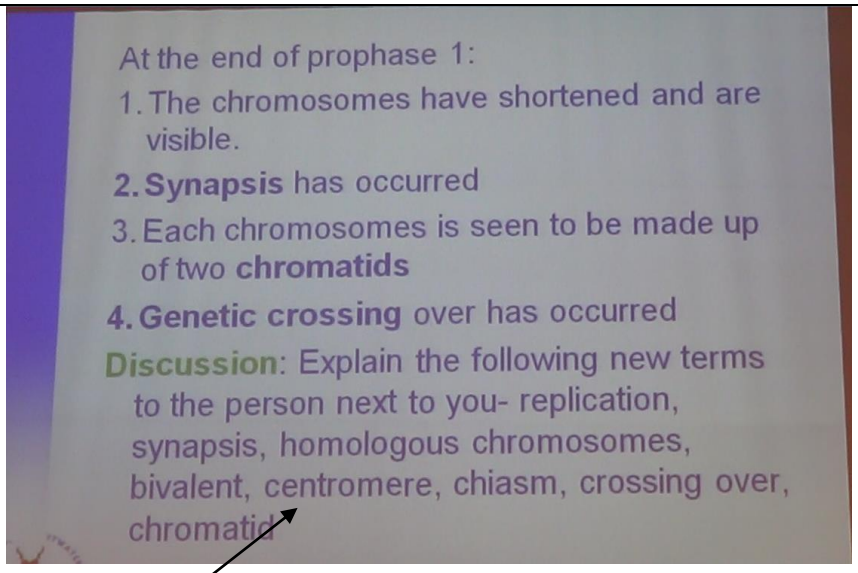
[16] Consent to take these pictures was given by the students. We agreed that those who did not want their faces to be seen would cover their faces when they raise the cards to show their answers.

The flash card quizzes resulted in high participation from the students. Although very time-consuming to prepare, the quiz enabled students to participate individually within a whole class activity and I was able to immediately assess understanding at both individual and class level and to give immediate feedback. Quiz in combination with the use of flash cards is therefore an effective assessment strategy that allows participation of students without fear that they will be ridiculed by their peers. I was however not able to use it for all the lectures as preparing multiple choice questions is a time consuming process. I then thought that in future, I was going to create a data base of multiple choice questions using appropriate resources such as text books then during my teaching, I would simply pick and choose appropriate questions from this data base.

Teaching procedures

Teaching procedures are the teaching methods that I employed to bring about teaching and learning. An example of a teaching procedure is a **discussion** for example when students discuss some content or questions followed by a feedback session. The excerpt below shows an example of a discussion followed by a feedback session. In this lecture, I taught about meiosis. I explained the events of prophase 1. I then decided to use a discussion and a feedback session to assess students' understanding of the events of prophase 1. Discussion and feedback sessions work on the principles of constructivism as they allow students to engage in active processing activities of reviewing their understanding, of comparing and contrasting their ideas with those of other students and of the teacher. Such activities have the potential to create dissonance in a student which may move him/her to revisit his ideas leading to the construction of new understandings

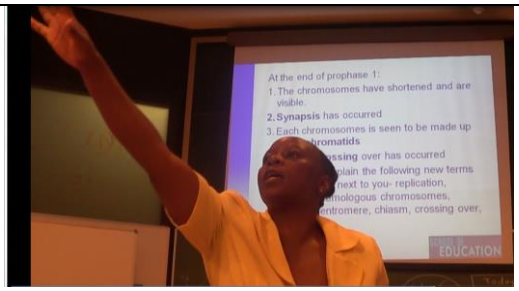
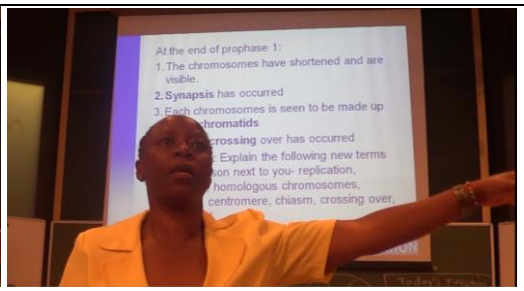
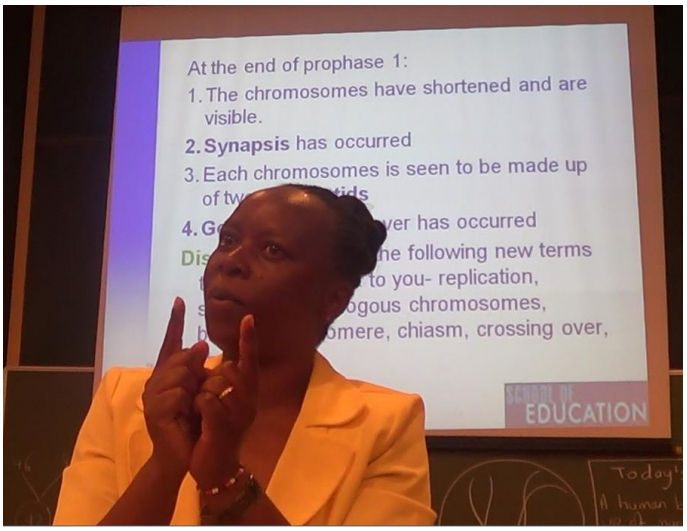
Lecturer	So at the end of prophase one, the chromosomes have shortened and are visible. You can see them. Synapsis has occurred. That is the pairing up of homologous chromosomes. Each chromosome is seen to be made up of two chromatids. Genetic crossing over has occurred



And now, all those terms describe the events we have looked at so far.

I had introduced a lot of new terminology (all underlined words above) within a short space of time. It was therefore important to find out if students had understood the meanings of these terms. It was during this teaching episode that I noticed students who were not participating in the pair discussions; an incident that I described as trigger incident number two in chapter 5.

Lecturer	Before we move on to the next phase, can you explain what those terms mean to the person next to you, your understanding of those terms.
Student	(*discussion between partners*)
Lecturer	Let's continue. Are there any terms that you feel you are struggling to explain?
Students	Yes
Lecturer	Right, which ones?
Student	The difference between bivalent and homologous chromosomes
Me	Okay, she says, she is finding it difficult to differentiate between bivalent and homologous chromosomes. Who can help? Right…yes?
Student	I think homologous means that like the same, and bivalent means two that's the same that have lined up
Lecturer	That are paired up
Student	Yes
Lecturer	Right. Homologue means, homo means same, so when we say homologous chromosomes, we are saying, similar chromosomes. So it doesn't matter when one is there and the other one is there,

	  They are homologous chromosomes. And then when they come together and pair up,  We then say now it's a bivalent. So homologous simply means they are similar in shape, they are similar in size, they carry the same genes. They may be paired up, they may be in different places within the nucleus, but the moment that they come together to form a pair, that pair we then describe it as a bivalent. The process of coming together and pairing up is synapsis. Your hand was up.
Student	Okay, does it mean that chromosome comes from the (?)?
Lecturer	Sorry, come again?
Student	Does the…I see different colours blue and red, so does it mean the other one comes from the mother and the other one from the father?
Lecturer	Yes. So we are using one colour to represent those that were in the egg. That is coming from the mother. And the other colour to represent those that were in the sperm that is from the father. Yes?
Student	Ma'am, please explain the difference between chiasma and crossing over.

The feedback session above continued until I had answered all the questions from students. While the discussion was meant to actively involve all students, I learnt during this episode

that it was not a preferred learning style for some students. The procedure also disadvantaged some students with poor English communicative abilities. This observation highlighted the need to vary teaching/learning styles. The discussion in the excerpt above also highlights the importance of having adequate content knowledge as a teacher educator as students' questions put you in a situation where you should be able to satisfactorily explain concepts.

Teaching and learning activities

An example of a teaching and learning activity is a **question and answer** (Q & A) session where I would ask a question and then the students would answer the question. When the question is answered correctly, I would ask the next question until all the questions I had were answered. Q & A is a constructivist teaching method as it allows a teacher to determine the knowledge and ideas that students have about the concepts under discussion (Cimer, 2007). Below is an excerpt of a Q & A session.

Lecturer	Right, so what are the products of meiosis? What are the products of meiosis? What do we intend to get at the end of meiosis, the whole process of meiosis?
Student	Four daughter cells.
Lecturer	Four daughter cells. And how are they different from the parent cells?
Student	They are diploid
Lecturer	Please come again
Student	They are haploid
Lecturer	They are haploid. You have really confused these two terms. Di- means two sets but they have one set. So they are haploid. And what do we call them? What do we call them, the four daughter cells?
Student	They are gametes.
Lecturer	Gametes. What do we call them in male animals?
Student	They are sperms
Lecturer	And in male plants?
Student	Pollen
Lecturer	What do we call them in male plants?
Student	Pollen.
Lecturer	Pollen. Pollen grains. And what do we call them in female plants?
Students	Ovules
Lecturer	Right. And in female animals?

Student	Ova.
Lecturer	Ova or egg cells. Okay. And then the role of meiosis, who can explain to us the role of meiosis? Why do we need it? Quick. Yes?
Student	Meiosis plays a role in maintaining the same number of chromosomes can also play a role in bringing about variation within species.

Although I had been using the Q & A method in my lectures, I used to wonder if all students in the lecture were benefiting from the Q & A method because the method has the disadvantage that only one student gives an answer at a time and if the answer is correct you move on to the next question making it difficult to assess individual understanding. Therefore, as I was preparing the questions for the Q & A session in the excerpt above, I also prepared questions that were based on the similar content for students to answer after the lecture as homework. When I marked the homework exercise, there was evidence in students' answers that they had engaged with the questions that I had asked and the answers that were given by their peers during the Q & A session. Therefore, while not everyone gets a chance to orally answer the questions, those students learn by mentally engaging with the questions that are asked and the answers that are given during the session. I therefore now use the Q & A method a lot in my teaching. I however make sure that the sessions are not random activities but planned sessions with well-thought out questions which have a mix of both lower order and higher order questions.

Role playing activities

The role playing activities that students did were described in section 4.6.6. Role playing activities encourage student participation and according to Cimer (2007), there is a general agreement in the literature that effective learning is promoted when students are actively involved in the learning process. The role-playing activities that students did allowed them to work with others, to ask questions about genetics concepts, to conduct research and to assess their own and other students' reasoning. All these concepts have the potential to produce cognitive conflict which is fundamental to learning (Joyce, 1997). The role playing activities also helped to reduce anxiety in some students as shown in my conversation with Simba, the student who in earlier lectures had indicated that he could not participate in class discussion for fear that his answers could be wrong (see trigger incident number seven described in section 5.2.7).

Student to student interactions

Just as with role playing, student to student interactions encouraged student participation in teaching and learning activities. I achieved students to student interactions in my teaching by allowing for group or pair discussions during lectures. Student to student interactions were also achieved during tutorials when students were given tasks that required them to work in groups. An example of such a task is when students were required to build models showing the events of meiosis. Each group of three students was assigned a stage of meiosis which they needed to model on poster sheets using pipe cleaners and other items like colored pencils, cello tape and glue. The pictures in Figure 34 below show students' models.

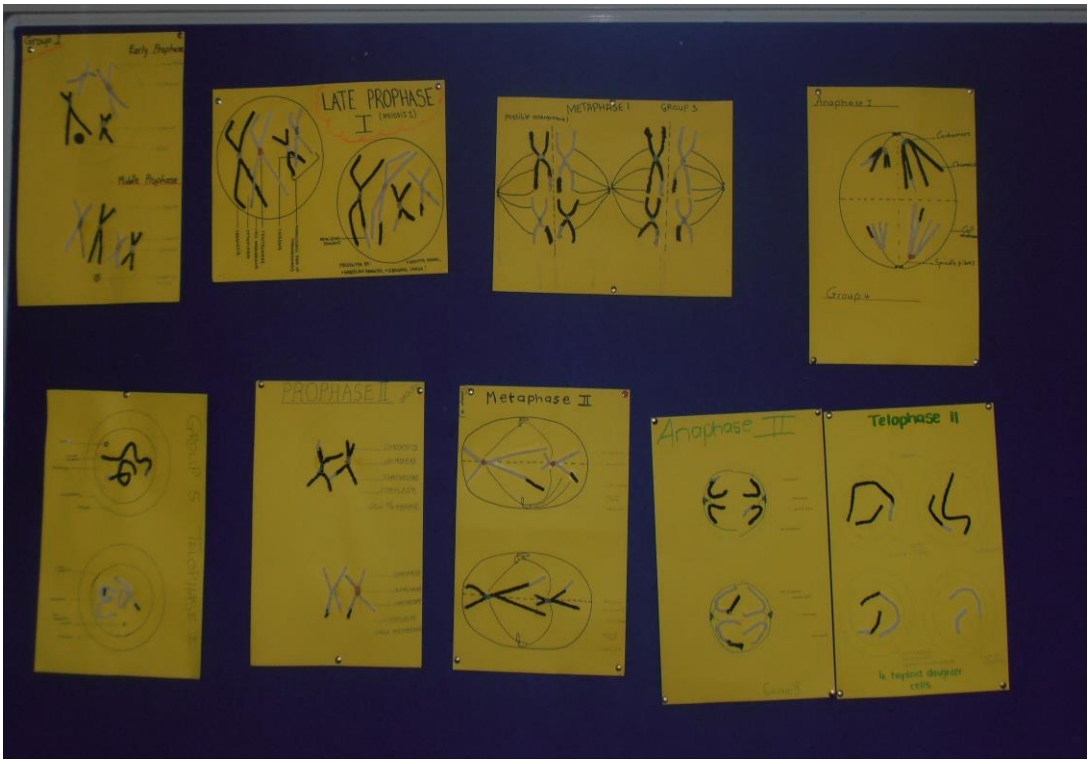


Figure 34: Students' models of the stages of meiosis

The purpose of exposing students do this modelling activity was to try and enhance students' understanding of meiosis by letting them visually represent the events. The modelling activity was followed by a presentation activity whereby each group would explain to a bigger group the events they had modelled.

Activities such as the presentations described above require good organization for them to be successful. Therefore, I first had to do the modelling activity on my own in order to work out the amount of materials and to figure out how to plan it effectively. The class was divided into three practical groups of 30, 30 and 31 students. Within each practical group, smaller

groups of three students each were assigned a stage of meiosis to model. For me to be able to listen to each group, I designed two other activities. Therefore, when I was listening to the presentation of one group of 30, the other two groups were working on the other activities. As indicated by Nico my critical friend, I did put a lot of effort in my teaching of the course but what needs to be appreciated here is that the kind of effort and time that I put will not remain consistently high. I now know how to organize the activities. I will also be using the same T/L aids like the posters, the flash cards and pool noodles for many years to come.

6.4.4 Knowledge of content

Knowledge of SCK and CCK

There is evidence in the video-recordings of my teaching that I included SCK in my teaching of the CCK. As explained in chapter two, the CCK that is found in textbooks includes the descriptions of the structure and functions of the genetic structures (DNA, chromatin material, chromosomes, genes and genetic information). What is not explicitly described in biology text books is the relationship between these structures and the purposes of some of these forms of the genetic material such as the purposes of chromatin and chromosomes. I therefore regard this content knowledge as specialized content knowledge (SCK). I used a lot of visuals to teach about the relationship between these different forms of the genetic material.

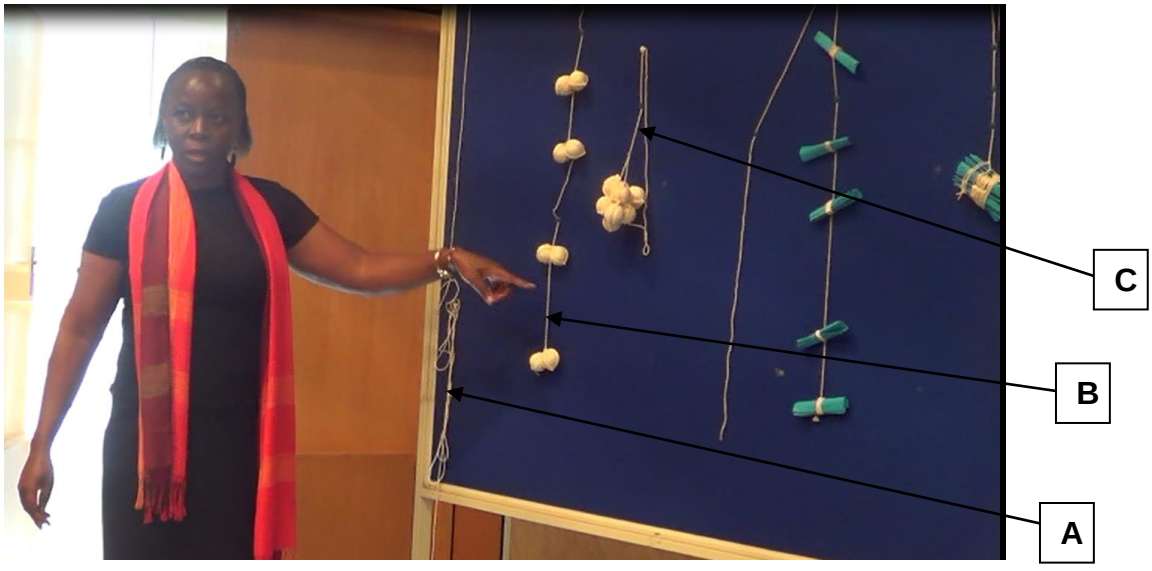


Figure 35: Using string and other materials to explain the relationships between DNA, chromatin and chromosome

The loose string (A) represents DNA. The structure with string wound around pairs of formica balls (histone proteins) or blue folded paper (again representing histone proteins) represents chromatin and the structure with many white balls and string and the one made of many blue folded paper and white string wound around them represent a chromosome

My presentation of Figure 35 during the lecture:

Lecturer	This string (A) is the same size as this one (B) and the same size as this one (C). Now if I say this string (A) represents DNA, this structure (B) represents chromatin and this one (C) represents a chromosome, can you explain the difference between DNA, chromatin and chromosome?

The excerpt and Figure 35 above show evidence of my content knowledge both CCK and SCK and how I taught it. I used SCK to prepare the T/L aids that I thought would bring a better understanding of the relationship among DNA, chromatin and chromosome.

Knowledge of the vertical curriculum

My knowledge of the vertical curriculum manifested every time I would make reference to what students had covered in the previous course as shown in the excerpt below:

Lecturer	This is what you did with Mrs Moletsane. So DNA is copied into mRNA. We have three types of RNA, mRNA, rRNA and tRNA. Can you remember? So transcription is the process that copies the genetic information from DNA into mRNA. And then mRNA is translated in a protein by the actions of rRNA and tRNA. And then the proteins form different features of the individual organism. Here this diagram shows that process.

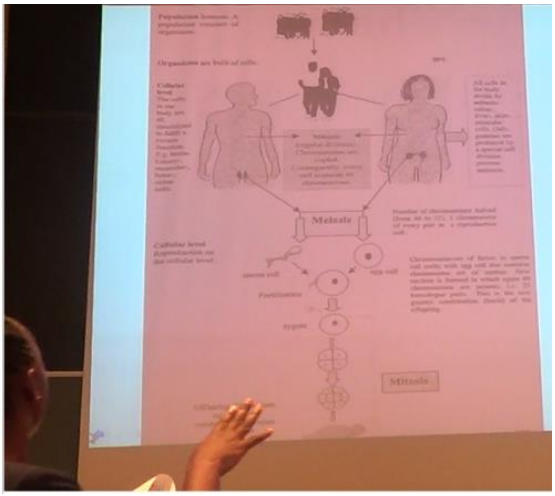
By continuously making reference to the content that students covered in the previous years, my hope was that students will see that the content that they cover in previous years is important as it is linked to future topics and therefore an understanding of those topics is necessary for understanding new topics.

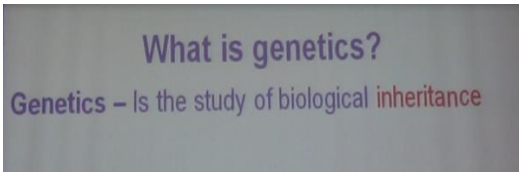
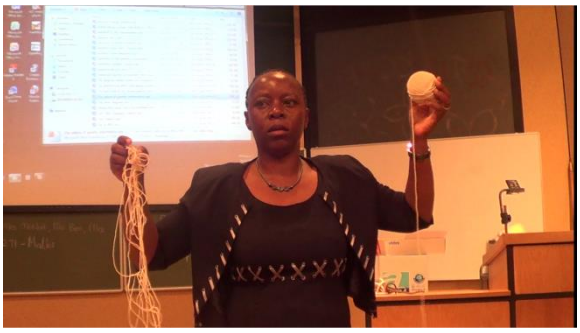
6.4.5 Manifestations of PCK

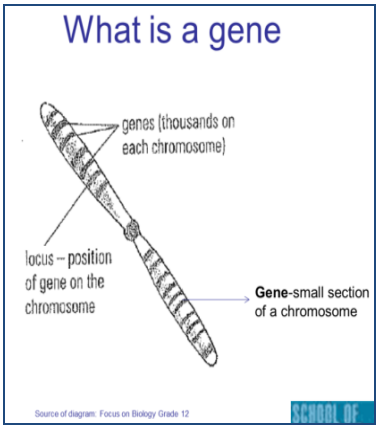
Curricular saliency and step by step sequenced teaching

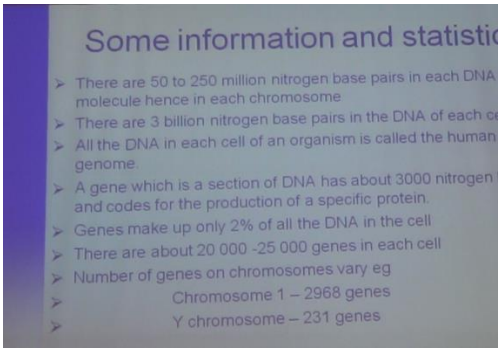
As explained earlier in section 6.2.1 curricular saliency is the ability to identify concepts and subordinate concepts that make up a topic and organizing those concepts in an order that is appropriate for teaching. At course level, curricular saliency will be the ability to identify appropriate topics for the course and organizing them appropriately for teaching in a way that will help students to understand the topics and the links between them. There is evidence of curricular saliency in my teaching at both course level and topic level. During the analysis of my teaching, I was able to break down my teaching into episodes with a beginning, a body and an end. These episodes helped me not only to identify evidence of curricular saliency but also many features of my teaching as they manifested in my teaching for example, step by step sequenced teaching in my lectures. Table 9 shows all the 12 episodes in lecture one (genetics at molecular level) and some of the features of my teaching practices found in those episodes. I chose to show episodes using lecture 1 because it is only in this introductory lecture that my curricular saliency at course level was shown as I was explaining to students what makes up genetics. In the rest of the lectures, there is evidence of curricular saliency at topic level. I also decided to show all the 12 episodes so that I can show how constructivism played out in my lectures.

Table 9: The episodes found in lecture transcript one

Episode number	Features of the episode			
	Concept/ Aspect introduced	**Introduction**	**Body**	**Closure**
1	Picture	Invitation to the students to look at the picture and to ask them to say what they can see 	-Students respond to the lecturer's question -Lecturer describes what the picture is showing -Lecturer explains the picture	The phrase 'right' signals the closure of this episode

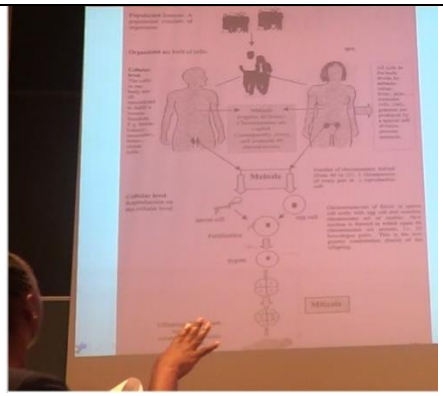
Episode number	Features of the episode			
	Concept/ Aspect introduced	**Introduction**	**Body**	**Closure**
2	Genetics-Biological inheritance	Question on PPt slide 	-Question and answer (Q & A) discussion on the concept-Explanation of concept	The phrase: right Question: Can we move on Students' response: Yes
3	An analogy	Students are shown two forms of one type of string 	-Q & A discussion on the analogy -Explanation	Phrase 'right'
4	Gene	Students are shown string made up of different coloured sections and are told that the sections represent different genes  Question: How do you define a gene	-Q & A discussion -Explanation	Phrase-Okay
5	DNA, gene, genetic information	Model of DNA 	-Students identify the different parts of the model -Explanation of a gene using the model -Explanation of genetic information	Phrase-Okay Student asks a question in response to the suggestive phrase for closure -Response to the

Episode number	Features of the episode			
	Concept/ Aspect introduced	**Introduction**	**Body**	**Closure**
				student closes the episode
6	Questions for discussion	• What is DNA? • What are genes? • What are chromosomes? What is the relationship between: ➢ DNA and genes ➢ DNA and chromosome ➢ DNA, gene and chromosome	Discussion in pairs or in threes	Phrase 'right'
7	Feedback session	Reading out of a question	Students give their answers Lecturer responds to the answers	
8	DNA structure	Diagram of DNA on PPt	-Description of DNA structure -Explanation of how DNA is organized into a chromosome Definition of a chromosome -Explanation of the relationship between DNA genes and chromosomes	Phrase 'right'
9	Gene	Diagram of a gene 	-Explanation of the diagram -Description of a gene -Description of the function of a gene -Description of a misconception about the function of a gene -Discussion of the misconception and clarification	Phrase 'okay'
	Gene	Flow diagram	Explanation of the	A

Episode number	Features of the episode			
	Concept/ Aspect introduced	**Introduction**	**Body**	**Closure**
10	expression		flow diagram	statement emphasizing the function of a gene
11	Information on genetic molecules	PPt slide 	Going through the information pointing interesting parts to the students	Statement: That is it Q-Any questions? Phrase 'okay'
12	Homework	Handouts 	Explanation of the work to be done and due date	Statement- That is all for today closes the last episode and the lecture

In total, lecture one had 12 episodes. Episode 1 shows course level curricular saliency where I was highlighting to students the topics that make up genetics and how they are linked to each other. The details of episode 1 are shown in the excerpt below. The topics making up the genetics course and also linked to the genetics course that I talked about are indicated in bold after the question and answer session in the body section of the episode.

Episode 1		
Lecturer	Now, I want us to look at that picture. Don't worry about the words and the description, just look at the picture and tell me what you can see?	**Introduction to episode 1**: a picture

		
Student	Reproduction is taking place.	**Body of episode 1:** Question and answer session
Lecturer	Reproduction is taking place. Okay. He says reproduction is taking place. What else can you see there? Yes?	
Student	The offspring	
Lecturer	The offspring is?	
Student	Is different to the parent.	
Lecturer	The offspring is different from the parent. Okay. That's what she can see. Yes?	
Student	Division of cells.	
Lecturer	Division of cells. Yes?	
Student	Multiplication of cells.	
Lecturer	Multiplication of cells. Yes, anything else? (*Some waiting takes place)*	
Lecturer	Okay, so let's look at the picture together. If you start from the top, that's a group of people there, and you can see it's a population. And then from that population we have two people, a couple there, and then something is happening between these two (*laughter*). What do you think is happening there?	
Student	(*laughter*) Students laugh throwing in comments like: they are loving each other	
Lecturer	Okay, meiosis is happening there (*pointing at the man's reproductive organs).* Meiosis is also happening in there (*pointing at the woman's reproductive organs*). Meiosis produces the sperm cell and egg cell, and then we have fertilisation then we have the zygote, we have a ball of cells, another ball of cells, and then we have a baby there. Right	**Body of episode 1 continues:** Description of the picture
Lecturer	If we look at, let's say, reproduction, if we are looking at genetics we can't separate it from **reproduction**. Reproduction results in the production of offspring and that offspring are determined by something that is passed on	**Body of episode 1 continues:** Explanation of what genetics is all about

	from parents to them (**inheritance** and **genes**), and that is what we talk about when we are talking about genetics. So if we start from here *(pointing at the man and the woman in the picture)* and then we end up with a baby, what has happened? That's what we will be talking about. And then you spoke of division of cells. Division of cells in **meiosis**, It can be **mitosis**. So under genetics then we are going to look at meiosis, and we are going to look at mitosis. These are two separate…different types of nuclear division and for different purposes. So we are also going to look at that. And someone said the offspring is different to the parents. And then we want to know why the offspring is different to the parents (**variation**). And then if we look at the population and if you consider ourselves here to be a population, we are all human beings but we are all different. Why are we different? We want to look at that, and that's what genetics is all about. So those are the issues that we will be looking at in genetics. And when we look at genetics we can't separate that from reproduction, because from parent to offspring it's reproduction. That's how the genes are passed on from parent to offspring.	
	Right.	**The word <u>right</u> signals closure of episode 1**

In addition to evidence of CS, I also see many features of constructivism in my teaching some of which I described earlier such as use of a picture and Q & A discussion. The details of the structure of the episodes are presented next.

The structure of the episodes

As can be seen in Table 9 above, the beginning of an episode took two main forms; a picture on a PPt slide (e.g episode 1), a question on a PPt slide (e.g. episodes 2 and 9), an analogy (3 and 4), a model (5), and diagrams (8 and 10). The body of the episodes was characterized by two main T/L activities namely whole class discussions and lecturer explanations. All these learning activities have features of constructivism as explained earlier for example some of them create attention and help students to retrieve prior knowledge as they represent ideas about the real world (pictures, models and analogies). Questions and discussions help students to also retrieve what they know and to air their views to peers. I used analogies to initiate discussions and to aid my explanation of concepts. Within some episodes were students' discussions in pairs and feedback sessions. There was therefore interaction (lecturer-student interactions and student-student interactions) throughout the lecture. The concepts that I chose to teach under the topic genetics at molecular level can

be identified (CS). The concepts are the components of the genetic material which include DNA, chromosomes, genes and genetic information. Step by step sequenced teaching can also be seen in the form of the episodes.

Step by step teaching of concepts is a type of teaching style that caters for students whose learning style has been described as sequential (Felder & Silverman, 1988). Therefore, by teaching sequentially, I was catering for those students who prefer step-by-step progression in their learning. By doing discussions, I was catering for those students who learn better through talk and by explaining the concepts in detail; I was catering for those students who learn better by listening. Analogies just like other T/L aids (pictures and models), they create attention in students and form a foundation for learning of concepts which are difficult to understand.

Classroom interactions

As can be seen in section 6.4.5 above, a lot of interaction occurred in my teaching. These interactions include lecturer-student interactions and student-student interactions. These are interactions that should occur in any classroom where effective teaching happens. However, what I noticed of importance is that I actively initiated the interactions by showing students and then basing my questions on T/L aids like charts and on analogies. Students then responded lively in the lecturer-students interactions which were mainly through a Q & A discussion. The use of visual aids seems to have enabled the students to participate in the discussions. It was as if the concrete materials or visuals were helping students to ask questions and also to respond to questions. So what I see here is that the visual aids became the medium for the interactions. I was on one hand communicating my ideas about a concept in form of questions with reference to the visual aids and students were on the other hand using the visuals to think about the concepts I was putting across and to respond. I see my ability to facilitate effective and lively discussions as a manifestation of a teacher's knowledge. One may ask the question what makes you think that they were effective and that they were a manifestation of a teacher's knowledge. When I watch the video, I see myself being able to explain the concepts, being able to respond to students' responses by prompting them until they get to a correct answer and my ability to acknowledge a good answer without hesitation. The excerpt below from episode 10 shows the above aspects in my teaching.

Lecturer	If I ask you, what is DNA, what would you say? Yes?
Student	DNA is a collection of genes with different characters.
Lecturer	DNA is a collection of genes with…?
Student	…with unique features.
Lecturer	With unique features. Oookay…?
Student	Each gene with unique (student *laughs*).
Lecturer	Instead of saying features, you said, a collection of genes with different features. Features is not the right word there.
Student	Genetic information.
Lecturer	Genetic information, well done.

6.5 A summary of my teaching practices as revealed from the analysis of my teaching

I used the four domains of a teacher educator's knowledge as presented in my conceptual framework as the framework for analyzing my teaching. I presented the findings from the analysis of my teaching in terms of these different domains of a teacher educator's knowledge. Firstly, there is evidence that I was aware of my context and students' future contexts. This was shown by the way I was explicit about the kind of teaching aids that the students as future teachers would need to consider for rural children and for urban children. My knowledge of students manifested when I talked about students' misunderstandings and misconceptions and what they find difficult to understand in genetics. My pedagogical knowledge was the most conspicuous in my lectures in terms of the teaching procedures, teaching activities and teaching styles that I used during my teaching. The teaching procedures included use of questions and discussions. The teaching activities included explanations of concepts and descriptions of processes. I was able to use a variety of teaching styles. My PK reflects the tenets of constructivism. I was also able to present both CCK and SCK during my teaching. My PCK also manifested in my teaching. According to Georgia, my PCK manifested in my ability to use appropriate T/L aids in most of my lectures, correct explanations, facilitating lively class discussions in which it was clear that learning was occurring. Therefore, in my teaching, I was able to expose students to knowledge about their future contexts, knowledge about their future students, pedagogical knowledge and knowledge of content as postulated in my conceptual framework.

The analysis of my teaching shows that I did not focus on teaching content only although it is a content course. I also taught students about their future contexts and their future students.

I taught students pedagogical knowledge by enacting the pedagogical aspects in my teaching. The purpose of deliberately exposing students to all these four forms of a teacher educator's knowledge was to achieve teaching content for understanding and for teaching. My conceptual framework postulates that if a teacher educator brings to his or her teaching these four domains of knowledge and teaches them to the students, students should be able to acquire these four domains of knowledge from the teaching and learning process. As stated in the introduction to this chapter, this chapter is a precursor to chapter seven in which I analyze students' interviews to find out how they experienced the teaching practices that I have identified and presented in this chapter. Will the analysis of students' experiences show that students gained the four domains of knowledge as postulated in my conceptual framework and presented in this chapter?

Chapter seven: What did they do, see and feel? Analysis of interview transcripts and presentation of findings

> *Of all the pedagogic tasks teachers face, getting inside students' heads is one of the trickiest. It is also one of the most crucial. When we start to see ourselves through students' eyes, we become aware of the 'different worlds' in the same classroom. We learn that students perceive the same actions and experience the same activities in vastly different ways. If we know something about the symbolic meanings that our actions have for students, we are better able to shape our behaviour so that desired effects are achieved* (Brookfield, 1995, p. 92).

7.1 Introduction

In chapter six, I presented the findings from the analysis of the teaching that I did in the genetics course. In this chapter, I present the findings from the analysis of students' experiences of my teaching as revealed in the interviews that were done with the students. I first present the results of the time triangulation that I employed in interviewing students as a way of validating what students were going to say in the interviews. I then describe how I developed a coding scheme for analysing the interview data which was in the form of text transcripts. Thirdly, I describe how I used the coding scheme to analyze the interview transcripts and lastly, I present my findings. The purpose of interviewing students was to find out what students had experienced in my teaching of the genetics course. The results of analyzing my teaching were presented and described in chapter six. The findings from this chapter will help me in answering my research questions three and four:

3. *What are students' experiences of my teaching practices?*
4. *What do I learn from students' experiences and how can I use that knowledge to improve the teaching of pre-service teachers?*

7.2 Results of time triangulation

As described in section 3.10.1, I employed time triangulation as a way of validating students' experiences of my teaching. Three groups were interviewed on the same day on 22 April

2013. The fourth group was interviewed two weeks later on the 6th of May 2013 and the last group six weeks after the first group on 3 June 2013. The responses of all groups have in them similar aspects of my teaching showing that they had all experienced these aspects. Reference to same aspects by students on the same day and over time show that time had no impact on their experiences. For example, in response to the first question of the interview, students in the groups that were interviewed on the same day and over time all made reference to the use of T/L aids and the use of today's questions as the aspects that were typical of my lectures. In response to Q2 students who were interviewed on the same day all mentioned practicals and tutorials as the other formats that I had used in my teaching. Group four mentioned the use of PowerPoint presentations as the other format that I had used in addition to practicals. Group five however had a different response. They argued that the way that I taught could not be referred to as lecturing because it was interactive. Table 10 shows students' responses to the first two interview questions. In yellow are students' responses on the same day, in green are students' responses two weeks later and in pink six weeks later. I have put in brackets and in bold the aspects of my teaching that are mentioned in students' utterances.

Table 10: Students' responses to the first two interview questions

		Q1: Describe a 'typical' genetics lecture session.	**Q2: Have you encountered formats other than a 'lecture'?**
Students' responses	**Group one**	**Agnes**: She seemed well prepared, she always had enough notes and she always had either the posters or something to refer to or hands-on materials like the strings and so forth, always just to give us concrete examples or something that we could see. **(Notes, T/L aids)**	**Servie**: The practicals. The practicals were so on point, easy to do and so I can't say simple, but challenging but in a good way, in a way that I learned at the end of the day. **(Practicals)**
	Group two	**Percy:** A typical genetics lecture would start with her giving us a sort of couple of questions at the start of the lecture which sort of led us into what we were going to do. We would on occasion have a small recap of the previous lecture and obviously those questions that we were given would lead into the content that we received afterwards. So she gave a good intro versus body in terms of the lectures. **(Today's questions)**	**Ngoni:** Okay, ja, she did. We did tutorials and practicals and during the tutorials we were assessed according to questions, like we were given questions and then we had to submit it at the end of the tutorial. And then in practicals... ja. **(Practicals and tutorials)**

		Q1: Describe a 'typical' genetics lecture session.	Q2: Have you encountered formats other than a 'lecture'?
	Group three	**Placki**: Okay, uh, she'd come into class, hand us notes, she'd always pose a question in the beginning of the class. After the question, she'd go through her slides, she'd always use like big diagrams on the board or actual props like wool which is showing a chromatin network going into a chromosomes, and then she'd go through the slides but they weren't just like slides where you read; there's always added information we had to write down, so we were always engaged. **(Notes, today's questions, T/L aids)**	**Plackie:** We had tuts and practicals. **(Practicals and tutorials)**
	Group four	**Admire:** In terms of the way she was teaching? Ja, I can say she managed to use the different strategies in terms of teaching for example sometimes she would come with some charts where it represent the phases of meiosis and other stuff. And in terms of practicals, her practicals I actually have respond well. Because everything is very organised, even in terms of giving feedback to us, we as students, I think, she was very spot on. **(T/L aids)**	**Ephy:** I think what's also good with her is that she uses the PowerPoint so well, and by using the PowerPoint so well, we understand what she is trying to say better. So by the use of the PowerPoint, it helps us understand whatever concept she's teaching much better, instead of just standing and lecturing whatever information she needs to give us. **(PowerPoint presentations)** **Munya:** And another thing I like, I liked about her teaching strategy was the practicals and the content knowledge linked, they go hand-in-hand with each other. You'll never get confused. **(Practicals)**
	Group five	**Tendai:** I think what was nice is that she always had those questions in the beginning, that was sort of a recap of what we'd done, so that we got a chance to see sort of how she would ask questions on what we'd learned, or, to remind us what we have done so that we can maybe relate it to what she's going to do in that time. **(Today's questions)**	**Tendai:** I think she never really truly lectured in the sense that she didn't let us interact. I think most of the time if she was lecturing, it was for bouts of ten minutes and then we would all be involved. **(She didn't lecture/ There was interaction)**

7.3 Developing the coding scheme

I read through all the transcripts three times to develop what Ely (1991, p. 150) called "intimate knowledge" about the data and get initial impressions. The first impression that I

got from reading interview transcripts was that the students described my teaching practices and commented on them. I therefore decided to use the same coding scheme that I developed in chapter six for analyzing my teaching. As described in chapter six, the development of the coding scheme that I used to analyze my teaching was informed by my conceptual framework (see section 2.11 for details). The final coding scheme had five

categories namely **knowledge of context**, **knowledge of students**, **pedagogical knowledge**, **knowledge of content** and **manifestations of PCK**. Table 11 below shows the coding scheme that I developed and used in chapter six for analyzing my teaching.

Table 11: My coding scheme developed in chapter six for analyzing my teaching

	Knowledge of context	**Knowledge of students**	**Pedagogical knowledge (PK)**	**Knowledge of content**	**Manifestations of my PCK**
Identified teaching aspects	-Knowledge of my classroom context-awareness of the acoustics of a big lecture room. -Knowledge of my classroom context-the diversity in my classrooms-e.g. knowledge of students' different linguistic abilities and schooling backgrounds -Knowledge of my students' context-description of T/L aids appropriate for rural children and for urban children	-Knowledge of misunderstandings that students bring to class e.g. that interphase is part of meiosis -Knowledge of misconceptions that students bring to class e.g. that genes are directly responsible for our features -Knowledge of genetics concepts that students find difficult to learn about.	-Use of a variety of **T/L aids** (pictures on the screen, charts, models, concrete materials) -**Teaching styles** (visual/auditory/active/passive etc. -**TA** e.g. explaining and describing -**TS** e.g. today's questions -**Individual work** e.g. draw, quiz -**Formative assessment activities** e.g. quiz -**TP**-Questions and feedback -**TLA** e.g. whole class discussion, worked examples -**Role-playing** a family with a father who is suffering from Alzheimer's disease **Student to student interaction** through small group discussions or discussions in pairs	-SCK-e.g. identification of aspects of content that makes genetics difficult to teach and learn -CCK-e.g. description of the structure of DNA -Knowledge of the vertical curriculum	-Curricular saliency -Step by step sequenced teaching -Lecturer-student interaction -Use of appropriate analogies

Although I started my coding with pre-defined categories, the process was also inductive because I was open to new categories as I read through the transcripts. The units of analysis were multiple; single words, phrases or episodes (Mpofu, Mushayikwa, & Otulaja, 2014). A student's complete response to a question was also a unit of analysis. To code, I would read through each student response at least three times to acquaint myself deeply with what I was about to code. I coded the first response in the first interview transcript. The coding took different forms. I used numbers to label the different sections of the students' responses that I was breaking up into parts. Later on I replaced the numbers with

descriptions. I also used lines to code sections of the students' responses to highlight different categories. The response by Agnes below illustrates my initial coding.

Agnes: She seemed well prepared (1), she always had enough notes (2) and she always had either the posters or something to refer to or hands-on materials like the strings and so forth (3), always just to give us concrete examples or something that we could see.

The section that is underlined with a solid line describes my teaching practices and the numbers are codes for the different aspects of my teaching practices that the student described. The text underlined with a dotted line is the student's response to the teaching practices that she encountered. The word **always** is a code on its own as it is conveying a meaning as a single word and was said several times. After I had done the coding that I have described above, I replaced the numbers with words or descriptions as these would be easier to remember than numbers. The labelling is shown below.

Agnes: She seemed well prepared **(preparation),** she always had enough notes **(Teaching procedure)** and she always had either the posters **(Teaching and learning (T/L) aids)** or something to refer to or hands-on materials like the strings and so forth **(T/L aids),** always **(actual word as a code)** just to give us concrete examples or something that we could see. **(Description of purpose of teaching practices).**

Table 12 below shows my coding of part of transcript one as an example. The labels to the codes are enclosed in brackets. During the coding, I derived other codes from the interview questions. For example in response to the question 'Have you encountered formats other than a lecture', students said practicals and tutorials. Therefore, **formats of teaching** became my code wherever students named practicals and or tutorials.

Table 12: Coding of interview transcript one

Students' coded responses
Servie: Well after Mrs Nyamupa's lectures I think I now understand what genetics is, **(outcome of my teaching practices)** I understand better than high school **(outcome of my teaching practices)** because you know in high school I had a very very bad Life Sciences teacher **(evaluation of high school teacher)**. The genetics course was something else. Especially when it comes to the hybrids, the crossings and stuff **(description of CCK),** the teacher used the textbook and then he would read everything from word to word **(description of the high school teacher's teaching procedure)** and then couldn't even interpret some of the things, **(evaluation of high school teacher's teaching)** so I think Mrs Nyamupa was the best

ever, I understood the topic better **(evaluation of the lecturer)**
Servie: The practicals **(format of teaching),** The practicals were so on point, easy to do and so I can't say simple, but challenging but in a good way, **(evaluation of teaching format)** in a way that I learned at the end of the day **(outcome of teaching format)**.
Agnes: We were able to visually see ourselves, **(outcome of teaching format/practicals)** we were able to create things ourselves, to give everybody an example of what... like with the Reebop[17], that of just mixing it up and making something out of something, **(outcome of practicals)** it just made it easier to understand maybe how it works in the body and so forth **(outcome of teaching format/practicals)**
Agnes: As a teacher **(identity)** it's of being prepared, **(outcome lesson about teaching - preparation)** of not having just one example or one way of explaining something; **(outcome lesson about teaching – teaching technique)** there was multiple She used multiple ways of teaching the same concepts, **(description of teaching technique)** so she didn't just rely on a definition, she elaborated on it, **(description of teaching technique - scaffolding)** she showed us visual examples, **(description of teaching technique)** and as a teacher it shows me how I should teach as a Science teacher or a Biology teacher **(lesson about teaching/awareness of future context)**
Margie: I think the way she posted notes **(description of t/l resources)** on Sakai, **(description of another teaching format – e-learning)** I think as a teacher also, **(identity)** you should give your learners all the resources that you can provide so that at least you know that when you give them a test, even you, yourself, you know that you've given them everything, it's up to them if they want to study or they…so I think that's something you can use **(description of lesson about teaching)**as a teacher **(identity)**.

After I had coded the whole transcript as shown in Table 12 above, I then extracted the codes from the transcript and listed them. I had a total of 47 different codes from the coding of transcript one. Below I show 25 codes that I extracted from transcript one to show how the list looked like. I chose these 25 codes as exemplars. The complete list is shown in Appendix G.

1. Description of a teaching practice **- preparation**
2. Description of a teaching practice **- Teaching procedure**
3. Description of a teaching practice **- Teaching and learning (T/L) aids)**
4. Actual word as a code - **always**
5. Description of purpose of a T/L aid - **purpose of T/L aids**
6. Description of an outcome of my teaching practices - **student's own understanding**

[17] See Appendix D for the description of the Reebop activity.

7. Evaluation of high school teacher - **evaluation of high school teacher's teaching practices**
8. Evaluation of the lecturer - **evaluation of lecturer**
9. Description of CCK **- Content knowledge**
10. Description of the high school teacher's teaching practices - **Teaching procedure**
11. Evaluation of high school teacher's teaching
12. Description of another format of teaching - **teaching format**
13. Evaluation of another format of teaching - **evaluation of teaching format**
14. Description of an outcome of using practicals - **outcome**
15. Description of self as a teacher **- identity**
16. Description of future context - **awareness of future context**
17. Description of a teaching technique - **use of multiple examples**
18. Description of a teaching technique - **scaffolding**
19. Evaluation of teaching practice - **evaluation**
20. Description of a teaching tool - **PowerPoint**
21. Description of T/L resources posted on SAKAI - **T/L resources**
22. Description of the importance of posting resources on SAKAI - **importance of SAKAI**
23. Description of assessment activity - **assessment activity**
24. Purpose of assessment activity for a teacher - **purpose and lesson learnt**
25. Evaluation of assessment activity - **evaluation**

After listing all the codes as shown above, I read through the list to see if I could assign them to my five categories in Table 11. I found out that I could only assign a few codes to these categories. Most of the codes could not fit into these initial categories. I therefore put aside the coding scheme in Table 11 and decided to create fresh categories from the list of codes that I had generated. I created three new categories. These three categories were: descriptions of my teaching practices, responses to my teaching practices and descriptions of students' identities. I gave these three categories the labels **students' descriptions of my teaching practices**, **students' responses to my teaching practices** and **students' descriptions of their identities**. After having assigned all the codes belonging to the three new categories, I was left with very few unassigned codes. All the unassigned codes were descriptions of the different forms of knowledge that were gained by students. Some of the codes were descriptions of the knowledge that students had gained about their future contexts. There were also codes which were descriptions of the knowledge students had gained about the misconceptions that students bring to class. Other codes still on the list

were descriptions of the content students had gained. The codes included descriptions of knowledge of students' future contexts, future students and content. I used this information to create a fourth category that I called **students' descriptions of the knowledge they gained.** Other codes such as the recurring word **always** remained as stand-alone codes. After assigning all the codes to categories, I had a total of four categories. These categories are shown in Figure 36 below. The four categories in Figure 36 superseded the five categories in Table 11. The four categories are described in detail in section 7.3.1 below.

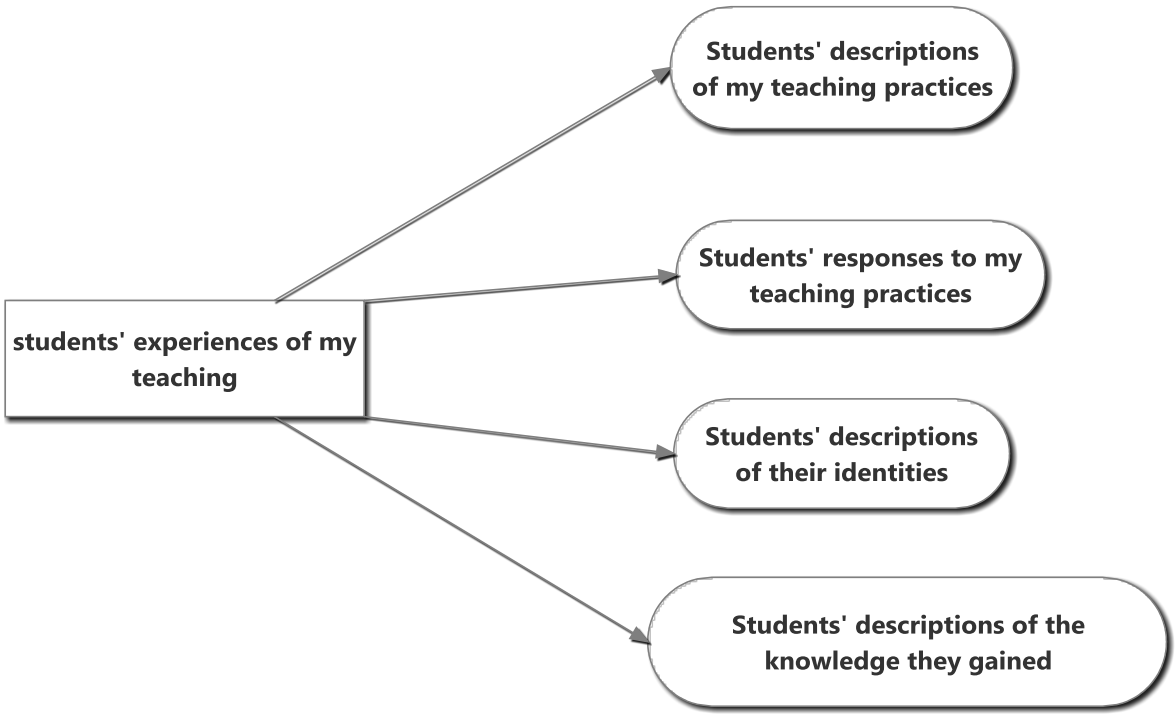


Figure 36: The four categories of students' descriptions of their experiences

7.3.1 Descriptions of the four categories of students' experiences

Students' descriptions of their experiences could be divided into four categories as shown in Figure 36. I describe these categories in detail below.

Category 1: Students'' descriptions of my teaching practices

Students' descriptions of my teaching practices included aspects of my teaching such as preparation and planning. Preparation and planning are aspects of teaching that are undertaken before the actual teaching is done but I still considered them to be teaching practices. I therefore, decided to split the category **students' descriptions of my teaching practices** into the following sub-categories: **pre-lecture teaching practices, during lecture teaching practices and post-lecture teaching practices** to accommodate practices such

as planning and preparation. The utterance by Agnes: “She seemed well prepared” contains an example of what I refer to as a pre-lecture teaching practice which is preparation. The teaching practices codes such as T/L aids would now fall into the sub-category **during lecture teaching practices**. T/L aids are listed under pedagogical knowledge in my initial coding scheme. Therefore, I put down my initial category **pedagogical knowledge** as a sub-category under **during lecture teaching practices** because all the codes in the pedagogical knowledge category were now falling under **during lecture teaching practices**. I also put the sub-category lecturer’s conduct which included enthusiasm and punctuality under during-lecture teaching practices. **Other teaching formats** could not fit in the pre-, during or post-lecture categories. I therefore made **teaching formats** a sub-category under students’ descriptions of my teaching practices but outside lecture categories of pre-, during and post lecture teaching practices. The sub-categories for the category students’ descriptions of my teaching practices are shown in Figure 37 below.

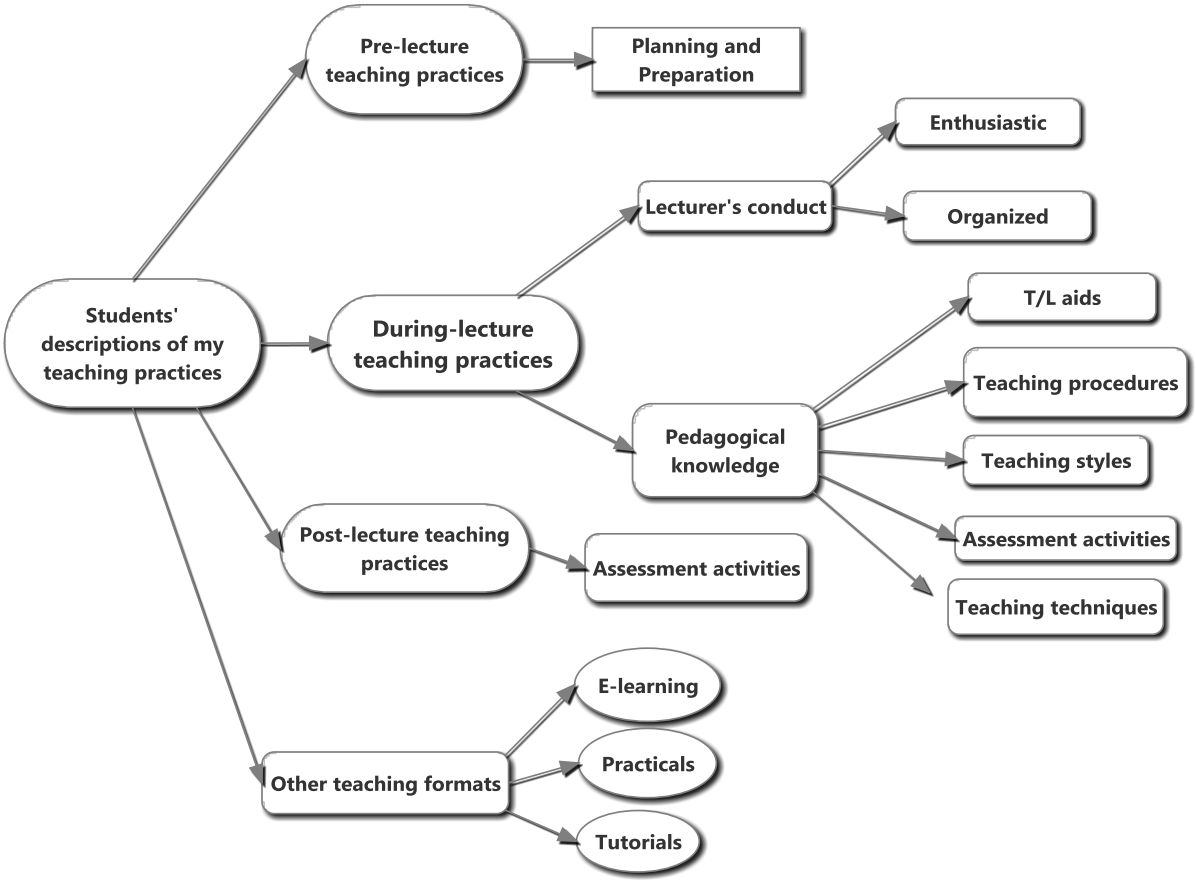


Figure 37: The category students’ description of my teaching practices and its sub-categories

Category 2: Students' responses to my teaching

Students' responses to my teaching practices included what the students thought were the **purposes** of the teaching practices that I was enacting, their **evaluations** of the teaching practices and **descriptions of outcomes** from my teaching practices. I created three sub-categories of students' responses to my teaching practices according to these descriptions and named them **descriptions of purposes** of my teaching practices, **evaluations** of my teaching practices and **descriptions of outcomes** of my teaching practices respectively. These sub-categories are shown in Figure 38.

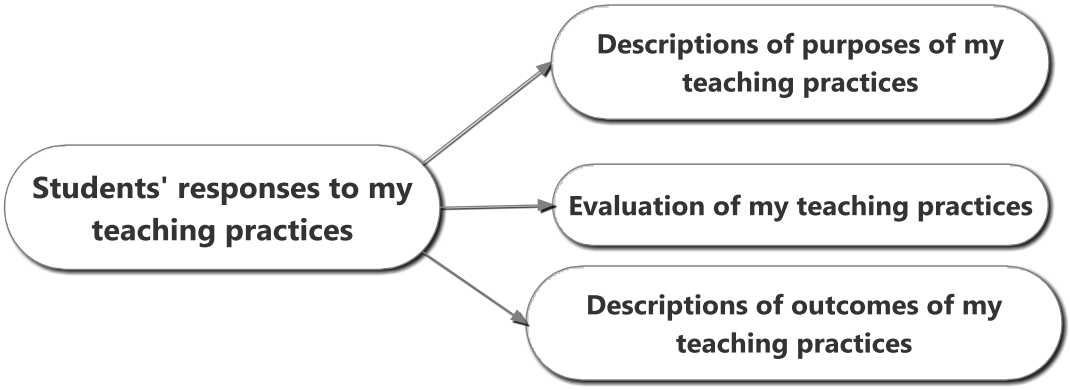


Figure 38: The category students' description of my teaching practices and its sub-categories

The section underlined with a dotted line in the response by Agnes below is an example of a student's response to my practice which is a description of what the student thought was the **purpose** of my use of T/L aids like posters and string (underlined with a solid line). The student's view was that the **purpose** of using these visual aids was to provide them with concrete examples.

Agnes: She seemed well prepared, she always had enough notes and she always had either the posters or something to refer to or hands-on materials like the strings and so forth, always just to give us concrete examples or something that we could see.

The section underlined with a dotted line in the response by Servie below illustrates an **evaluation** of the practicals by the student. The student's evaluation was that the practicals were challenging but doable. The section underlined with a double solid line is an example of an **outcome** of doing the practical work.

Servie: The practicals. The practicals were so on point, easy to do and so I can't say simple, but challenging but in a good way, in a way that I learned at the end of the day.

Category 3: Students' descriptions of their identities (How students viewed themselves)

Students took on multiple identities during the teaching and learning process. They sometimes saw themselves as learners, sometimes as third year students and sometimes as teachers. I grouped these codes into a third category that I called **students' descriptions of their identities**. The utterance by Agnes shows a student who was identifying herself as a third year student:

Agnes: Okay some of the activities, you'd do it and you'd be like, "okay, we could have just left that little part out", like with the Reebops, with the building of the marshmallows and everything, that for me was just a little bit maybe not for the level of the third year student. It was a good activity, just the concept, but just maybe don't take it as far as having to build the little creature.

Figure 38 shows the subcategories for students' descriptions of their identities

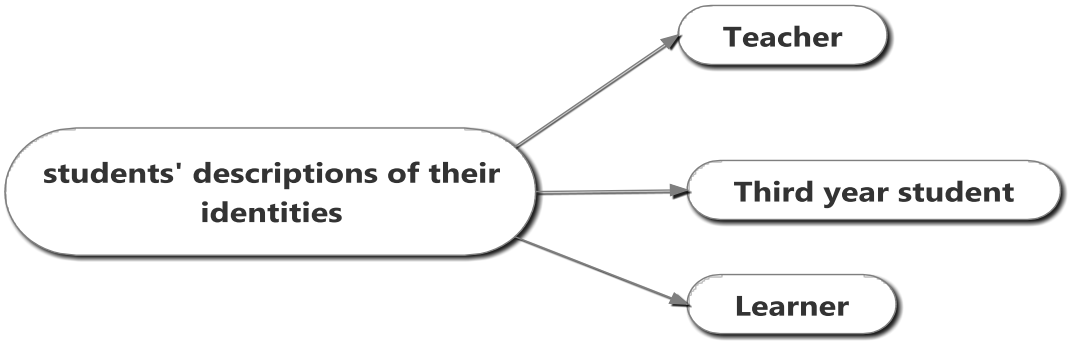


Figure 39: The identity category and its sub-categories.

Category 4: Students' descriptions of the knowledge they gained

I adapted my initial categories of knowledge of context, knowledge of student and knowledge of content to create sub-categories for my fourth category **students' descriptions of the knowledge they gained**. The first sub-category of the category became *knowledge of students' future contexts*. The second sub-category became *knowledge of students' future students* and the third sub-category became *knowledge of content*. The three sub-categories were about the knowledge students had gained and were adaptations of the three of the

initial categories that are in Table 11; knowledge of context, knowledge of students and knowledge of content. The code students' knowledge of their future contexts was used to code for the students' knowledge of the schools that they are likely to teach after qualification. The code students' knowledge of their future students was used when students indicated some knowledge about their future learners e.g. learners' misconceptions. The code knowledge of content was used to code instances where students described the genetics content that they had gained. Figure 40 below shows the three categories of knowledge that was gained by students

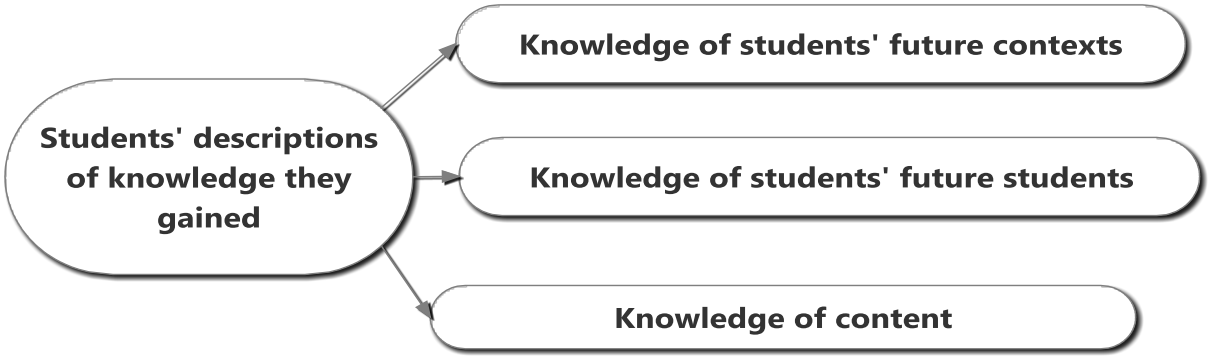


Figure 40: Categories of knowledge that was gained by students

Students also gained pedagogical knowledge. However, pedagogical knowledge would be described under the description of during-lecture teaching practices

7.3.2 A further look at the codes

After I had grouped all the codes into categories and sub-categories, the next step that I took was to go back to the transcript and study it further to see if I had not left out any interesting data. As I was reading the sections of the interview that I had coded responses to my teaching practices, I noticed examples of students' descriptions of the purposes of a number of my teaching practices which included purpose of using T/L aids, purposes of questions at the beginning of each lecture and purpose of posting resources on SAKAI. All the descriptions were about my teaching practices.

When I looked at students' responses to my teaching that I had coded as evaluation responses, I also noticed examples of students' evaluations. However, unlike the descriptions of purposes of my teaching practices which focused only on my teaching, students' evaluations had gone beyond the evaluation of my teaching practices to evaluation

of other contexts. I therefore changed the evaluation label from evaluation of my teaching practices to evaluation of teaching contexts. The other contexts included **high school**, **the genetics course**, **other courses,** the **science programme** and **me as their lecturer.**

In the interviews, students evaluated their high school teachers and the teaching that they had encountered in high school e.g. because you know in high school I had a very very bad Life Sciences teacher. The genetics course was something else. Especially when it comes to the hybrids, the crossings and stuff, the teacher used the textbook and then he would read everything from word to word and then couldn't even interpret some of the things. In this excerpt, the student is evaluating her high school teacher's teaching practices. I described this evaluation as **evaluation of high school teaching.**

Students evaluated the different aspects of my teaching i.e. teaching styles, teaching aids and assessment activities e.g. I can say the strategies were good.... I described this evaluation as **evaluation of my teaching practices**. Students also evaluated me as a lecturer e.g. She's been a good example of what a good teacher or lecturer should be. So I think she's done her part, obviously just the rest needs to come from us as the students, so she's done her part, she's given us the information that we need, she's used different strategies as she should, so, according to Wits' standard of what I understand from Teaching Experience, she's filled up all the blocks. I described this evaluation as **evaluation of the lecturer**. In addition, students evaluated the genetics course as a whole, other science courses and the science programme. I described these evaluations as **evaluation of the genetics course**, **evaluation of other science courses** and **evaluation of the B Ed science programme** respectively. The response by Servie reflects the evaluation of courses:

Servie: Well, I honestly think it was appropriate, like everything was appropriate for us as Life Sciences teachers to be **(evaluation of the genetics course)**. Unlike with the course X and the Y and Z, just stuff that we did here were, like the engineering stuff, I didn't know why are we supposed to be doing that, yet we're not going to teach that (**evaluation of other courses**). But with this genetics course, I think everything was so relevant to what those kids in high school do, so everything was appropriate. The content was good **(evaluation of the genetics course**).

The different contexts that were evaluated by the students are shown in Figure 41 below. These descriptions are not sub-categories. I included them in Figure 41 to highlight the other contexts that students evaluated besides my own teaching. I have used a different shape and normal font to indicate that these evaluations are not sub-categories.

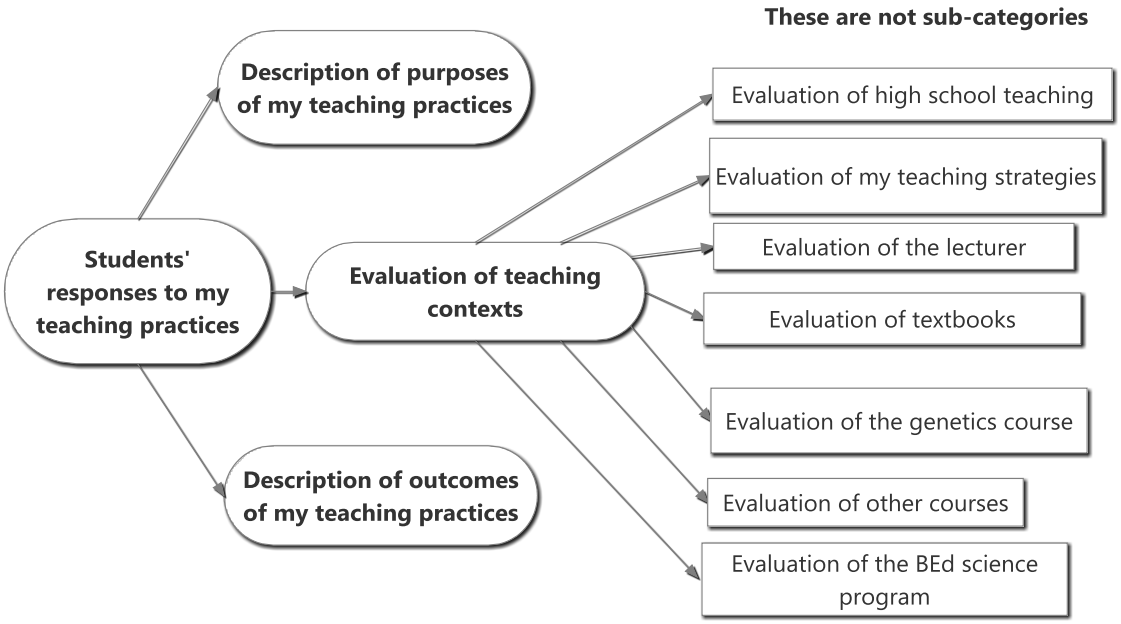


Figure 41: Teaching contexts that were evaluated by the students

I identified a number of **outcomes** of my teaching practices in transcript one. These outcomes were an understanding of new content, practical experiences, lessons about teaching, opportunities for self-assessment, motivation, generation of positive attitudes and confidence.

7.3.3 The final coding scheme for analysing students' experiences of my teaching

After assigning all the codes to categories and sub-categories, I had completed my coding scheme. I had identified **four** categories from the coding process of transcript one. These four categories were: **students' descriptions of my teaching practices**, **students' responses to my teaching practices, students' descriptions of their identities, students' descriptions of the knowledge they gained.** All the four categories had sub-categories. The sub-categories for the category students' descriptions of my teaching practices were *pre-lecture practices*, *during lecture practices*, *post lecture practices* and *other formats of teaching*. The sub-categories for students' responses to my teaching practices were *descriptions of purposes of my teaching practices*, *evaluation of teaching*

contexts and *descriptions of outcomes of my teaching practices*. The sub-categories for the fourth category **students' descriptions of the knowledge they gained** were *knowledge of their future contexts*, *knowledge of their future students* and *knowledge of content*. The stand-alone code was the recurring word **always**. I used the above coding scheme to analyse the rest of the transcripts. While I was coding the transcripts using the codes in the scheme, I was still open to any new codes that I could come across. Therefore my coding was still both deductive and inductive. Figure 42 below shows my final coding scheme.

As can be seen in Figure 42, the categories students' responses to my teaching practices, students' descriptions of their identities and students' descriptions of the knowledge they gained have one group of sub-categories each. I described this situation when a category has just one group of sub-categories as having first level sub-categories. Where I could divide sub-categories further into other sub-categories, I described the second group of sub-categories as second level sub-categories and so on. The category **students' descriptions of my teaching practices** has sub-categories at three levels. The yellow colour indicates the four categories of my coding scheme. The blue colour indicates the first level of sub-categories, the pink colour the second level and no colour indicates the third level of sub-categories.

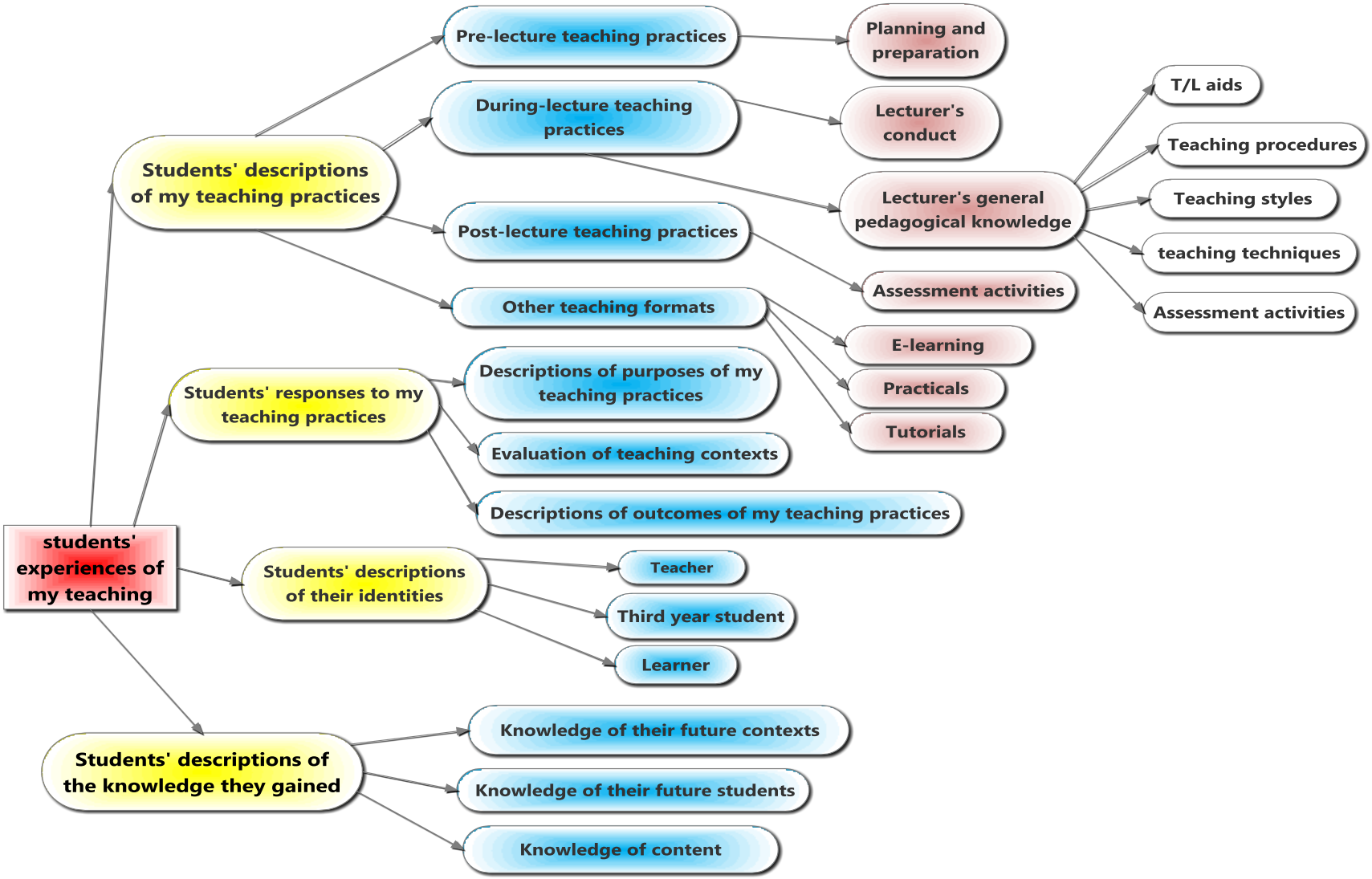


Figure 42: My final coding scheme for analysing students' experiences of my teaching

7.4 Presentation of my findings

As indicated earlier, the findings that I present below answer the following research questions:

2. What are students' experiences of my teaching practices?
3. What do I learn from students' experiences and how can I use that knowledge to improve the teaching of pre-service teachers?

7.4.1 Background to the findings that I am going to present: A preamble

The results of analysing the interviews that I present below show that most of the students' comments about my teaching were very positive. Students showed that they 'loved' and 'enjoyed' what they had experienced and they didn't hide the excitement and enjoyment that my teaching had generated in them. Students expressed positive feelings about the teaching that they had experienced and the learning that they were taking away from my teaching as prospective teachers. For example, Servie, Mufaro and Ephy had this to say about the course:

Servie: Honestly I've never been absent, I've never been absent, the reason being that I enjoyed being in her lectures, tutorials, practicals, everything. So, ja… it was so good. I even wished she could continue with the evolution. And I loved the fact that you know, with her lectures, you knew exactly that the following day you would be doing this, because she gave us this outline. That on this particular day we will be doing this, and then the following day after that we will be doing that.

Mufaro: If I would just study genetics all throughout, I wouldn't complain, I wouldn't mind because you are always looking forward to learning something new, even if you know something but you feel like, "oh my God, I didn't know it, I was just fooling myself", there's just so much new knowledge being presented on every session that we had new things, new teaching styles as a teacher. You know, it was fun, informative and marvellous, I enjoyed it.

Ephy: I would say yes I enjoyed the course very much because of the way she presented the content, because from past experiences I know walking into certain

lectures where content wasn't presented as well, we lost, we sort of lost, we stopped paying attention because it was boring but in ma'am's class, she always kept you on the ball, whether it was whatever the case may be, answering questions, or doing a diagram, or actually showing us something using teaching aids and you didn't feel that the two hours was taking too long (or whatever time she had). Time flew by, so I think that's what made the course enjoyable - the way she presented it.

Because this study was a self-study, I presented my findings to critical friends for critical feedback on what students had said about my teaching. My critical friends had different views in response to what students had said. California did not get worried about the positive comments from the students. Her first comment was an expression of wanting to know what I had done in my lectures that had resulted in students giving such positive comments. For her, that was the point of departure. I needed to relook at what I had done and articulate it as it was what had positively impacted students' learning and was likely to improve my teaching and that of others too.

Nico (whose other comments I made reference to in chapter 6) posed this question: *Why are there no tensions and contradictions in your teaching to make the whole thing credible? You would need to analyse your quotations in detail to bring about the hidden meaning behind all those nice words students say about your teaching.* Nico was not aware of all the tensions I had about my teaching which I described in chapter one. It was those tensions which had motivated me to do this study and to do it in the way I did it: modelling good teaching. For example the biggest tension at the time of doing this study was how I should teach a content course to pre-service teachers having come to understand from Garbett (2012) that pre-service teachers need to learn not just content but how to teach that content too. I was conscious of this tension from the beginning of my study and it was the driver of how I eventually taught my course.

Tony expressed a concern that most of the students' comments were positive. According to him, one is bound to think that the students were after pleasing their lecturer. He felt that the students were saying what they knew their lecturer would want to hear. He even asked if there were no negative comments that I could include to make the students' responses more authentic.

While the comments from Tony and Nico were very illuminating and critical, I wondered why they had not seen the positive side of what students were saying about their experiences of my teaching. Why would negative comments from students be considered more authentic than positive ones? Why should a success story in teaching be viewed with suspicion? Is good teaching not what we strive for? Is good teaching not possible to achieve? Could it be the reason why every time I say I am studying my own teaching colleagues would say 'You are very brave' because maybe they know that people would view with suspicion anything positive that you would say about your own teaching? As I pondered over these questions, I went to see Virginia (CF) and asked her this question: **Why are they treating what students said about my teaching with suspicion despite knowing that I searched around, I consulted widely, I searched far and wide and thought long and hard about my teaching when I was preparing to teach this course?** I went to Virginia because she understood the complexity of my study and had hinted several times that the nature of my study would require that I dig deeper into what students had said about my teaching for other people to be able to understand and appreciate your findings. Below is Virginia's response: *Your question is very simple to answer* She said, w*e are used to learning about teaching from failures but your study is showing that learning about teaching can also come from successes.*

What Virginia said was illuminating because, although there are some self-studies that report on learning to teach from successes e.g. Garbett (2012) who successfully introduced peer teaching in her teaching practice, most self-study literature is replete with reports of learning to teach from negative experiences such as failures, dilemmas, tensions, challenges and frustrations (e.g. Berry, 2008; Brown & Russell, 2012; Garbett, 2012). In addition, as highlighted in chapter two, most of the self-studies that are reported in the literature are on teaching about teaching not teaching content to pre-service teachers mostly because many teacher education institutions follow the CC1 or the CS models (see chapter 1 for models of teacher education) whereby content courses are taught in other faculties and in the education faculty teacher educators teach methodology courses only. As a result of the above scenario, there isn't much literature on teaching content courses to pre-service teachers. It is against this background that I present the findings from my analysis of students' interviews.

The aim of my study was to find out how I should teach a content course to pre-service teachers. One way of knowing how I should teach pre-service teachers was to find out what would count as good teaching in pre-service teacher preparation as seen from the students'

perspectives. I discussed in section 2.2.1 what counts as good teaching in higher education and what would count as good teaching when teaching a content course to pre-service teachers. Therefore, although I am going to describe students' experiences which show that they endorsed my teaching as good, it is not the 'goodness' of my teaching that is of importance here. It is what students experienced as good in my teaching that is important. My focus as I was presenting my findings was therefore not to just present the positive comments from students but as suggested by California and Virginia above, to also engage with students' comments so that I could bring out not only what it is that students found to be good with my teaching practices, but also why they considered them to be good.

Throughout the presentation of my findings, I added my own comments to make explicit the understanding that I was developing about my teaching and students' learning.

In section 2.8, I described in detail the lens that was used by Alsop and Watts (1997) and later by Lelliott (2007) to describe learning experiences as I intended to use the same framework to describe students' experiences in this chapter. The frames of this lens are:

1. The **cognitive** frame which describes what happens when information in the environment is transformed into knowledge

2. The **affective** frame which has four categories namely **enjoyable**, **germane**, and **salient** and **wonder**. The category **enjoyment** covers anything a student enjoys, likes or dislikes. **Germane** describes the extent to which something is personally relevant. **Salient** describes the extent to which the learning experience is prominent or important in the learners' environment and the fourth category of **wonder** describes the dimension of affective when students show amazement or awe at something they have learnt about (Lelliott, 2007). **Conation** which describes the degree to which knowledge and understanding can be practically useful and made applicable and **self-esteem** which relates to how individuals see or feel about themselves (Alsop & Watts, 1997). The above descriptions of learning experiences will be used to explain students' descriptions of their learning.

Students' descriptions of their experiences of my teaching fall into the following 6 categories as described in section 7.2: Students' descriptions of my teaching practices, students' responses to my teaching practices, students' descriptions of their identities, students' knowledge of their future contexts, students' knowledge of their future students and

students' knowledge of content. In my presentation of the findings, I have used these categories of students' experiences as sub-headings.

7.4.2 Students' descriptions of my teaching practices

In the interviews, students identified and described a large number of my teaching practices which I divided into pre-lecture, during-lecture and post-lecture activities as shown in Figure 37 above. Each of these teaching practices is described below. It was however difficult to describe the category **my teaching practices** separately from other categories as they are all inextricably intertwined within students' utterances. I therefore used an integrated approach in my presentation of my teaching practices whereby as I presented **my teaching practices** as identified by students, I at the same time highlighted aspects of students' experiences from other categories. For example, as I was presenting my teaching practices, I highlighted how students **responded to those teaching practices** (second category)**.** I also highlighted the **identity** lens, (third category) the students viewed my teaching practices. I also indicated cases where students showed evidence of having **knowledge of their future context**, **knowledge of their future students** and **knowledge of content**.

Students' experiences of my pre-lecture teaching practices

I have used the phrase pre-lecture teaching practices to describe what I did before my lectures. Students did not see or observe these practices but inferred them from during-lecture teaching practices that they actually experienced. The pre-lecture teaching practices that were identified by the students were preparation, planning and punctuality.

Planning: Planning was identified by Munya in response to the question: Can you describe any new experiences of learning that you had in the course? Munya's response shows that he experienced thorough planning and what it can achieve. By experiencing planned teaching, he came to understand the importance of planning in teaching and articulated that understanding in the utterance below:

Munya: I think also the key aspect that she displayed was planning. I learned that if you're going to teach learners, and make sure that they understand, you first as a teacher must first be prepared - fully prepared - and organise each and every thing that you are going to use, so that when you implement whatever plan you had, you have, you cannot be confused and will be able to clarify any misconception and challenges that you're going to encounter.

Munya attributed the understanding that he gained from my teaching to my thorough preparation for lectures. He learnt the importance of planning by experiencing what it achieves; the ability by the teacher to explain and to clarify misconceptions. Munya's utterance also shows the germane aspect of planning (Alsop & Watts, 1997; Lelliott, 2007). Experiencing the importance of planning was personally relevant to Munya. It is important to note that Munya observed and experienced what was happening during lectures with the identity of a teacher. Looking at my teaching practices with the identity lens of a teacher is what made Munya to find planning to be important and personally relevant. Hence, he was able to learn that planning is important for a teacher. According to Ainley and Ainley (2011), a learning activity that has personal relevance and meaning to students' lives can generate enjoyment. Therefore, by experiencing something that was relevant to his future context as a teacher from my teaching, Munya is likely to have been enjoying my teaching and he confirmed this in the utterance below:

Munya: I will say that there's nothing that motivates me more to go to a class where you know that you're going to do something constructive. So basically, as I have mentioned that she was always prepared, that motivated me to keep on going to class each and every day, so it helped me to enjoy and love the genetics course as a whole. And also based on the practicals, like in genetics, I never thought of any practicals that are possible to be carried out within the context of genetics, so to me it was challenging to see the new strategies she came up with to try and outline the concepts within meiosis using her practicals.

My comment: If as teacher educators, we can identify what is personally relevant to our students as individuals, as future teachers and as members of communities, and make those aspects part of our courses or programmes, students will find our courses relevant and meaningful and they will be motivated to attend them and to learn. When students have prior knowledge of pedagogical practices e.g. lesson planning, they are able to deduce or to learn about the importance or relevance of that practice when they experience it in a teaching situation. Although Munya was attending a content course, he was learning more than content. Planning is a pedagogical feature. Therefore, Munya gained some **pedagogical knowledge;** importance of planning for lessons from my teaching of a content course and was able to articulate how planning would be of importance in his future **context**.

Tendai also made inferences about the same teaching practices of preparation and planning from what was happening in the lectures. Her experiences were that the lectures were always prepared and this enabled her to develop a trust in what I was teaching them. Tendai also noticed that I was “always early” for my lectures and that generated positive feelings in her. Note the use of the word **always**. What Tendai is describing is not something that happened once but from her point of view, it is something that was happening all the time. Preparing thoroughly for my teaching promoted the development of trust in Tendai of what I was teaching them.

Tendai: Yeah, I think that it was always nice that she was always early and you could see she was always **prepared**, she always had something prepared for us to do. It wasn't like she stood up there and thought, "well today we'll do this…", you could see she was always prepared and that made it so much easier to trust what she was saying; to believe it - you know what I mean? That she's not just thumbsucking, so I think that was a big thing for me and that if she'd **planned** to work for an hour and give us an hour's work, that's what she did, it wasn't just, "well I've run out of things to do now, so you can just leave", it always came across as though it was planned.

My comment: There are two important issues in Tendai’s utterance. The first one is the issue of trust and the second one is about the positive feelings that were generated by my punctuality for lectures. The first aspect that we see is an aspect of conation in what Tendai said about trust. By being prepared for my lectures every time, Tendai felt that she could **trust** what I was teaching them. Tendai chose to trust and to believe in what I was teaching them because she had seen that I was always prepared. This issue of students having to trust and believe what is being taught is something that I was not aware of and hence had not considered in my teaching before. Even if I had, I wouldn’t have known how to achieve it. Therefore, knowing that we need to build trust in our students about our teaching is important and even more important is to know how to build that trust. From what Tendai said, it seems like being prepared for our lectures always is one way that is likely to build trust in our students about what we teach them and I think it is because being prepared is evidence that you have seriously thought about what you will teach.

In chapter five I discussed a type of trust that I got to learn about, a trust that we as teacher educators need to develop in our students a trust that if they ask questions or raise any issues and concerns that they may have about their learning, the questions, the issues and

concerns will be taken seriously. Here, I have come to understand another kind of trust that we need to build in our students, the trust that what we will be teaching them is appropriate and relevant so that they can 'believe' it.

The second important issue in what Tendai said is the indication that positive feelings were generated from experiencing **punctuality** and **preparation** in my teaching practices: it was always nice that she was always early. There is an aspect of enjoyment in what Tendai said. By describing my punctuality and preparation as nice, it shows that it was an enjoyable experience. Enjoyment of an activity or a behaviour can promote students' engagement with the content being taught which in turn brings about learning (Ainley & Ainley, 2011). The fact that my punctuality and preparation for lectures were enjoyable experiences for Tendai, makes it possible that she may emulate that behaviour as a teacher. We can see here that it is not the complicated 'things' that we need to do to motivate students to want to learn. In this instance, thorough preparation for lectures and punctuality is what motivated Tendai to enjoy, to trust and to believe in what I was teaching them.

Students' experiences of my during-lecture teaching practices

Lecturer's conduct: By lecturer's conduct I am describing the way I was delivering my lectures. An example of what can be described as a lecturer's conduct is enthusiasm. Naison had this to say about the manner in which I was delivering my lectures:

Naison: In terms of teaching I think that she was active, ja, she was so organised, I think that the lesson itself was just flowing and I was impressed the way she prepared the lessons, the way she delivered the lessons, she was confident, she was… I was very fascinated, I was like… here we kind of like doing something for the first time since I came to Wits seen someone delivering a lesson like that.

Naison's utterance paints a picture of an enthusiastic and confident lecturer and my enthusiasm fascinated him and made him to enjoy the lectures. Enthusiasm is one of the attributes that students in the studies by Entwistle (1990) and Marris (1964) described as an attribute of good teaching practices and good lectures respectively. These studies were done 14 years and 50 years ago respectively but as can be seen from what Naison said above, the findings from these studies are still applicable today. There is a lot of research that has been done and documented on how to improve our teaching. What would happen if we start implementing what research says will improve our teaching. I asked this question in

chapter 4 and I am asking the same question here. The reason for asking this question again is because in this study, it was by implementing what literature says that I was able to make a positive impact in my teaching and in students' learning. Nico my critical friend was however critical of my application of what literature says about good teaching as part of my study and had this to say "If we can get all this from reading literature i.e. what makes good teaching, then where is your research?"

My comment: The important insight that Nico missed which this study is bringing out is that what makes good teaching and can improve our teaching and students' learning is there in the literature but the biggest 'tragedy' and 'scandal' is that we are not using it to improve our teaching. We keep on researching about education filling in volumes and volumes of journals with important information that is never used. Sometimes we actually use teaching practices that have been shown by research to promote minimum learning such as information transmission or content delivery (van der Vleuten & Driessen, 2014). As argued by van der Vleuten and Driessen, our educational practice and educational research are not aligned.

Why are we (teacher educators and lecturers in HEI) not implementing what research says will improve our teaching and students' learning? Could the problem be ignorance of what is in the literature? When I look at my own personal experiences, ignorance of what literature says about good teaching was the main contributing factor to my failure to implement what research says about good teaching. The other factor was failure to adjust what I knew about good teaching to a large class context. Both factors point to the importance of having effective PD activities at HEI. For PD activities to be effective and to be taken seriously by lecturers, time should be given to lecturers for these activities and be made part of the lecturers' workloads. If that is not done, lecturers are likely to concentrate on what is in their workloads because there is just not enough time to find out what will improve one's teaching unless it is part of one's research or one's workload. For example, at my institution, there are opportunities for teacher educators to share insights about teaching from their research activities. However, the seminars are presented at lunch time and not everyone is free at that time to participate. Once time is made available to lecturers for PD activities, there should be opportunities for lecturers to share good and effective teaching practices including those that are described in the literature. Teaching and Learning conferences such as the Higher Education Learning and Teaching Association of Southern Africa (HELTASA) and the American Educational Research Association (AERA) are also important platforms for sharing knowledge about teaching and students' learning and also for getting to know what others are successfully doing in their classrooms.

In addition to the description of the lecturer's enthusiasm, I again see in Naison's utterance the impact of thorough preparation on students; Naison was impressed by the way I prepared for my lectures. Naison's utterance also shows what Lelliott (2007), described as **wonder** which is a show of amazement and awe in what he was experiencing. The utterance contains statements that indicate aspects of enjoyment: "I was impressed" and "I was very fascinated". Being impressed and fascinated are indications that positive feelings were generated in Naison by my manner of teaching. Feelings of wonder fall under the affective domain and activation of the affective domain is said to influence cognition (Alsop & Watts, 1997).

My comment: A lecturer's conduct which includes enthusiasm and punctuality can be an activator of the affective domain in students and as teacher educators we should make these attributes explicit to our students by practicing them.

Lecturer's pedagogical knowledge: The sub-category pedagogical knowledge includes the use of T/L aids, teaching techniques, teaching procedures and teaching styles. These aspects of teaching were defined in chapter 2. In the interviews, students, being third and fourth years, who have been doing methodology courses, showed that they came to the genetics course with some pedagogical knowledge which they used as a lens to view and to evaluate my teaching. The students also described the pedagogical knowledge that they learnt from the course. Both the pedagogical knowledge that they brought to the course and they got from the course will be described.

Students' experiences of my use of T/L aids*:* In the interviews, students made reference many times to my use of T/L aids. The T/L aids included visuals like charts, diagrams on the chalk board, models and real objects like flowers and string. The students did not only mention the T/L aids. They also described what they thought were the purposes of using them. Agnes for examples saw provision of concrete examples as the purpose of my use of the T/L aids.

Agnes: … she always had either the <u>posters</u> or something to refer to or hands-on materials like the strings and so forth, always just to give us concrete examples or something that we could see.

Agnes utterance shows that she was knowledgeable about the purpose of using T/L aids during teaching which is pedagogical knowledge and was drawing from that knowledge to

describe in an appreciative way her perspective of what was happening. Her perspective was that I was using T/L aids to give them concrete experiences of the phenomena that I was teaching them. I see my use of T/L aids as having provided students not only with concrete examples of the phenomena they were learning but also concrete experiences of the pedagogical knowledge that students already possessed, such as the knowledge of the usefulness of T/L aids when teaching. The fact that Agnes and others were able to recall the T/L aids that I had used in the lectures and to explain what they thought was the purpose of the T/L aids confirms Cyrs' claim (1997) that visual T/L aids provide unforgettable images in students' minds

My comment: Pre-service teachers have 13 or more years of prior knowledge about teaching. That prior knowledge consists of both good and bad experiences and our teaching practices as teacher educators either add to the good experiences or to the bad experiences. Being the exit point for our students before they become qualified teachers, it is imperative that we do not reinforce bad experiences by our way of teaching but rather strive to reinforce the positive experiences about teaching. Pre-service teachers at 3rd and 4th year level have been exposed to two or three years of learning about teaching. The knowledge that they have gained about teaching influences the meaning that they derive from what they experience in the teaching of the content course. In addition, concrete experiences of the knowledge students have about teaching have the potential to deepen their awareness of that knowledge and its usefulness and to create opportunities for students to re-learn about pedagogy in practical ways. Our teaching in content courses should therefore support the learning that the students get from their methods courses.

Placki found the use of T/L aids to be "good" because using them had helped her to visualise what I was explaining during the lecture.

Placki: Ja, when she was explaining the chromatin network and how it shortens and thickens with the different ropes like a good visual, like you could actually see it happening and picture it in yourself. And then also getting us to view the slides and identify what cells were going under what. Those were good teaching strategies and tools.

Plackie experienced what can be achieved by the use of visual aids: ability to bring to life the abstract concepts being described so that students can visualise and picture them. The language that Placki used such as "a good visual" and "good teaching strategies" indicates

possession of knowledge about teaching; pedagogical knowledge that she was now using to evaluate my teaching practices. Exposure to the use of visual aids created opportunities for Placki's knowledge of why we use visual aids to deepen by allowing her to experience how the use of visual aids promotes learning.

My comment: The use of visual aids can promote the learning of content as well as the development of an understanding of the usefulness of T/L aids in pre-service teacher preparation.

In addition to helping Placki to learn about the content and the use of visual aids, my teaching methods also made Plackie to enjoy the course.

Placki: I enjoyed it (genetics course) a lot, like I wanted to come back. Like I like her methods and I understand them. Because she's understandable, and even if things are extremely difficult, she'd explain them in a way that you can understand.

My comment: The positive impact of the T/L aids on Placki may act as a motivation for her to use T/L aids in her future teaching.

Chipo experienced a different aspect of the T/L aids that I used in my teaching; she came to realize that the T/L aids that I used could easily be sourced in a variety of contexts and that was a lesson for her as a teacher.

Chipo: I think another thing is we as teachers we are going to teach at schools which are not equipped with the resources, the resources she used, any teacher can use, anywhere. So I think it kind of teaches us to kind of use different variety of resources. For example, she used pictures, a normal picture. Any teacher can get a picture of the different varieties of cow skin. Another thing she used was the flowers, the roses, she brought red roses, yellow roses, white roses, to show us the different variations of roses, colour in roses.

Chipo's utterance shows that she viewed herself with the **identity** of a future teacher who was aware of her possible future **contexts** which maybe poorly resourced schools. With the identity of a future teacher, she gained some pedagogical knowledge regarding what she can do in such contexts. We see here evidence that the use of T/L aids was not only useful

in terms of helping students to understand content but was of personal relevance to students who viewed themselves as future teachers.

My comment: I see Chipo's utterance as confirming that the use of T/L aids in my teaching may have indirectly provided some training on how to select and use T/L aids something that Maduna (2002, p. 17) lamented that "most teacher-training institutions do not provide any formal training and practice in the selection and use of teaching aids. Teachers enter schools without this valuable information…".

Chipo also affirmed the assertion by Ainley and Ainley (2011) that once a teaching activity brings relevance and meaning to a student's life, they are likely to enjoy it. In the utterance below, Chipo shows that she had not only found personal relevance from the kind of T/L aids that I used in my teaching but also that the strategies that I used in my teaching got them interested in what I was teaching them.

Chipo: I think I'm going to definitely take away the teaching strategies; the strategies that she used, I think are applicable to me as a teacher. I can walk into a classroom and I think that I can make the learners engage with the knowledge as fully as Mrs Nyamupa did by using her strategies, and also, her strategies got us engaged, it got us interested in the topic of meiosis, and each and every week we went to class thinking, "what does she have in store for us this time?", so I think definitely her strategies.

My comment: Knowledge of various school contexts which are pre-service teachers' future contexts can be taught and can be learnt in a content course and when students view themselves as future teachers, they see the relevance of the teaching activities beyond helping them to understand content to their future contexts. Therefore, to help our students to benefit more, we as teacher educators should make explicit our choice and use of T/L aids

In addition to being a lesson about teaching, Chipo, found the T/L aids to have engaged her "prior knowledge" which helped her to understand what I was teaching and made her to like my lectures. Liking is an aspect of enjoyment. Chipo was familiar with the materials that I used such as string (what she referred to as cotton wool) and this familiarity helped her to connect to the new information (tenets of constructivism). Note here that the prior knowledge that Chipo was referring to was knowledge of the everyday materials that I used as T/L aids that she was familiar with.

Chipo: Um, I think what I liked about her lectures is the fact that they engage our prior knowledge. And everyday knowledge, even though you might not have a basis of meiosis, but if you go to the lecture, she shows you images or pictures or she uses the cotton wool and all that to demonstrate the difference between chromosome and DNA and that actually engages our prior knowledge and actually links the information.

Chipo's reference to 'prior knowledge' and 'everyday knowledge' is evidence that she was aware of the importance of the pedagogical aspect of prior knowledge in teaching which is evidence of pedagogical knowledge.

My comment: Students had pedagogical knowledge and from the lectures they got to experience first-hand the application of that knowledge and as I said earlier the application and use of pedagogical knowledge in my teaching created opportunities for students to re-learn about pedagogy in practical ways.

Students' experiences of my teaching procedures: The teaching procedures that were commented on by students include today's questions and group work.

Today's questions: Today's questions refer to the feature of my teaching whereby I was beginning every lecture with some questions that students had to discuss. This feature was identified and explained in section 6.4.3. For Percy, today's questions were a good introduction to lectures. By evaluating my introduction as good, Percy showed that he had knowledge of what constitutes a good introduction.

Percy: A typical genetics lecture would start with her giving us a sort of couple of questions at the start of the lecture which sort of led us into what we were going to do. We would on occasion have a small recap of the previous lecture and obviously those questions that we were given would lead into the content that we received afterwards. So she gave a good intro versus body in terms of the lectures.

Tendai described a number of purposes for the same teaching procedure of beginning my lectures with a set of questions. For Tendai, the questions served as a recap of what they had done, they served to familiarise them (students) with the kind of questions that I would ask in tests and exams and they served as an introduction to the lectures.

Tendai: I think what was nice is that she always had those questions in the beginning, that was sort of a recap of what we'd done, so that we got a chance to see sort of how she would ask questions on what we'd learned, or, to remind us what we have done so that we can maybe relate it to what she's going to do in that time.

The unprompted use of the word *recap* by both *Percy and Tendai* shows salient application of pedagogical knowledge that students had and used to evaluate my teaching. The use of today's questions generated positive feelings in Tendai which means that she enjoyed this teaching practice (Ainley & Ainley, 2011).

Group work: Another teaching procedure that students made reference to was group work. The comment by Percy about the use of group work procedure reflects knowledge and understanding of the learning theory of constructivism and he used it to explain what he had come to understand from my teaching again showing that students were experiencing in real terms what they knew in theory about teaching.

Percy: From a theoretical point of view, Mrs Nyamupa based a lot of teaching from a constructivist point of view where we had a lot of group work, we had a lot of tasks where we had to construct our own understanding and information, and from a teaching and learning point of view, it puts a lot of emphasis on self-responsibility, taking ownership of your learning, and so from a… it teaches learning as a proactive thing rather than a reactive thing.

My comment: The teaching of a content course can provide students with a link between the theory they learn about teaching and practical application of that theory.

Students' experiences of my teaching styles: The meaning of the term teaching style was explained in section 2.11. Mufaro made reference to teaching styles. I cannot tell if Mufaro was referring to teaching styles as explained in section 2.11 when she used the word. However, whatever Mufaro was referring to as teaching styles provided her with extended opportunities for understanding the content that I was teaching which generated positive feelings in her. What is striking is how Mufaro articulated her understanding of the purpose of using a variety of teaching styles in a teaching situation.

Mufaro: Can I just say one more thing? And I love the fact that she uses a variety of teaching styles. That I think will suit everybody, because if you didn't understand on the first teaching style, you'll catch up on the next and definitely on the third one, so, ja, you participate, you put your whole heart there because you feel like, "yes, she's doing her job and she's going the extra mile at the end of the day".

The prior knowledge about teaching styles and the knowledge of why we use a variety of teaching styles when teaching helped Mufaro to see that I was using a variety of teaching styles in my teaching and to articulate why it was important. There is another dimension to what Mufaro said about the use of a variety of teaching styles. She 'loved' my use of a variety of teaching styles and their use motivated her to participate in the learning process. It is important to note that it was not only the use of a variety of teaching styles that motivated her, it was also what my use of a variety of teaching styles meant to her; what she described as "going the extra mile" which means giving more time or doing more than what is expected of you. I see here another aspect of teaching that can motivate students to learn; showing students in one way or another that you care about their learning.

Students' experiences of teaching techniques: Agnes used phrases and terminology which are indicative of someone with pedagogical knowledge; phrases like 'she started off from the basics' and 'she gave us scaffolding'. It seems the pedagogical knowledge that Agnes had, helped her to understand the teaching she was experiencing.

Agnes: I don't think it's maybe new but just she started off from the basics, she started off finding out what do we know, what don't we know. And then she built from that, and she went from genes to... and she moved on... just she gave us scaffolding and she built on that for us.

My comment: Prior pedagogical knowledge that students bring to a content course gives meaning to the teaching that students experience in a content course.

Although she showed that she brought with her some pedagogical knowledge, Agnes also showed that she gained some more pedagogical knowledge from my teaching. This is shown in her description in some detail, of the techniques of teaching that she had experienced from my teaching which again include preparation and using multiple examples and visuals. In her description of these techniques, Agnes said that my teaching had shown her how she should teach in her future context as a science or biology teacher

Agnes: As a teacher it's of being prepared, of not having just one example or one way of explaining something; there was multiple. She used multiple ways of teaching the same concepts, so she didn't just rely on a definition, she elaborated on it, she showed us visual examples, and as a teacher it shows me how I should teach as a Science teacher or a Biology teacher

My comment: Identifying themselves as teachers helps pre-service teachers to derive meaningful lessons about teaching during the teaching and learning of a content course.

Percy and Placki gained pedagogical knowledge by learning how a number of teaching activities and skills such as oral presentations and PowerPoint presentations can be used effectively to teach.

Percy: Look, I have to admit, before this course if I had to teach genetics, it would have probably been diagrams on the board, a couple of worksheets, chalk-and-talk, I might have shown them a video or two, but I wouldn't have really had that tangible aspect. From the course itself in terms of the practical activities and even from the group works and presentations I have learned techniques from other students which I am going to use as well, and you know that's something that I think is very valuable as well, is that we share our wealth of knowledge and for the course to then have permitted (sic) that was good in itself.

Percy shows that he learnt teaching techniques from the teaching activities such as group work and presentations that he encountered in the course. Placki also learnt some teaching techniques from my teaching:

Placki: How to present proper PowerPoints and still keep learners actively engaged so they're not really missing lectures. I don't know, we have a new lady teaching us now, but she's given us empty slides, and for us it, like, we don't want to be hand-fed the information but we, like everybody feels the way Mrs Nyamupa presented her information was a lot better because there were some points then questions and we'd answer the questions but it wasn't just blank slides where we had to put in all the information… because you don't know what is going to be expected from you like in exams and stuff.

My comment: Both Percy and Placki were viewing themselves as teachers and as a result, they both talked about the knowledge that they had gained about teaching. Students' ability to derive lessons about teaching from a content course shows that the identity lens that students take on in a content course influences what they learn from the course.

Students' experiences of assessment activities: Some assessment activities that students made reference to in the interviews were done during the lectures and others were done after the lectures during practical and tutorial sessions. The assessment activities that were done during the lectures were the quiz and worked examples. The quiz activity was described in chapter 6. The worked example activities involved me giving students questions to work on after which I would provide them with solutions to the questions within a PowerPoint presentation. The assessment activities that were done after the lectures were role-playing activities and oral presentations. I regarded these as post-lecture activities and will be presented in the next section. During the interviews, students expressed their views on the use of these assessment activities.

Quiz*:* Percy made reference to the pop quiz. Firstly, he used the word formative assessment showing that he had knowledge of the different forms of assessment. Secondly, he evaluated it to be "a very good technique" because it had "exposed" the areas where his own understanding of content was weak and this in turn had motivated him to revise***.**

Percy: I think it was the lecture before we wrote our test we had a bit of a pop quiz thing where we would all have flash cards and stuff, and I actually found that in terms of a formative assessment it was really good because for myself it exposed the areas where I was lacking even though I thought that I was on point with the information, some of those questions were quite trick, and it showed me that, yes, I need to then further myself so as a teaching technique I would think that it's a very good technique.

Mufaro also commented on a different dimension of the quiz. The quiz activity had enabled them as students to answer questions individually and to get immediate feedback during the lecture. It had never occurred to her that there could be assessment activities that could be done in a big venue like a lecture room involving everyone. For Mufaro the quiz had achieved: “collaborative learning” or “learning together” as she described it, in a big lecture room.

Mufaro: Adding on what Percy said, collaborative learning in science could really show learners that as much as science is 'hard-core' as learners refer to it, science is really fun when you're actually learning together because with the quiz thing, it was, you know how big the lecture venue is, but at the end of the day, you got what she was trying to give across to us and we're actually prepared for the test, so I think here collaborative learning was the best strategy that I didn't think would work because sometimes you're thinking, "oh my, this class is too big, so individual work"

For Chipo, the benefit of using the flash cards was that everyone participated.

Chipo: I think I liked the interactive cards because … it kind of forced everyone to kind of engage with the knowledge. Because if you ask a question like in a lecture, "what is meiosis?", maybe like one person is going to answer, but with those cards, everyone had to answer.

My comment: Chipo raised an issue that had been a source of frustration for me for a very long time; the issue of using formative assessment techniques in a large class that only involve one or a few students at a time. I had completely failed to think of new formative assessment strategies that I could use in a large class that would involve all students until a

colleague introduced me to the use of flash cards. The use of flash cards was only one of the many teaching ideas that I got from colleagues. I therefore realize that what Percy said in an utterance that I presented earlier about learning teaching techniques from other students also rang true for me. He said:

I have learned techniques from other students which I am going to use as well, and you know that's something that I think is very valuable as well, that we share our wealth of knowledge and for the course to then have permitted (sic) that was good in itself.

Just like Percy, I got a lot of teaching ideas from colleagues that I used to effectively teach some difficult concepts during the genetics course and again just like Percy; it is something that I have found to be valuable. As teacher educators therefore, we need to realize that we have as individuals a wealth of knowledge about teaching that we have gained through experience, through research and from reading literature. If we can pursue ways to share that wealth of knowledge about teaching pre-service teachers that we have come to know, then those around us and those who will come after us won't have to make the same mistakes that we have made or to use teaching techniques that we know are not effective or to re-invent the wheel. Therefore PD activities involving experienced and new academics should be taken serious at HEI and opportunities for sharing what we know from our own experiences, from research or from literature should be created.

Use of examples: Ephy described how I was using examples for formative assessment and what was achieved by the way I approached the use of examples in my teaching.

Ephy: There was (sic) a lot of examples, which she makes us do and then once we're done, she does the same example on the PowerPoint, to see where we went wrong or whatever the case may be.

My comment: Students seemed to have noticed every teaching and assessment technique that I used in my teaching as they were able to describe them as part of their experiences. Students' ability to notice and to remember what happened in the course shows how important it is to practice good teaching in our content courses and that we can actually use our content courses as a platform for teaching about teaching.

Post-lecture activities

Assessment activities

Oral presentations: For Mufaro, oral presentations was a method that I was using to assess their understanding of the content. She therefore felt that the presentations were a "magnificent" assessment activity.

Mufaro: With the... was it practicals? Or tutorials rather, we did this chart thing whereby each group explained meiosis and stuff. I found that it was very magnificent, especially with varsity, you know with varsity everything is just pushed up to you but I felt with Mrs Nyamupa she made sure that we really understand what we're talking about.

Mufaro was also able to articulate how oral presentations as a pedagogical technique promote understanding of content; you listen to peers while they explain the content during the presentations: it sticks in your head, you really understand, you really grasp the content and you're comfortable to teach it to learners.

The presentation activity made Ngoni to speak in class for the first time in more than two years and she was very clear on what she viewed as the purpose that is achieved by participating in oral presentations; one gets a chance to show their understanding and to be corrected if they show some misunderstandings of the content.

Ngoni: She was the first one for me, since I was here, from first year and second year; she was the first one to introduce presentation in science. Like, I haven't talked for two years in science, so like, everybody got the chance to say something about genetics, so if you didn't understand then there will be a platform to show that you don't understand and then the misconception you have will be corrected.

Ngoni seems to be that kind of student who is not pro-active. She waits for things to happen to her and as a result she had not said anything in class for the past two years. Therefore, for the oral presentation to have created that opportunity for Ngoni to say something in class made it a good pedagogical activity for use in large classes where there is a high possibility of some students hiding behind others not participating in class activities.

Role playing: Doing role-playing in the context of science was not only creative for Ngoni; it was also a lesson on how to make children interact in a science classroom. The only activities that Ngoni knew about in science were tutorials and practicals. The course introduced her to another form of activity that she didn't know could be done in science; role playing and what it achieves that is promotion of interaction. Therefore, Ngoni gained some pedagogical knowledge.

Ngoni: For me, like, science is not very creative, if you don't do tutorials you do practicals of experiments, but then the teaching styles that I learned from her was presenting role-playing and like interacting children in groups, because in most cases we, in science, children just do work individually, "do this on your own" and that's the way. I think interaction for me is the major point and the major style

Tendai showed an understanding that learning in pre-service teacher preparation is dual, learning the content and learning to teach. Therefore, although she didn't learn much in terms of content from the role-playing activity, she got pedagogical ideas on the use of role-playing as a teaching activity.

Tendai: Well she gave us a lot of ideas about what we could potentially do in a classroom. Like that role-play maybe didn't mean a lot to us in terms of learning about genetic counselling, but it gave us an idea about how we can use that topic in a classroom with kids that would appreciate it and that would learn from that.

My comment: Students learn about teaching through observing and participating in activities that are done in the teaching of a content course. This way of learning about teaching is similar to the apprenticeship of observation that was described by Lortie (1975). The apprenticeship of observation postulates that students learn about teaching throughout their many years in the primary and high school classrooms from observing how their primary and high school teachers were teaching them. From what Ngoni said above, for pre-service teachers, the apprenticeship of observation does not end at high school, it continues into their Teacher Education classrooms. That being the case, the way we teach our content courses is therefore important as according to Kennedy (1998), this apprenticeship of observation gives pre-service teachers a frame of reference that will give them ideas on what is expected of them in school and also how to response to what they are likely to experience in schools. In Taylor's study (2013), a former student of hers (Ms Emeni) who

was now a practicing physical science teacher said that her use of an A4 page to engage with content in preparation for her lessons and her use of science apparatus to elucidate difficult content were practices she had observed from Taylor who was her former university lecturer. Therefore, what we do in our teaching is observed by our students and is a message to our students as future teachers.

Other formats of teaching

By other formats of teaching, I mean the different forms of activities that I used to engage students in learning besides lectures. The main format is the lecture. Students identified practicals, tutorials, and e-learning as other formats of teaching that they encountered in my teaching. Students described what they thought were the purposes of these other teaching formats and they also evaluated them and described what they gained from them. Agnes for example commented on what she gained from practicals.

Agnes: We were able to visually see ourselves, we were able to create things ourselves, to give everybody an example of what... like with the Reebop, that of just mixing it up and making something out of something, it just made it easier to understand maybe how it works in the body and so forth.

There is an indication in the comment by Agnes that students were evaluating the usefulness of the learning activities that I gave them. In her comment Agnes described what she thought were the purposes of the practical activities to her as a learner. What then would be students' responses if they do not seem to find any purpose in the teaching activities that we engage them in during our teaching? This strengthens the suggestion that I made earlier about making our courses and programmes and how we teach them personally relevant to the students.

Ephy described in detail how I made use of the e-learning system SAKAI. What is more important is that he was able to see the usefulness of SAKAI that is it enabled me as the lecturer to engage with students outside the official contact times.

Ephy: I would say that a strategy that I learned from her lectures was that we could, she was engaged with us as a class, …by having the website, Sakai, she used that really well, like giving us all the resources we need, whenever we did a practical, she after the practical was done she would give us a memo to see where we went wrong, how we can

correct ourselves, she gave us extra information on the website which helped us with the course - things that she couldn't cover in the lecture were on the website, so I think that strategy by making us all involved all the time instead of just that time that is allocated with us.

Tendai was also able to see the usefulness of E-learning as posting resources on SAKAI had enabled them to prepare in advance for lectures.

Tendai: Because it gives you the opportunity to be as prepared as she is. That you've never felt like you were behind or that you had to catch up

The utterances by Ephy and Tendai bring out clearly the importance of SAKAI not only to them but also to us as teacher educators. We are able to engage with our students outside the official contact times and the students are able to work with material to be covered in the lectures, in practicals and in tutorials in advance, and to continue to work with the materials after the contact times. Therefore, ability to use the university's E-learning system is an important asset that can improve our teaching.

7.4.3 Students' responses to my teaching practices

Students' descriptions of the purposes of my teaching practices

As I have explained at the beginning of section 7.4, I have already highlighted some of what students perceived to be the purposes of the teaching practices that they encountered in my teaching. Below I just give a summary of some of those purposes.

Agnes viewed the purpose of using **T/L aids** as to provide them with concrete examples of phenomena under discussion. For Placki, the purpose of **visual aids** was to help students to visualise and to picture the phenomena being described. Chipo saw my use of **T/L aids** as a lesson for students to see the kind of resources that they can make use of in poorly resourced schools. Munya reasoned that the purpose of **planning** was to enable a teacher to clarify any misconceptions or challenges during teaching. Tendai and Percy saw the purpose of **using questions at the beginning of my lectures** as that of recapping on what was covered in the previous lectures and also to introduce the new lecture. Mufaro saw that I was using a **variety of teaching styles** and reasoned that the purpose was that if a student fails to understand content being taught from the use of one teaching style, he/she has an opportunity to understand when a different teaching style is used. According to Percy, the

use of **quiz** exposed the areas of content students had not understood thereby motivating them to go and revise. For Mufaro, the **quiz** and the cards promoted collaborative learning and forced everyone to participate. The purpose of the **oral presentations** was to assess students' understanding and to give everyone a chance to participate. The role-playing activity gave Ngoni ideas of how to promote interaction in science classrooms. According to Ephy, the use of E-learning enabled me as the lecturer to interact with the students outside the official contact times. These are some of the reasons that the students gave for the different teaching practices that they experienced in the genetics course. A closer look at what students described as purposes of my teaching practices shows that most of the purposes that students described are components of pedagogical knowledge that students can make use of in future as teachers. The purposes of my teaching practices that students were able to interpret from observing my teaching confirms the power of the apprenticeship of observation that I discussed earlier. These purposes of teaching practices that students were able to derive from my teaching can act as frames of reference that will enable them to evaluate their own teaching later in their future teaching after qualification.

Evaluation of my teaching practices and other aspects of teaching

Analysis of the interviews shows that students evaluated my teaching practices and also other practices in conjunction with my practices. I present examples of students' evaluations below.

Examples of students' evaluations of my teaching practices

Students' evaluation of the T/L aids: Margie said that she "liked" the visual aids and as explained earlier, to like is an affective aspect which falls under the category enjoyment. If you like something, you are likely to enjoy it. Margie liked the T/L aids which means that she was enjoying their use in the lectures. Enjoyment has been seen to promote learning of content (Ainley & Ainley, 2011). Therefore, the use of T/L aids in our teaching of content courses to pre-service teachers can promote learning.

Margie: And the one thing I liked the most was the visual aids, because there was PowerPoint, there was, she'd come maybe with a board, put posters and stuff, so ja, that was nice.

Knowing what students like and enjoy is important information for me because I want students to enjoy my teaching. This is however a personal attribute that may not be shared by other teacher educators especially if we consider that pre-service teachers are adults

whom we expect to understand that they need to attend lectures to learn not because they enjoy them. When I consider my own experiences which show that when I enjoy something, I look forward to doing it or to experience it more often, I envisage that if I am able to make my teaching enjoyable, students would want to experience it more often. This means that students will not come to my lectures because the lectures are scheduled on their timetable but because they will be motivated to attend them. In addition, research shows that poor attendance of lectures is a problem in HEI and one of its causes is low motivation (Moore, Armstrong, & Pearson, 2008). There is not enough that happens in the lectures to motivate students to attend. Therefore, if I can incorporate in my teaching, aspect that will help students to enjoy my lectures, the students will most likely be motivated to attend the lectures. Besides, research by Ainley and Ainley (2011) showed that enjoyment of a teaching activity by students promotes their engagement with that activity and in turn promotes learning.

Students' evaluation of the teaching formats e.g. practicals: Agnes disliked the Reebop practical activity (See appendix D for the description of the activity).

Agnes: Okay some of the activities, you'd do it and you'd be like, "okay, we could have just left that little part out", like with the Reebops, with the building of the marshmallows and everything, that for me was just a little bit maybe not for the level of the third year student. It was a good activity, just the concept, but just maybe don't take it as far as having to build the little creature.

Please note that I am using this utterance for the second time in this chapter. I used the same utterance earlier to show that students take on different identities when learning in a content course. In this instance I am using the same utterance to bring out the impact that taking on a certain identity can have on students' learning. Agnes disliked the Reebop activity because for her, the activity was not for the level of a third year student. If Agnes had approached the activity with the identity lens of a teacher, she may have appreciated the importance of actually doing the activity because as a teacher, you need to be able to do the activities that you ask your learners to do. However, because of the identity lens that she used of a third year student, the activities were not appropriate.

My comment: Agnes' utterance shows that not all students are able to see our teaching intentions and the reasoning and thinking behind some of the teaching activities that we engage them in during our teaching. This observation brings out the need for us as teacher

educators to be more overt about why students need to sometimes do 'babyish' things. Maduna (2002), argued that teaching aids that are selected for teaching should serve a definite purpose in the lesson and should contribute towards the achievement of specific objectives. In pre-service teaching, the purpose and objective of using T/L aids or activities should be made explicit if pre-service teachers are to benefit from them as students and as future teachers. As future teachers, students will then learn about how to select and use T/L aids and teaching and learning activities something that Maduna argued that teacher-training institutions are no longer doing.

The utterance by Agnes also confirms what literature says that it is important to make explicit to our students the tacit knowledge underpinning the pedagogical decisions behind our teaching. Garbett (2012) tried to achieve that by embarking on team teaching in which the teaching sessions were followed by debriefing sessions in front of the students so that students could hear how their lecturers had articulated their thoughts before and during the teaching process. However, according to Garbett, the team teaching project was met with mixed reactions by students with some students saying that team-teaching made the sessions disjointed and confusing while others were saying that they had experienced better and deeper discussions and had learnt about teaching decisions. What was not clear in Garbett's report are the numbers of students who had seen the benefits of the team teaching project and those who were against it probably because the project ran for a long time (seven years).

Students' evaluation of teaching strategies: Chipo's utterance shows that she had evaluated the teaching strategies with a focus on her future teaching and concluded that she can also apply similar teaching strategies in her own future teaching

Chipo: I think I'm going to definitely take away the teaching strategies; the strategies that she used, I think are applicable to me as a teacher. I can walk into a classroom and I think that I can make the learners engage with the knowledge as fully as Mrs Nyamupa did by using her strategies.

Being able to see that she can apply the strategies to a different teaching situation is an aspect of conation. Chipo had evaluated and come to trust that the strategies that I used in my lectures can also effectively engage her future learners. There is also an aspect of confidence in what Chipo said: I can walk into a classroom and I think that I can make the learners engage with the knowledge. Confidence is an ingredient to self-esteem (Alsop &

Watts, 2003). In addition there is evidence of the apprenticeship of observation. Chipo has learnt about the teaching strategies that she can apply to her future teaching through observation of my teaching.

My comment: In contrast to Agnes in an earlier utterance, Chipo who used the identity lens of a teacher to view my teaching was able to see the relevance of the teaching strategies that I had used in my teaching of the genetics course to her own future context as a teacher. What influences students to view themselves as teachers or as learners or as third year students are not clear. What is clear is that students do take on these different identities which then influence what they learn from the teaching that takes place. What I would suggest therefore is that as teacher educators we should constantly remind students that although they maybe third or fourth year students, our teaching focuses not only on them as students but also as future teachers. Therefore they should also view themselves in that regard i.e. viewing themselves as both students and as future teachers in order for them to fully benefit from and to appreciate what would be happening in our courses.

Students' evaluation of their high school teachers and teaching: Students evaluated the teaching that they had experienced in high school.

Margie: In high school my teacher never did that, so it was new to me and I must say I did struggle a bit when we had to do all those incomplete dominance and stuff. I struggled a lot because it was new to me completely, my teacher, she was like, "okay no, you must read these notes, you don't have to know all...", like she said just cram to pass, you don't need to understand. She never explained anything so, ja. That's what I learned as something completely new.

The evaluation by Margie above shows that the teaching that she experienced in the genetics course activated her previous experiences of learning the same content which were negative experiences. This is in agreement with the findings by Pekrun (2002) that students bring to their learning thoughts and feelings from earlier learning experiences and such thoughts and feelings can influence new learning in a positive or negative way. If what Ross (1987) as cited by Lyngsnes (2012) said that student teachers have a tendency of wishing to provide their pupils with what was missing in their own schooling experience is anything to go by, then there is a possibility that Margie will discard the negative high school experiences and implement the positive ones in her future teaching.

Students' evaluation of the genetics course and of other courses: Servie evaluated the appropriateness of the genetics course which is a Life Sciences course and also other courses. The evaluation focused on whether the courses were appropriate or not for them as future teachers which is an awareness of his future context.

Servie: Well, I honestly think it was appropriate, like everything was appropriate for us as Life Sciences teachers to be. Unlike with the Physical Sciences and the chemistry and physics, just stuff that we did here were, like the engineering stuff, I didn't know why are we supposed to be doing that, yet we're not going to teach that. But with this genetics course, I think everything was so relevant to what those kids in high school do, so everything was appropriate. The content was good.

While Agnes evaluated some of the activities they did in the course as inappropriate because she was looking at herself as a third year student (see number 2 above), Servie evaluated everything that he had encountered in the genetics course as appropriate. This was because he was looking at himself not as a third year student but as a Life Sciences teacher. This shows that the identity lens that students of teaching use in their learning impacts the value they can see in the teaching activities.

My comment: The utterance by Servie above strengthens the need to make explicit all our pedagogical decisions as teacher educators. There should have been good reasons for the physical science lecturer to teach the 'other stuff' that the student referred to but because maybe he/she did not articulate his/her reasons for teaching it, students did not get to know why he/she was teaching the stuff and as a result, they labelled the stuff as irrelevant. It is also possible that Servie had limited knowledge of his future context in terms of the school curricular which then contributed to his thinking that the content was irrelevant.

Students' evaluation of the BEd Life Sciences programme: Tendai commented about the BEd Life Sciences programme as a whole***.***

Tendai: But one thing that does concern me, and I don't know, maybe I've had the wrong idea the whole time, but if it's our sub-major, we don't teach Grade Eleven and Matric, so genetics is maybe too much for us doing a sub-major, that perhaps we should have focused on things that we will definitely teach in Natural Science. Not that this wasn't useful, but it just seems almost like a waste that maybe she should have taken a topic that will definitely help us in our teaching and perhaps genetics should be a fourth

year topic because I feel like I learned so much from this genetics course and I'll never be able to go out there and actually use it in its entirety. I mean I can now apply sort of similar things when, if I ever teach mitosis or something like that at a lower level, but I don't think I'll ever actually teach genetics, and that for me is quite sad now that I've seen how interesting and how fun and stimulating it can be.

Tendai did not see much personal relevance in the genetics course as biology was her sub-major subject and genetics is a grade 12 topic in the South African curriculum which means that she was not going to teach it. Tendai's utterance reflects a limited understanding of her future context. While in ideal situations there will be enough teachers for each subject and as such she will not be expected to teach biology at Matric level, she doesn't realise that her future context is far from this ideal and she may be expected to teach biology at Matric level. In addition, curriculum documents are not cast in stone, they are changed every now and then according to a nation's needs. Therefore, although genetics is being taught in grade 12 at the moment, we may find some aspects being moved to lower grades in future for one reason or another. Furthermore, although she hinted that she can apply the knowledge that she gained from the genetics course to other contexts, Tendai doesn't seem to fully grasp that that is actually our aim as teacher educators; to teach them skills using any topic in such a way that they can apply the knowledge gained from learning that topic to other topics.

When students do not see personal relevance in the content they are learning like Tendai in this case, they may disengage from the learning process (Ainley & Ainley, 2011). I therefore reiterate the importance of making explicit to students our pedagogical decisions. For example, in this case, I should have explained to students why we decided to make genetics a third year course and not a fourth year course.

Descriptions of outcomes of my teaching practices

By outcomes, I am referring to anything that students developed, learnt or gained from my teaching. These outcomes include motivation to attend lectures, interest in learning, confidence, an understanding of content, and lessons about teaching. Below I present examples of outcomes.

Motivation to attend lectures: One of the outcomes of my teaching is that students got motivated to attend my lectures. Munya was motivated when he observed that I was always prepared for my lectures. Being prepared always made him to enjoy and to love the genetics course. I used the same utterance earlier to confirm the findings by Ainley and Ainley (2011) that when students find personal relevance in the teaching and learning activities that they are engaged in, they enjoy that teaching and learning activity.

Munya: I will say that there's nothing that motivates me more to go to a class where you know that you're going to do something constructive. So basically, as I have mentioned that she was always prepared, that motivated me to keep on going to class each and every day, so it helped me to enjoy and love the genetics course as a whole. And also based on the practicals, like in genetics, I never thought of any practicals that are possible to be carried out within the context of genetics, so to me it was challenging to see the new strategies she came up with to try and outline the concepts within meiosis using her practicals.

Preparation, new strategies, new ways of teaching and learning genetics all motivated Munya to attend my lectures and brought joy to his learning.

Confidence: Another outcome of my teaching was that students developed confidence as future teachers. Chipo said in the interview that she was going to “take away teaching strategies”. That is what she had learnt from my teaching and by gaining knowledge of the teaching strategies she also gained confidence as a future teacher. The teaching strategies also got her motivated to come for lectures. I used this quote earlier to show what students said about my teaching practices. Here I am using the same quote to show that students gained confidence from my teaching practices.

Chipo: I think I'm going to definitely take away the teaching strategies; the strategies that she used, I think are applicable to me as a teacher. I can walk into a classroom and I think that I can make the learners engage with the knowledge as fully as Mrs Nyamupa did by using her strategies, and also, her strategies got us engaged, it got us interested in the topic of meiosis, and each and every week we went to class thinking, "what does she have in store for us this time?", so I think definitely her strategies.

My comment: I did not tell Chipo or other students how they should teach; I showed them how they should teach by modelling the teaching practices. By modelling the teaching practices, I gave my students a chance to experience what is possible. Chipo's utterance above shows that by doing teaching instead of telling about teaching as a teacher educator, I was able to not only teach about teaching in a content course but I was also able to build confidence in students as future teachers. Students also developed interest in what they were learning: it got us interested in the topic of meiosis, and each and every week we went to class thinking, "what does she have in store for us this time?

While Chipo gained confidence from the knowledge about the teaching strategies that she had gained, Ephy gained confidence from gaining content knowledge. The content knowledge that he gained made him feel comfortable as a future teacher. From my own experiences as a novice teacher and a novice teacher educator, knowing that you have adequate content knowledge is a confidence booster for a new teacher and as said earlier confidence is an ingredient to the development of self-esteem (Alsop & Watts, 2003). Ephy also gained knowledge about genetic disorders and was confident that he now knew how to interact with friends or family members who may have genetic disorders.

Ephy: I have found it useful by I know one day that I'll have to teach this, so with the content that she's given us, I feel comfortable in knowing enough so when I enter that classroom and I have to teach it, I know that my content knowledge is sufficient. As well as by doing this course it's also taught me how to differentiate between genetic disorders and we can, if we encounter one of our friends or family members to have certain genetic disorders, by doing this course we know how to interact and how to treat them and stuff like that, so by that I know as a student, I'm taking it as I'm learning about this disorder so I can, if I encounter it in real life, I know how to deal with it.

Just like Ephy, Mufaro also gained content knowledge and because she displayed that knowledge to others through a role-play, she gained confidence from the role-play.

Mufaro: Because, okay, most of us weren't really familiar with the disease but it made us to go out there and research more about the disease, and because we had to role-play, you had to master what really is Alzheimer's, you had to get your facts straight,

rather, so ja, that's the kind of content I got and the skills of researching as well. And confidence, I really think most of the activities requires you to, you know, to, like Ngoni said, some of us hardly speak in class, hardly participate, but this year we were taken out of our comfort zones to say, "you know what, you are a teacher, you have to own your content".

When I came to know about the above outcomes that my teaching had achieved in students, I realized that at the beginning of my teaching of the course, I had a narrow view of what should be students' outcomes from my teaching. I had not considered some of these outcomes at all e.g. trust, motivation and confidence. My initial outcomes were that students should understand the content and how to teach that content. Now I see that there is more to my teaching responsibilities than just helping students to understand content and how to teach it. Students should be motivated to teach that content. Student should not only understand content and pedagogical practices but they should have the confidence to teach that content using the pedagogical knowledge that they gain from our courses. We can cultivate confidence in our students as teacher educators by making sure that they develop the four domains of a teacher's knowledge; knowledge of their future contexts, knowledge of their future students, pedagogical knowledge and knowledge of content. Therefore, as teacher educators we need to be more explicit about these domains of knowledge in our teaching of pre-service teachers.

7.4.4 Students' multiple identities and the tension they create

As has been shown in this presentation of findings so far, students took on multiple identities during the teaching of the genetics course. Sometimes they saw themselves as learners, sometimes as teachers and sometimes as third or fourth year students. The multiple identities that students have to assume sometimes create tensions with regards to the appropriateness of some activities. Some students are able to negotiate that tension by recognising the multiple identities of learner, third or fourth year student and future teacher and others are not able to negotiate between these multiple identities. As a result, they then view some of the activities that they do as inappropriate.

For example, while Tendai did not see the value of the role playing in terms of helping them to learn about genetic counselling, she saw the value of the role playing concept as a teaching procedure that can be used to promote learning in the classroom and therefore didn't see the activity as inappropriate.

Tendai: Well she gave us a lot of ideas about what we could potentially do in a classroom. Like that role-play maybe didn't mean a lot to us in terms of learning about genetic counselling, but it gave us an idea about how we can use that topic in a classroom with kids that would appreciate it and that would learn from that.

Earlier on in the section on evaluation of teaching contexts, I presented Agnes' evaluation which showed that she did not like the Reebop activity because she was viewing herself as a third year student. Below, I present Percy's view of the same activity. Percy was a fourth year students who was doing Life Sciences as his sub-major:

Percy: Looking at the practical aspects especially the practical with the Reebop, it gives a different dimension to what can be done in terms of Biology. It makes it more fun and entertaining for if you're looking at kids - Grade Nine, Grade Ten, it sort of almost personalises the content to a certain extent where they can actually interact with what's happening and with Biology it's not always the easiest things because you can't give them a live animal and watch this thing mate to a certain extent, so it's a good representation, it brings the knowledge onto the learners' level.

Percy, because he took on the identity of a future teacher liked the same Reebop activity that Agnes disliked. With the identity of a learner, Agnes was able to appreciate what was happening in the course:

Agnes: She manipulated all of the theories for Biology in particular, she didn't just brush over everything, just to give us the knowledge. She actually prepared and made it specific for us as learners and not just us as a class.

With the identity of a teacher, she was able to derive meaningful lessons about teaching from the course:

Agnes: As a teacher it's of being prepared, of not having just one example or one way of explaining something; there was multiple. She used multiple ways of teaching the same concepts, so she didn't just rely on a definition, she elaborated on it, she showed

us visual examples, and as a teacher it shows me how I should teach as a Science teacher or a Biology teacher.

My comment: Students take on multiple identities and the identity they take at any given time influences the way they perceive the teaching that will be happening at that time and what they learn from that teaching. I therefore, cannot overemphasize the importance of continuously reminding students of their multiple identities and of making explicit the purposes of the activities that our students engage in.

7.4.5 Students' descriptions of the knowledge they gained

Knowledge of their (students') future contexts

Some of the excerpts above showed that students were aware of their future contexts. I also presented a case where a student showed that she was not fully aware of her future context and as a result did not see genetics as an appropriate topic to teach to pre-service teachers who are doing biology as a sub-major. Here, I present more evidence of students' awareness of their future contexts (schools). As explained in chapter six, knowledge of context sometimes overlaps with knowledge of students. Therefore, the evidence presented below shows students' awareness of both their future context and also their future students. Ngoni showed awareness of their future contexts and their future students by explaining during the interview how oral presentations and group work would be good teaching procedures to use with their learners.

Ngoni: It's very useful (presentations), ja, for using them in a classroom situation or context because learners tend to get bored when it's teacher-centred teaching and learning, so I think getting them involved more in the lesson would incorporate more effective learning in schools so like I think that I enjoyed her getting us involved, because like I said earlier, I didn't do much talking in lectures and tutorials; I'd just write and then submit, so I think that would help me also as a teacher, see which children are struggling in class who didn't understand, because if they are discussing then I go around and check and when one learner's taking the role of the group leader, now what's wrong with the others? It helps you as a teacher identify which children understand and then you can just... correct them and scaffold more on your lesson.

Ngoni described her context which is the classroom and displayed her knowledge of students by highlighting what bores students and how presentations can overcome that boredom. We again see here the manifestation of the knowledge that is gained through the apprenticeship of observation. Ngoni's knowledge of what tends to get students bored in a classroom situation is likely to be a result of her own experiences as a high school student. Now she is using that knowledge as a frame of reference to evaluate how oral presentations would be useful to overcome that challenge of student boredom.

Percy showed an awareness of his future context and future students by evaluating the appropriateness of the practical activities in terms of relevance to the high school context. There is again evidence of the manifestation of the knowledge that was gained from the apprenticeship of observation.

Percy: Looking at the practical aspects especially the practical with the Reebop, it gives a different dimension to what can be done in terms of Biology. It makes it more fun and entertaining for if you're looking at kids - Grade Nine, Grade Ten, it sort of almost personalises the content to a certain extent where they can actually interact with what's happening and with Biology it's not always the easiest things because you can't give them a live animal and watch this thing mate to a certain extent, so it's a good representation, it brings the knowledge onto the learners' level. But another thing with that is classroom management, make sure that learners are getting the actual purpose of it and not just playing around and looking at it as a kind of perverse-type exercise which may happen with teenagers to a certain extent.

Agnes learnt how she should handle children with albinism. She showed that she was aware that this is something she may encounter in her future contexts and felt that the course had prepared her for such situations.

Agnes: As a teacher like for example, with the albinism, we were made aware of if we have a student like that in our classroom, let them sit a little bit more in front, try and keep it a spot in the classroom where's there's not much light or whatever that's going to distract the learner or whatever and their ability to see, so as a teacher it made me

it will prepare me for maybe students that may have some of the genetic mutations and so forth. So it will help me to understand my learners a bit better.

For Servie, the course was not an end in itself. He was able to see that the course was preparing him for the future. Therefore, he was saving all the materials that he got from the course for future use e.g. the PowerPoint presentations.

Servie: Her notes. I've saved them and I think I'm going to use them in future for my own lessons, genetics lessons. Like honestly, I have saved the PowerPoint, the presentations on my laptop, even the notes, I have filed them in my resource file.

Percy saw the knowledge he had gained about genetic diseases especially Alzheimer's as relevant in his own home and community context.

Percy: I think what I also grasped was that, we were [inaudible], we need to then define empathy versus sympathy. Yes, have empathy for people with genetic disorders but don't have sympathy for them, don't feel sorry for them because, don't treat them as different people, you know, they might have a genetic disorder, it's something they cannot help, but they themselves have found a way to live with it, so who are you to try look down on them, type thing. That's what I really got from the course, and the Alzheimer's thing as well, it was good to see because I myself have a grandmother with Alzheimer's, and there is a lot of people who don't know what it is and what it's about and it's a good approach, it's something that I would use especially to get people to just know more about these disorders so that if they do come across someone they can treat them with respect, you know.

Tendai showed a very interesting view of the university's context. She seems to be of the view that lecturers are not expected to use T/L aids. Therefore, she appreciated the fact that I used T/L aids in my teaching which helped her to enjoy the course.

Tendai: I personally really enjoyed the fact that she was always prepared. It makes a big difference, and that she put so much effort into making us understand, because she didn't have to get flowers and she didn't have to do any of those things because, I

mean, she's a lecturer, and she said that this is the textbook, do it, that she could have quite easily have done that. But the fact that she always tried to get us to learn and that she was showing us more than just learning genetics; that she was actually being a good example of a teacher. I think that was very helpful.

In the excerpts above, students showed that at third and fourth year level, students are well aware of their future contexts. Knowledge of one's context is a knowledge domain that a teacher should have for effective teaching to occur (Rollnick et al., 2008). Therefore, we should aim to develop further, students' knowledge of their future contexts by showing them the importance of that knowledge and how it is useful when making pedagogical decisions such as the type of examples and T/L aids to use.

Knowledge of their (students') future students

Knowledge of students sometimes overlaps with knowledge of context. In this section therefore, I describe aspects of knowledge of students that does not overlap with the knowledge of context that I have described above. Students showed some knowledge of their future students. Agnes made reference to what could happen with learners if interactive activities like oral presentations are not used.

Agnes: And another thing is... when we had to create the posters ourselves of the phases of meiosis, and then describe what happened at each phase, that's something I would use because it helps you to... I mean a learner can say, "yes, I understand; I know meiosis", but then actually describing it and showing it is another thing, and that is for me a good teaching strategy.

Students indicated that they had learnt in the course about misconceptions. I consider this to be knowledge by students of their future students as they were now aware of some of the misconceptions that students bring to class about genetic phenomena.

Placki: Well you'd learn about the misconceptions because you'd end up having them and then in order, with like correction then you'd know.

Just as with knowledge of context, knowledge of one's students is a domain of knowledge that a teacher should have if effective teaching and learning is to occur (Rollnick et al.,

2008). Therefore, I am happy that there is evidence that students gained knowledge of their future contexts and of their future students from the course.

Knowledge of content

Genetics is a content course and the main aim of the course is to teach students about genetics. All students encountered the same content but they experienced the content in a variety of ways. Students' responses to the content that they encountered in the course are discussed below. Margie encountered **new content** which she had not encountered in high school.

Margie: I'd say the crossing part of monohybrid and dihybrid... all of that. In high school my teacher never did that, so it was new to me...She never explained anything so, ja. That's what I learned as something completely new.

Servie in addition to encountering and learning new content, she also encountered **content that was taught in a different way** when compared to what he had encountered in high school. In high school, his high school teacher's approach to teaching had forced him to cram the content without understanding it. Now he had encountered the teaching that had helped him to "understand and to accommodate' the content.

Servie: I've also said earlier that I had the very horrible teacher, like the diseases, we didn't touch that part, like the genetic disorders and dihybrid, we only did mono. And yes, by just cramming, not really for understanding. For the sake of passing the exam. So I first did this with Mrs Nyamupa in this genetics course, the diseases, and I'm like, "oh, okay, so this is how it is". And the dihybrids, like the peas, and Mendel, I only did it with Mrs Nyamupa but the experience was good, it was my first time but I was able to understand and accommodate the new knowledge.

Tendai also **gained a new understanding** of the content she had learnt in high school.

Tendai: Well we did the structure of DNA and chromosomes, and it was actually the first time that I really understood chromosomes, I realised at school I never understood them [laughs].

Just like Tendai, Agnes and Placki had not understood the content that they had encountered in high school as teachers had 'literally brushed over' the content. This time in the genetics course, there was **'depth'** in the content the students encountered.

Agnes: Something also, I had horrible textbooks when I was in school so the teachers didn't really have much to refer to and in the classroom it was mainly just discussion-based and she'd have some slide shows but not much, so, but, and like we didn't cover that also of crossing over like that of chiasma and all of that just going more into detail. They literally just brushed over it but Nyamupa went into depth.

Placki: The relationship between... like... knowing that genes are DNA which are chromosomes... like that whole relationship... I never knew it worked like that, I didn't know, and also that everything happens in the nucleus of the cell, not the cell itself; like we always see it as the cell. So that was new content that I gained

Ephy encountered **content that was likely to confuse them** had it not been explained thereby preparing them to be able to deal with the same content in future as teachers.

Ephy: I think what I came to understand is she focussed on stuff that we would get confused, so we as future teachers know how to, if we are faced with the same confusion, we know how to engage with that information and put it to our learners in a simpler way. So she's creating understanding, making sure we understand whatever concept that she's teaching well, so when we go back to the classroom, we can teach that concept well.

In addition to content that offset potential confusion, Ephy also felt that the content that he encountered in the course was **useful and sufficient** enough to comfortably prepare him to teach it in future. Furthermore, the **content gave him knowledge about different genetic disorders** and taught him how to interact with family or friends who may have such disorders.

Ephy: I have found it useful by I know one day that I'll have to teach this, so with the content that she's given us, I feel comfortable in knowing enough so when I enter that classroom and I have to teach it, I know that my content knowledge is sufficient. As

well as by doing this course it's also taught me how to differentiate between genetic disorders and we can, if we encounter one of our friends or family members to have certain genetic disorders , by doing this course we know how to interact and how to treat them and stuff like that, so by that I know as a student, I'm taking it as I'm learning about this disorder so I can, if I encounter it in real life, I know how to deal with it.

Three aspects of the affective experience are reflected in the response by Ephy. He found the content that he had learnt to be useful to him (salient aspect) and personally relevant (germane). He had understood the content well enough to trust that he can comfortably teach it in future (conation). These aspects reflect the extent of relevance Ephy had found the genetics course to be in his life not only as a future teacher but also as an individual.

Munya did not only encounter new content, he encountered **a sequencing of the content** that promotes learning.

Munya: I think also what I have gained from this course would be the content as a whole, though I did genetics at school, but there was some information, new information added on, what I have already knew, and also the strategy of sequencing the content, that it must not be confusing, it just have to flow from one concept into the other, from the other to the other. So that helps learners or us, even us as students to kind of know the track, to keep track of our work, so because you won't study for this week, only to find that tomorrow's lecture they're going to teach about a different thing, so that's quite confusing, so that's what I gained.

The students in the excerpts above raised a number of important issues about the content that they encountered in the genetics course. Firstly, they encountered new content. Secondly, they had gained a new understanding of the content that they had done in high school. Thirdly, they experienced depth to the content that they had learnt. Fourthly, they encountered SCK that prepared them to deal with confusion their learners may display when they teach the same content later in their working lives. Fifth, the content was taught in completely new ways that helped them to understand the content better. Sixth, they had encountered a structure to the content that had helped them to keep track of their learning. Seventh, they had learnt about misconceptions associated with the content they were

learning and lastly, they had learnt content that was useful and sufficient enough to make them feel comfortable when they thought about teaching the same content in future. The important aspect for me, that is coming out of the students' comments is that in the genetics course, they did not only learnt genetics, they understood the content (cognitive aspect) and the experience of learning that content was good (affective).

The other important aspect coming out from what students learnt about content is that students were able to use their experience of learning the genetics content as a lens to look back and evaluate the teaching that they had experienced in high school and the textbooks that they had used and to pinpoint what was bad about them (conative). As discussed earlier, this ability by students to pinpoint what was bad about the high school teaching that they experienced is likely to motivate them to adopt the teaching that they experienced in the genetics course or other methods as according to Ross (1987) cited by Lyngsnes (2012) students teachers tend to be inclined to provide their pupils with that which was missing in their own schooling experiences. This inclination if it happens will promote a better understanding of content by their students in future.

The different aspects about content that students talked about reflect the diversity that is characteristic of our classes which we need to consider when choosing content for our courses. There is a lot that I need to consider when choosing the genetics content for teaching pre-service teachers. The considerations include students' academic backgrounds, socio-cultural backgrounds and future contexts. For example, what would be the appropriate content for those who would have done biology at Matric level, appropriate content for those who never did biology at Matric level, appropriate content for students as future teachers, as individuals and as citizens of South Africa and of the world? Choosing appropriate genetics content is a complex task. I am therefore of the idea that the choosing of content for a course should be a collective endeavour where all members of the discipline get involved. Inputs from colleagues based on their own knowledge of contexts, knowledge of students and knowledge of content is likely to build a course that will cover most of the aspects about content outlined above.

7.5 Summary and discussion

In this chapter, I have described how I developed my coding scheme and how I used the coding scheme to analyze the interview transcripts. I have also presented the findings from the analysis of the interviews. The analysis of the interviews showed that students' experiences of my teaching could be put into four categories namely *students' descriptions*

of my teaching practices, *students' responses to my teaching practices*, *students' descriptions of their identities* and *students' descriptions of the knowledge they gained*. Students' descriptions of their experiences showed that they gained knowledge of context, knowledge of students, pedagogical knowledge and knowledge of content from my teaching of the genetics course which is important as these are the domains of knowledge that a teacher must have in order to teach effectively (Rollnick et al., 2008).

A number of themes emerged from the analysis of students' experiences as represented by the four categories of students' experiences outlined above. The themes that emerged from these categories of students' experiences are listed and explained below.

1. Pre-service teachers are motivated to attend lectures and to learn when teaching practices and the content of a course bring personal relevance to them as students and as future teachers.
2. Students' prior knowledge *about teaching* helps students to find meaning and relevance in the teaching practices that are employed in a course and to learn about teaching.
3. It is important to develop trust in our students that we take their questions, issues and concerns about their learning seriously and also trust that what we teach them is appropriate and relevant.
4. Observing basic pedagogical practices (planning, good organization, punctuality, and enthusiasm) can motivate students to attend our lectures.
5. Use of visual aids influences both learning of content and learning about teaching.
6. The identity lens that students take on during the teaching and learning process influences the way they see the T/L activities and what they learn from them.
7. Modelling or practicing good teaching in the teaching of content courses can be an effective way of teaching about teaching.
8. There is a need for us as teacher educators to be more explicit about our teaching practices including the teaching activities that we engage students in and the content that we teach them.
9. Learning and gaining knowledge about the four domains of a teacher's knowledge develops confidence in students as future teachers.

The first theme that emerged from students' experiences is that **pre-service teachers are motivated to attend lectures and to learn when teaching practices bring personal relevance to them as future teachers and as students**. Students found personal

relevance in my teaching practices which motivated them to attend lectures and to learn and made them to enjoy the course. Students' responses to my teaching practices, whether it was a description of purposes of my teaching practices, evaluations of my teaching practices or descriptions of outcomes, brought out what students found to be personally relevant from the teaching practices. The teaching practices that students described included use of T/L aids, planning, preparation and punctuality, use of a variety of teaching styles and teaching techniques and assessment activities. Every description of these teaching practices by students was followed by a response which was a description of the relevance of that teaching practice to the student as a student, as a future teacher and sometimes as an individual. It appears that once students could see relevance in my teaching practices and in what I was teaching them; positive feelings were generated towards the teaching and learning process which caused students to enjoy the course. Therefore, students were motivated not by the teaching practices that I used in my teaching but by finding personal relevance in the use of those teaching practices and in the content of the course. This is an important insight as lecture absenteeism is a problem in Higher Education (Moore et al., 2008; van Walbeek, 2004). If we can get to know what motivates students to attend lectures, then we can be in a position to overcome the problem of lecture absenteeism.

The second theme that emerged from an analysis of students' experiences is that **students' prior knowledge *about teaching* helps them to find meaning and relevance in the teaching practices that are implemented during the course and to learn about teaching**. The analysis of students' interviews showed that students came to the genetics course with some knowledge of their future contexts i.e. schools and classroom environments, knowledge of their future students, pedagogical knowledge and knowledge of content. The knowledge of the four domains of a teacher's knowledge that students had, helped them to understand my teaching practices and to derive meaningful lessons about teaching as they could visualize their application in their future contexts. For example, the knowledge that Chipo had about various school contexts helped her to appreciate the kind of T/L aids that I used in the course such as pictures and flowers because she saw them as easy to get even in poorly resourced schools. The knowledge that Agnes had about her future students helped her to appreciate and to understand the importance of having students do oral presentations because she was aware that school learners may say "yes I have understood a concept" when they have not. Therefore, oral presentations by the learners would provide a platform for students to show their understanding of concepts taught.

According to Loughran (2006), teacher educators when teaching about teaching need to articulate and to make their pedagogical decisions explicit for the benefit of their students. I also wanted to apply the same suggestion in my teaching of genetics although it is a content course. I could not however carry out Loughran's suggestion as I could not think of a way that I could use to explain my pedagogical decisions without disrupting the flow of the lectures. The analysis of students' interviews however reveal that it may not have been necessary for me to explain what I was doing and why as the prior pedagogical knowledge that students brought to class acted as a frame of reference that helped them to interpret and to understand my teaching practices resulting in them learning about teaching even though it was a content course. The students used their prior knowledge to interpret what I was doing and why I was doing it. For example Margie correctly said the reason why I was using T/L aids was to provide them with concrete examples of abstract concepts. Percy correctly reasoned that I was using a constructivist approach to my teaching to place the responsibility for learning on students themselves and Mufaro also correctly reasoned that I was using oral presentation so that I could assess their understanding of content. Students' understanding of the teaching practices that I was implementing in the course led them to see the relevance of the teaching practices and the content of the course to them as future teachers and as individuals. Understanding the relevance of my teaching practices in their future lives as teachers made students enjoy the course.

In the science education literature, the prior knowledge that is discussed and focused on in the teaching of sciences is the ideas and conceptions (which maybe misconceptions) that students bring to class about the science phenomena that they will be taught (e.g. Cimer, 2007; Mintzes et al., 1998). Therefore, the prior knowledge that I focused on when I was preparing for my teaching and during the teaching was about genetic phenomena only. It was only after analyzing students' experiences of my teaching that it clicked in my mind that students do not come to the content courses as blank slates when it comes to knowledge about teaching. They actually bring remarkable knowledge about teaching. A search of the education literature then helped me to see that actually students have prior knowledge about teaching such as ideas and images about what teaching is all about that they acquire through what is called the apprenticeship of observation that I was not aware of (see Kennedy, 1998; Lyngsnes, 2012). According to Lyngsnes (2012, p. 2), this prior knowledge maybe "common sense, personal, non-analytical and make up a limited perspective on teaching and teachers' work". Nevertheless, these ideas may strongly influence the way pre-service teachers think about teaching. In addition, it also came to my mind that most of the students in my genetics class had already done at least two years of methodology courses

and some teaching experience in schools(see the WSoE teacher education programme in section 1.2.2). This meant that students were also bringing knowledge about teaching from their methodology course as prior knowledge of teaching to the genetics course. While the knowledge that students gain from the apprenticeship of observation was labelled as common sense and limited by Lyngsnes (2012), I see the knowledge that students get from their methodology courses as robust and informed and therefore give students an informed frame of reference for their experiences of teaching in the content courses. According to Lyngsnes (2012), attributes and practices that pre-service teachers' observe from their apprenticeship of observation influences the kind of teachers that they become. This is because the pre-service teachers use those attributes and practices to create the image of a teacher that they would want to be. This means that if the attributes and practices that pre-service teachers have observed and experienced are not 'good' they will carry them into their teaching. This then highlights the importance of us as teacher educators to model good teaching attributes and practices in our teaching to try and replace any bad attributes and teaching practices that pre-service teachers may have acquired from their apprenticeship of observation in schools.

Analysis of the interviews showed that by modelling good teaching in my teaching of the genetics course, I provided students with good teaching practices and attributes such as thorough planning and preparation, punctuality, T/L aids, good organization and use of a variety of teaching styles that they confirmed as practices they were taking away for use in their future teaching. Students' confirmation that they had learnt some good teaching practices from the course confirms that the apprenticeship of observation that happens in schools also occurs in our teaching of content courses. This supports theme seven that modelling good teaching in the teaching of content courses can be an effective way of teaching pre-service teachers about teaching.

The third theme was that **it is important to develop trust in our students that what we teach them is appropriate and relevant**. I was not aware that students can actually doubt the appropriateness and relevance of what we teach them. Tendai made me aware that because I was always prepared for my lectures; it made her to trust and to believe in what I was teaching them. Earlier on in chapter 5, a trigger event that I reflected on helped me to see that as teacher educators we need to build in students a trust that we take seriously their questions, issues and concern about their learning. There is therefore a need to build trusting relationships with our students with regards to our pedagogical practices if effective learning is to occur.

The fourth theme that emerged from the analysis of students' interviews is that **observing basic pedagogical practices can motivate students to attend our lectures.** Several studies in the literature indicate that lecture absenteeism is a problem in HEIs and the reasons for poor attendance points to lower motivation of students (Moore et al., 2008). A number of studies also confirm that poor attendance of lectures may affect learning and students' subsequent performance in exams (e.g. Riggs & Blanco, 1994; Romer, 1993; van Walbeek, 2004). The studies are however inconclusive as there are cases where students still pass without having attended all lectures. There are other reasons why it is important for students to attend lectures other than passing exams such as being exposed to the fundamentals of a disciplines that are not necessarily examined (Riggs & Blanco, 1994; van Walbeek, 2004). Therefore many HEIs have put in place mechanisms to encourage or rather 'force' students to attend lectures. For example at my institution, there is what is called **Due Performance** which means that a student must attend a certain percentage of lectures in a course for him or her to qualify to sit for the final exam for that course. This means that registers must be marked and kept. Due to logistical problems of marking registers when teaching large classes, in the Science Division, we only make practical and tutorial attendance compulsory and not lectures and that is where attendance registers are kept. It was therefore very exciting to find out that there are other ways that can motivate students to attend lectures such as lecturer enthusiasm, confidence, punctuality and thorough preparation for lectures. According to D. Palmer (2007), when a teacher shows enthusiasm for a topic, the enthusiasm convinces students to believe that there is value in knowing about the topic and therefore to attend lectures. Palmer went further to describe how teachers can express their enthusiasm: by facial expression, body language, describing personal experiences or amazing facts, using humour and also putting energy into lesson preparation and meticulously preparing materials. Students' responses to my teaching in which they explicitly stated that they were motivated to attend lectures because I was always prepared, organized and enthusiastic confirm the motivating aspects in Palmer's list above. Students also got motivated by finding personal relevance in the content of the course, and by use of a variety of teaching styles and by experiencing that I care about them.

The fifth theme is that the **use of visual aids influences both learning of content and learning about teaching in pre-service teaching**. Before this study, I hardly used T/L aids in my teaching despite what literature says about the use of T/L aids. Literature says that the use of T/L aids can promote learning by representing the reality of a concept or phenomenon and facilitates remembering. When describing a structure, a process or a relationship, the use of T/L aids supplements those descriptions and help to explain words, to illustrate the

relationships and to give a more accurate impression of subject matter that is being discussed (Van Rooyen & Van der Merwe, 1996). The use of T/L aids can also help students' whose first language is not English to understand difficult concepts and to improve communication between them and their lecturers (Luthuli, 1992).

The reason why I decided to start using T/L in my teaching was to model good teaching so that my students could learn about good teaching from what I was doing not what I say. From what students said in the interviews, I am not the only one who was not making use of T/L aids. I therefore see here an example of not implementing what research says will improve our teaching and students' learning. What could be the reason? For me, the first reason for not using T/L aids was that I thought it was no longer necessary to use T/L aids at tertiary level; a thinking which shows the necessity of induction and PD in HEIs. The second reason was that it was not easy to think of the T/L aids that could be seen by all students in a big lecture theatre. In this study, through consultation, I then got lots of ideas on the kind of T/L aids that I could use from colleagues. My second reason for not using T/L aids again shows the necessity of PD in HEIs and also the necessity for the creation of professional learning communities (PLC) where teaching ideas can be discussed and shared (Abbott, Guisbond, Levy, & Sommerfeld, 2014). As I said earlier, as teacher educators we have a wealth of knowledge about teaching that we have gained through experience, through research and from reading literature. We can share this knowledge through PLC to improve each other's teaching.

The last reason why I was not motivated to use T/L aids in my teaching as a teacher educator was ignorance of what the literature says about the benefits of using T/L aids at HEIs. English is the official language of instruction at my Institution and the majority of my students are not English first language speakers. From my experiences as an English second language learner, teacher and teacher educator, I am fully aware of the learning challenges that can be imposed by learning in a language that is not my first language. Therefore, if I had known that the use of T/L aids can help students whose first language is not English to overcome this linguistic challenge, I would never have stopped using them when I became a teacher educator. I therefore reiterate here that there is evidence and information in education research of what we can do and make use of to improve our teaching and students' learning.

The sixth theme was about students' multiple identities and learning. **The identity lens that students take during the teaching and learning process influences what they see and**

what they learn from the T/L practices. When students interpret teaching practices that they will be encountering, they sometimes interpret them with the lens of a learner and sometimes with the lens of a teacher and sometimes with the lens of a third year student. Lectures, practical or tutorial sessions are spaces where a pre-service teacher shifts identity between being a learner and being a teacher and being a third year student. The shift in identity that occurs sometimes causes tension in the pre-service teachers as some of them see some activities as inappropriate for them as third year students while others are able to see the appropriateness of the activities for them as they will be using the lens of a future teacher. This highlights the importance of us as teacher educators of being overt when it comes to the activities that we choose to do in our day to day teaching of pre-service teachers which is theme number eight. We need to be explicit about the relevance of the teaching activities to students as students and as future teachers. On the other hand, because students are able to see themselves as teachers, a lecture in a content course can be a space for effectively teaching pre-service teachers about teaching.

The final theme that emerged from the analysis of students' interviews was that **learning and gaining knowledge about the four domains of a teacher's knowledge developed confidence in students as future teachers.** Students learnt some aspects of their future contexts and their future students. Students also gained pedagogical knowledge from my teaching. They gained knowledge of teaching procedures, knowledge about T/L aids and knowledge of teaching techniques and how to effectively use them to engage learners. Experiencing and gaining such practical knowledge built confidence in some students as future teachers. Having actually observed me enacting and implementing the various teaching practices, students came to trust that they also could enact similar teaching practices now that they had actually seen how it can be done and what can be achieved. Students showed that they had learnt about teaching by observing and experiencing what I was doing in the course thereby confirming the assertion by Russell (1997) that students learn from what we do not what we say. The study also confirmed the suggestion by Loughran (2006) that we can teach pre-service teachers about teaching by modelling good teaching practices. Although Loughran made this suggestion in the context of teaching methodology courses, this study has shown that the same can be achieved in the teaching of content courses. What I was not able to convey to students however is that teaching is affected by context. Therefore, what worked well in one context may not work as well in a different context.

In this chapter seven, I have presented the findings from the analysis of students' experiences of my teaching which answered my third research question. I have also highlighted what I have learnt and have come to understand about teaching pre-service teachers from students' experiences which answers the first part of my fourth research question. In chapter eight, I am going to present suggestions on how I can use what I have learnt and what I have come to understand about teaching pre-service teachers as presented in chapters 4 to 7 as part of my conclusions and recommendations.

Chapter eight: Conclusions and recommendations

8.1 Introduction

The purpose of my study was to investigate my teaching of genetics, a content course to pre-service teachers. My concern when I began this study was how to teach pre-service teachers for understanding and for teaching. The study was guided by the following research questions:

1. What knowledge should I have as a teacher educator in order to effectively teach genetics, a content course, to pre-service teachers?
2. How is my practice as a teacher educator transformed as I examine and reflect on my teaching of genetics to pre-service teachers?
3. What are students' experiences of my teaching practices?
4. What do I learn from students' experiences and how can I use that knowledge to improve the teaching of pre-service teachers?

In this chapter, I answer the research questions above focusing on how the findings speak back to my concern of how to teach pre-service teachers content for understanding and for teaching. I present this concluding chapter in four sections. In section one; I present my revised conceptual framework as the framework knits my conclusion into one piece. In section two, I answer my first research question. In section three, I answer my second research question and in section four, I answer my third and fourth research questions. In addition, I present some methodological findings and suggest possibilities for future research. Lastly, I reflect on my PhD study.

8.2 My conceptual framework

8.2.1 My initial conceptual framework

I described and explained my initial framework in chapter 2. The framework is shown again in Figure 43 below.

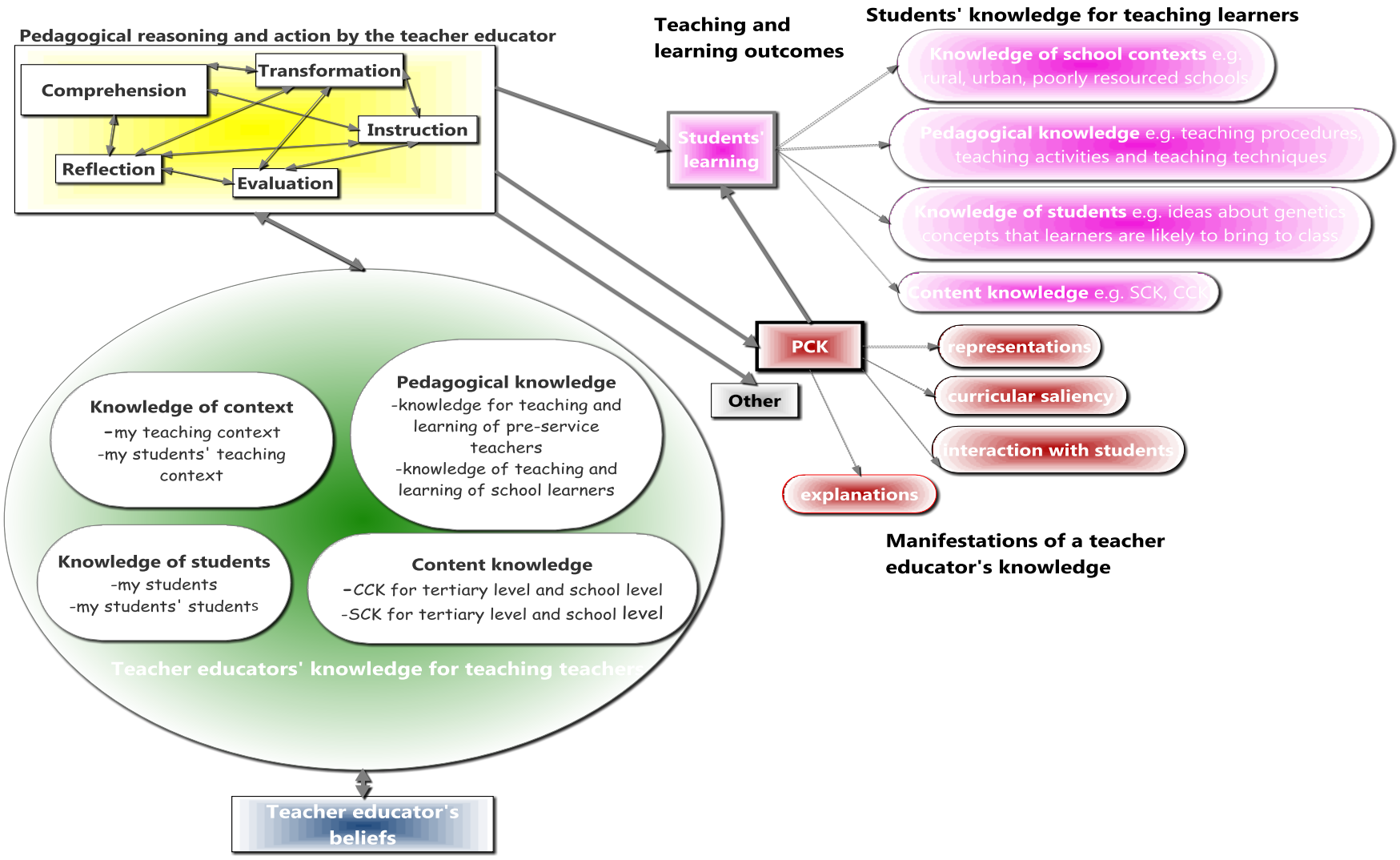


Figure 43: My initial conceptual framework for the study

My framework in Figure 43 above indicates what teacher educators bring to the classroom (beliefs about teaching and learning - blue) and the forms of knowledge teacher educators should have and should bring to the classroom (knowledge of context, knowledge of students, pedagogical knowledge and knowledge of content - green). The framework also shows that teacher educators carry out various pedagogical reasoning and action processes before, during and after the teaching process (yellow). After the teaching process, there are teaching and learning outcomes. The outcomes include pre-service teachers' learning outcomes (shown in pink) and teaching outcomes in the form of manifestations of a teacher educator's knowledge which I take to be indicators of PCK shown in red. There may be other outcomes other than students' learning and indicators of a teacher educator's PCK. These possible outcomes are represented as other outcomes in grey in Figure 43 above.

8.2.2 My revised conceptual framework

The analysis of students' interviews showed me that third and fourth year students bring many forms of prior knowledge from their previous learning and from the apprenticeship of observation which includes knowledge of school contexts, knowledge of school learners and pedagogical knowledge in addition to knowledge of content, misconceptions and misunderstandings. This knowledge about students' prior knowledge informed the revision of my initial conceptual framework on the teaching and learning of pre-service teachers. The new framework is shown in Figure 44 below.

Explanation of the revised conceptual framework

I used the same colours that I used in the initial framework to show what I have retained from the initial framework. Everything in a red outline is therefore new in the framework. In my explanation of the revised framework, I used horizontal lines in the colours that correspond to the colours that I used for the different components in the framework diagram as a way of signposting back to the components.

> As explained in chapter 2, teacher educators bring their beliefs about teaching and learning to the classroom. The revised framework in Figure 43 shows that it's not just the teacher educators who bring beliefs about teaching and learning to the classroom but both teacher educators and students.

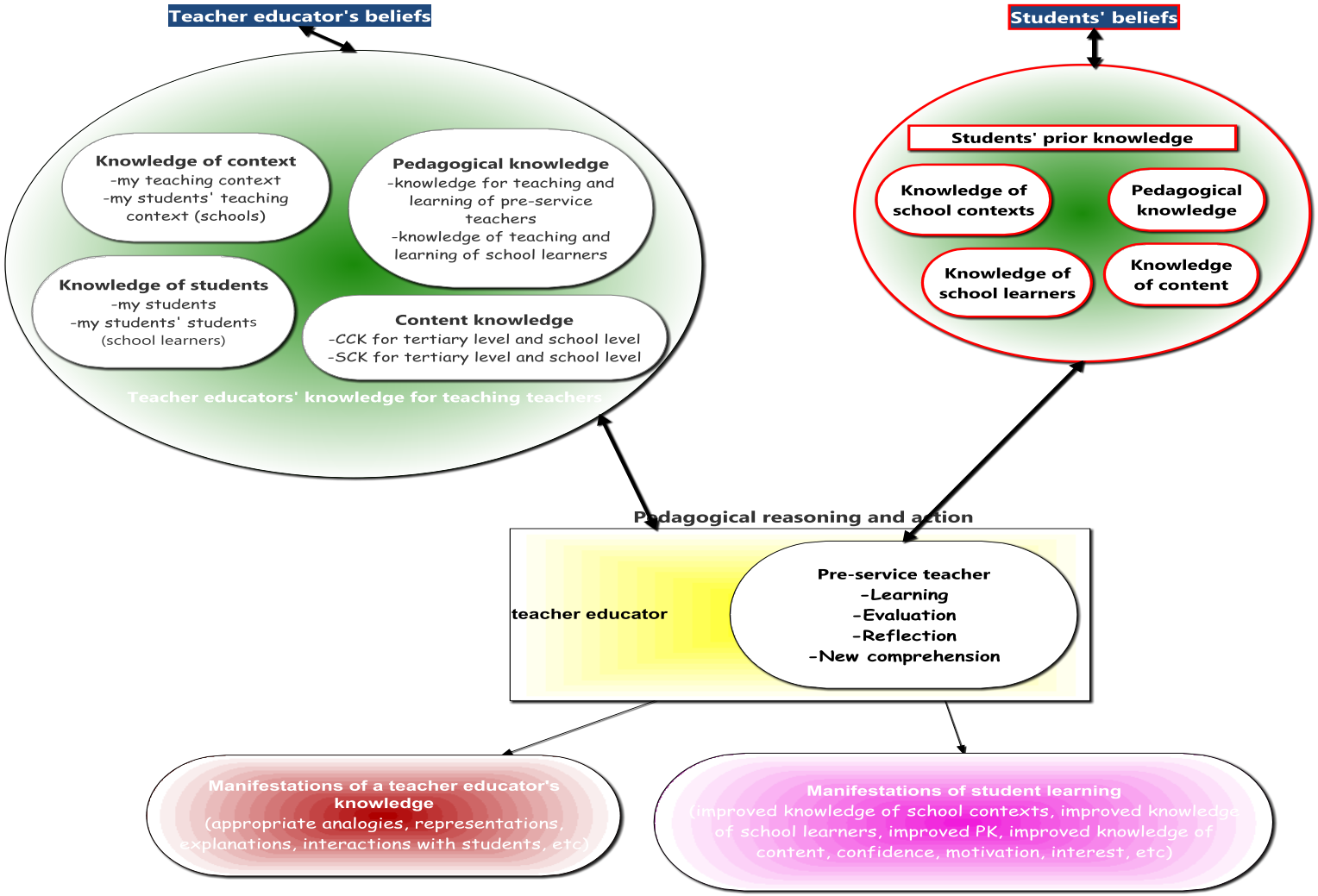


Figure 44: The revised conceptual framework for the teaching and learning of pre-service teachers

My initial framework showed that teacher educators bring or should bring knowledge of their context and of their students' contexts, knowledge of students and of their students' students, knowledge of PK for HE and PK for school teaching and lastly, knowledge of content for HE and for school level. The revised framework shows that students also bring to the classroom the second level knowledge domains; knowledge of school contexts, knowledge of learners, PK for school teaching, and knowledge of content that they have accumulated over the years from the apprenticeship of observation. Students' knowledge about content may include misconceptions and misunderstandings.

The knowledge that teacher educators bring to the teaching and learning situation influences the pedagogical reasoning that occurs before and during the teaching and learning process. The knowledge that students bring to the teaching and learning process influences their learning. During the teaching and learning process, students, just as with the teacher educators, also reason pedagogically about the teaching that they experience. The students do not however go through the full cycle of pedagogical reasoning and action which includes transformation of content and instruction. Hence the pedagogical reasoning that they do is only a subset (shown in white) of the pedagogical reasoning and action that is carried out by their teacher educators (yellow). The subset includes evaluation of the teaching process, reflection on the teaching and learning process and development of a new comprehension.

One of the outcomes of the pedagogical reasoning and action process is the manifestations of a teacher educator's knowledge. The manifestations of teacher educators' knowledge include explanations, representations, interactions with the students and use of appropriate analogies. These manifestations can be viewed as indicators of a teacher educator's PCK.

The other outcome is students' learning. Students' learning is expected to result in improved knowledge of context, improved knowledge of school learners, improved PK, improved content knowledge, motivation, enthusiasm and interest in students.

The double arrows from the knowledge domains to the pedagogical reasoning and action block show that the pedagogical reasoning and action that occurs during the teaching and learning process brings about a new comprehension which feeds back to the knowledge that both teacher educators and students bring to the teaching and learning process thereby modifying that knowledge. For example, during my teaching, I got to know more about how students learn. That new understanding increased my knowledge of students. One student, Chipo said she got to learn about the resources she can potentially use in poorly resourced

schools such as charts and pictures and this knowledge added back to her initial PK. The double arrows from teacher educators' and students' beliefs blocks to the knowledge domains shows that when the knowledge domains get modified, their modification feeds back to the beliefs reshaping them. My belief about the 'universal' effectiveness of group discussions during lectures changed when I found out that some students for example Dylan preferred to go over what they had learnt in silence during brief lecture intervals instead of discussing it with others. Nyasha was of the belief that as teacher educators we don't need to read anymore, the knowledge that we need to teach students is now in our heads. While I cannot confirm if that belief had changed at the end of the course, I am hopeful that the conversation that I had with him explaining why we need to continuously read (see trigger incident number six in chapter five) reshaped his beliefs. The arrows going out of the framework show possible outcomes. The left arrow points to the possible teaching outcomes; manifestations of teacher educators' PCK and the right arrow shows the possible learning outcomes; improved knowledge as listed in the previous paragraph. This conceptual framework represents what I came to understand from this study as what happens in the teaching and learning of pre-service teachers.

8.3: The knowledge that a teacher educator should have in order to effectively teach a content course to pre-service teachers

Although in this study, I looked at my teaching of genetics which is a content course to pre-service teachers, my conclusions and recommendations go beyond the teaching of genetics to the teaching of any content course to pre-service teachers. In preparation for teaching the genetics course, I first developed a course outline for the genetics course and planned the content for each topic. I described this process in detail in chapter 4. In the process of developing the course outline and planning for teaching, I gained not only the **content** knowledge for teaching genetics to pre-service but also knowledge of my **context** and **pedagogical** knowledge and how to develop **knowledge of students.** As indicated in my conceptual framework above, these are the four domains of knowledge that teacher educators should have in order to effectively teach not only genetics but any course. I discuss these knowledge domains below. The discussion will be presented under the following headings:

- Knowledge required for teaching genetics, a content course to pre-service teachers
- Knowledge about my other roles and responsibilities as a teacher educator
- Insights about induction of BTEs and PD in HEIs

- Framework for the induction and professional development of BTE and of new lecturers at HEIs

8.3.1 Knowledge for teaching genetics, a content course to pre-service teachers

According to the PCK literature, a teacher must possess four domains of knowledge as a basis for effective teaching (Rollnick et al., 2008). These knowledge domains are knowledge of context, knowledge of students, general pedagogical knowledge and knowledge of content. From this study, I have come to understand that in order to effectively teach genetics, a content course to pre-service teachers, teacher educators must also have the above four domains of teacher knowledge but at two levels. These knowledge levels are presented in Table 13 below.

Table 13: Knowledge domains required by teacher educators for teaching pre-service teachers

Knowledge domain	Domain level and explanation
Knowledge of context	Teacher educators' context (the institutions where the teacher educators teach)
	Students' future contexts (Schools where students will teach)
Knowledge of students	Teacher educators' students (pre-service teachers)
	Students' students (learners in schools)
Pedagogical Knowledge (PK)	PK for teaching pre-service teachers
	PK for teaching school learners
Knowledge of content	Content for teaching students at tertiary level
	Content for teaching at school level

Having the knowledge domains shown in Table 13 would enable teacher educators to fulfil their dual roles as described by Garbett (2012) of teaching content for understanding and at the same time developing in the pre-service teachers the competency and skills for teaching that content. By planning my teaching of the genetics course using the above domains of a teacher educator's knowledge as the guiding template, I gained knowledge for my practice as a teacher educator. I will discuss the knowledge that I gained using the four domains of knowledge as subheadings.

Knowledge of context

According to Rollnick et al. (2008), context includes all factors that influence the teaching situation such as resource availability, class size, students' backgrounds and curriculum. As a member of staff who had been at the institution for six years, I was aware of the resources

that we have, the size of our classes and the backgrounds of our student body (academic, cultural and linguistic). I however did not know our overall B.Ed. curriculum which is an important part of my context. Knowledge of the B.Ed. curriculum is important as it helps us as teacher educators to answer the question: What am I teaching this material for? I only knew the curriculum for the courses I was responsible for teaching. Knowledge of the courses that I was teaching was not enough to answer the above question. Therefore, I looked for the documents that would give me the information about our B.Ed. programme. I got a document that outlines the aims and objectives of our B.Ed. programme titled: *A Vision for a B.Ed Graduate: what kind of teachers for South Africa do we want to produce at Wits?* From the document, I did not only gain knowledge of our B.Ed. curriculum but also knowledge of the kind of teacher that we want to produce from our programme. Knowledge of the overall B.Ed. curriculum gave me insights into the kind of content knowledge third and fourth year students are likely to bring to the genetics class. As part of knowing my context, I also got to know the whole Life Sciences programme in terms of the content that is taught in each of the four years of the B.Ed. programme. This knowledge about our B.Ed. programme developed confidence in me because I was now in a position to prepare materials for teaching that would enable me to answer the curriculum question: What am I teaching this material for? I now know the Life Sciences content that students are taught before the genetics course and after the genetics course and this knowledge is important when you are planning your own courses. Previously, the content of genetics I had been teaching was the content that had been given to me when I became a teacher educator and if I had been asked why I was teaching that content in the manner I was teaching it, I would not have been able to answer the question. It is clear from what I have presented above that my own induction as a teacher educator was inadequate and poorly done.

Knowledge of students

Knowledge of students includes knowledge of students' prior knowledge, their learning styles, linguistic abilities and interests and aspirations (Rollnick et al., 2008). Knowledge of students also includes knowledge of students' cultural and schooling backgrounds. In this study, knowledge of students' prior knowledge included the knowledge of pre-conceptions and misconceptions about genetic phenomena, the knowledge gained from having done high school biology and the knowledge gained in the first two or three years of university learning. I had knowledge of some of the pre-conceptions and misconceptions that students are likely to bring to class from my experiences as a high school teacher and teacher educator. I however gained a lot more of these prior ideas from literature. Therefore,

research literature can be a source of important knowledge for teaching such as students' prior knowledge.

To be familiar with the knowledge students are likely to have from their high school learning, I read the CAPS document and the IEB syllabus which are the two national school syllabuses in South Africa. I also read the "O" and "A" Cambridge Examination Syndicate syllabuses and the US Atlas of Science Literacy maps. The reading of these documents widened my knowledge of the genetics knowledge students are likely to bring to tertiary institutions from high schools and also the genetics content knowledge they are likely to teach after their training at both national and international level. As for the knowledge that students were bringing from their first two or three years of university learning, I was already familiar with the curriculum as described in the earlier section. Therefore, I was now aware of the knowledge students were bringing to the genetics course from their other courses. For example, from their education courses, students were bringing knowledge about learning theories and from methodology courses they were bringing pedagogical knowledge.

Knowing students also includes knowing individual students' learning styles. Knowing individual students' learning styles before teaching them is not possible and knowing them when teaching big groups is difficult. Therefore, instead of trying to learn about individual students' learning styles, I decided to consolidate my knowledge of teaching and learning styles using literature so that I could vary my teaching styles as a way of catering for a variety of students' learning styles. Note that I again used literature to improve my knowledge for teaching big classes. I then had to think deeply of ways of achieving a variety of learning styles in my teaching. This is one of the points where I employed metacognition and consulted colleagues (see the next section). I had to think deeply about the concepts I was going to teach and how I could teach those concepts in different ways within one lecture.

Pedagogical knowledge

I read literature, consulted colleagues and surfed the internet for teaching ideas that would be effective for teaching genetics to pre-service teachers. I also utilized my prior experiences of teaching and practiced metacognition to come up with novel teaching ideas. Some of the teaching ideas were generic to the teaching of science and others were specific to genetics. The novel teaching ideas that I came up with include the use of the string analogy to explain the relationships between DNA, genes and chromosomes and the use of the concept of packaging to explain why DNA folds into chromatin and into chromosomes. I described in

detail in chapter 4, the teaching methods that I developed and used in my teaching. Below I discuss some of the sources of the teaching ideas that I used in my teaching.

***Literature as a source of teaching ideas*:** This thesis demonstrates the effectiveness and importance of keeping track of and using researched knowledge in the teaching of genetics. I got lots of ideas about teaching from reading research literature; ideas such as storytelling, role-playing and use of questions. When I was reading the literature, I did not randomly pick the teaching methods. I used my knowledge of context and my knowledge of students to decide on the methods that would be appropriate and effective. Reference to the use of stories in the literature helped me to see that we are always telling stories in our teaching of science; stories of many discoveries of science such as the story of Mendel. According to Taylor however, students find it difficult to relate to these stories because they are all about 'dead white males' (personal communication). In this study therefore, I decided that a story similar to Mendel's story about pea seeds and the concept of inheritance would be appropriate for introducing the topic of inheritance. I then created my own story to introduce Mendelian inheritance in place of Mendel's story (section 4.6.5). Through the use of my own story, I was then able to take care of the "dead white males" issue by showing students that what is described in Mendel's work is not far removed from our own present day experiences. Students were captivated by the story. They listened. They asked questions and participated in the discussion that followed showing that story telling can be a good way to facilitate a discussion.

Just as with story-telling, I chose to use role-playing as the literature that I read had shown that role-playing was an effective way of actively involving students. Even those students who had shown anxiety during lectures due to their poor English communicative competency participated in the role-playing activities without showing similar anxiety.

From research literature, I also gained knowledge of what makes genetics difficult to teach and learn. This knowledge informed my planning on how to teach various genetics concepts. Research literature is therefore, a good source of pedagogical knowledge that teacher educators can use to improve their own practice.

Colleagues as sources of teaching ideas: In this study, I employed the novel method of involving colleagues in conversation about teaching genetics concepts. Conversations with colleagues were therefore an on-going process during my teaching of genetics. I asked colleagues questions regarding the teaching of some difficult concepts that I taught in the

genetics course. From these conversations with colleagues, I came to know that colleagues especially experienced colleagues have a wealth of teaching ideas that can be shared for the benefit of both other colleagues and BTEs and ultimately for the benefit of pre-service teachers. Unless we consult and converse with each other within our institutions and departments, effective teaching ideas will remain with individuals who will eventually resign or retire with them. The challenge is how to encourage conversations and consultation among colleagues. Below are some suggestions on how to encourage colleagues to share teaching ideas. Members of staff can be encouraged to share teaching ideas in formal or informal platforms.

Formal arrangements: Teaching and learning seminars where members of staff take turns to present teaching ideas that they have found to work in their own teaching.

Informal arrangements: One possible platform is a blog in which members of a subject or discipline are invited to share their teaching ideas and experiences. The purpose of the blog is made clear; to improve our teaching by sharing ideas that we have found to be useful and effective in our own teaching. Another possible platform could be digital presentations where members of staff prepare 5-10 minute digital presentations in the form of video clips, pictures and stories. These presentations are shown on the screen in a place like a staff lounge, tea or coffee room where members go to on a daily basis. Members of staff can then watch those short presentations as they take a tea or coffee break.

Knowledge of content

Knowledge of content in this study referred to the knowledge of the genetics content that was appropriate for teaching pre-service teachers. To make sure that I had adequate knowledge that pre-service teachers would need for teaching, I extensively read the literature on genetics teaching and learning. From that extensive review of literature, I added two genetics models; the **cellular** model and the **mitotic** model to the three models I found in the literature (the molecular model, the meiotic model and the inheritance model), as essential core knowledge models in genetics teaching and learning. I also added **partial/incomplete** dominance to the four groups of inheritance pattern problems (complete dominance, codominance, multiple allelic and sex-linked) as the fifth group of inheritance patterns problems. From an extensive review of literature, I gained SCK for example knowledge of what makes certain genetics concepts difficult to teach and to learn.

In addition to consulting literature, I also consulted a number of syllabi: CAPS document, IEB and Cambridge syllabi and the US Atlas of Science Literacy. By going through these documents, I became familiar with the CCK that students would need for teaching. Therefore, national curricular documents and curricular documents from elsewhere such as the US Atlas of Science Literacy maps are sources of information a teacher educator can use to decide on the content to cover in a course and research literature is a rich source of SCK.

8.3.2 Insights into my other roles and responsibilities as a teacher educator

By developing my own course outline, I became aware of my other roles and responsibilities as a teacher educator beyond my teaching role. I got to learn that teaching was only one of my many roles and responsibilities. As a teacher educator, I was also responsible for the development of the curriculum, for continuously evaluating the curriculum in the light of the needs of our students and our country and also to solve curriculum problems. I became aware of these responsibilities because in the process of developing the genetics course outline, I identified content gaps in our curriculum. I had therefore done some curriculum evaluation. When I brought these content gaps to my colleagues, it was suggested that we needed to meet regularly to discuss those curriculum problems. These meetings are now an established routine. As Life Sciences lecturers we meet once a month to discuss curriculum issues. Through these meetings, we have developed a new Life Sciences curriculum in which the content gaps that I had identified were taken care of. It was from this curriculum development exercise that I learnt that as a teacher educator, I am also responsible for the development of the curriculum and for solving any curriculum issues that may arise. I have therefore developed an understanding that a course outline is a very valuable document especially for BTEs. However, its importance seems to be undervalued; otherwise, there would be guidelines that teacher educators can use to develop course outlines that can effectively inform what they teach.

8.3.3 Insights about induction of BTEs and PD in HEIs

This thesis confirms what has been argued about by many researchers that there is a need for induction of BTE and for PD programmes at HEIs (e.g. Chetty & Lubben, 2010; Murray, 2005a). When I embarked on this study, I had been a teacher educator for six years but even after these six years as a teacher educator, I still had not developed adequate knowledge required for effectively teaching pre-service teachers. This finding is in agreement with the findings from the study by Dinkelman et al. (2006) which show that,

because of a lack of induction or training structures in HEIs, it takes many teacher educators who are appointed to teacher education straight from being classroom teachers up to five years to develop the knowledge, skills and expertise required in teacher education. Research also shows that learning to teach by themselves is a typical scenario for many BTEs (Berry, 2004). In this study I confirmed the knowledge that BTEs can learn to teach by themselves using the methodology of self-study by successfully demonstrating my identity transition from being a conventional teacher to being a teacher educator in terms of skills, roles and responsibilities.

From this study, I demonstrated that guided planning of one's courses can facilitate the induction and professional development of BTEs. The planning that I did in preparation for teaching the genetics course helped me to become aware of and to develop the knowledge, skills and expertise that I need for teaching the genetics course to pre-service teachers. Therefore, having used the four domains of a teacher educator's knowledge to identify the knowledge that I had and to identify the knowledge that I needed to have as a teacher educator, I am of the idea that these four domains of knowledge can be used in the induction and professional development (PD) of BTEs to help them to identify the knowledge that they have and the knowledge that they need to have then use that information to plan induction and PD activities that will help the BTEs to develop the new knowledge and skills required for teacher education. The planning of the induction and PD activities can be done as individual inquiry or action research or as is the case in this study, through a self-study. What I have found to be powerful in using the four domains of teacher knowledge for induction and PD is that it caters for context specific, personal and dynamic nature of teacher educators' work. The four domains of a teacher educator's knowledge can also be developed for use in workshops as a framework for the induction and professional development of teacher educators who are new at an institution.

How the framework can be used

Knowledge of context: As argued in chapter four, BTEs must have knowledge of their new context and of the school contexts where their students will teach after qualification. The framework will guide individuals or facilitators of induction workshops as to what the BTEs need to know about their new context. Some of the factors that BTEs would need to know about their new context will include resources available, the size of classes, students' academic, linguistic, cultural and socio-economic backgrounds. If the BTEs will be coming from being classroom teachers, they will be familiar with some school contexts. However, they may not know about all school contexts i.e. rural schools, urban schools, township

schools, private schools, well-resourced schools and poorly resourced schools. Therefore, some form of induction workshops in which BTE are familiarised with the contextual factors of various school types will help them to develop knowledge of those school contexts. Literature and Departments of Education can also be sources of such information.

Knowledge of students: Knowledge of one's students is important for effective teaching to occur. Knowledge of students includes knowledge of students' prior knowledge, their learning styles, linguistic abilities and interests and aspirations (Rollnick et al., 2008). Most of the aspects under knowledge of students are difficult to know about outside the teaching contexts. However, BTE can benefit if they can be given ideas on how to develop their knowledge of students. In this study, I used a variety of questionnaires to get to know about my students. The first questionnaire was a biographical questionnaire which gave me information on students' academic backgrounds and linguistic abilities. The biographical questionnaire can be expanded to also provide information about students' interests and aspirations. The biographical questionnaire doesn't have to be filled in by every teacher educator. It can be done at departmental level or even school level. Then the BTE will just be provided with the information for the students in his or her class. The other questionnaires were pre-tests on each of the genetics topics that I taught. The completion of these pre-tests gave me insights into students' prior knowledge about the genetics topics. While I did the pre-testing and post-testing for my own purposes, students also benefited by becoming aware of the knowledge they had before the course and the knowledge they had gained from the course. Margie had this to say about the pre- and post-tests.

Margie: I remember the first lecture that we had she gave us that survey thing…ja… and now she ended off with the same survey, so at least now we also see, "okay, I couldn't answer this question before and now I can". So it helps us to see now, "okay, I'm walking away with more knowledge".

Knowledge of students' prior knowledge also includes knowledge of misunderstandings and misconceptions that students are likely to bring to class about a topic. That kind of knowledge can also be obtained from literature and BTEs need to be made aware of the importance of research literature in this regard.

Pedagogical knowledge: A BTE needs to know that teacher educators have a dual role: teaching for developing an understanding of content and for developing competencies for

teaching that content (Garbett, 2012). New teacher educators need PD on how to achieve that dual role. This study confirmed the suggestion by Loughran (2006) that one way of achieving the dual role of a teacher educator is by modelling good teaching i.e. demonstrating good teaching practices in one's teaching from which students are expected to learn. My thesis further extends the knowledge of modelling good teaching by demonstrating how to successfully apply the concept to the teaching of genetics, a content course to pre-service teachers. The assumption here is that BTEs would have ideas on what good teaching entails. Literature is a rich source of teaching ideas that can be adapted for teaching in a variety of contexts.

Knowledge of content: Shulman (1986) described content knowledge as defined by three distinguishable categories namely subject matter content knowledge, pedagogical content knowledge and curricular knowledge. These categories of content knowledge were described in detail in section 2.3. My assumption here is that BTEs are appointed on the basis of having qualifications that gave them subject matter content knowledge for teaching at least at undergraduate level. If BTEs only have qualifications for teaching undergraduates, then part of their PD should be to enrol for a higher qualification. To be able to teach content however, the BTEs will also need knowledge of both the vertical curriculum and the lateral curriculum (Shulman, 1986). BTEs can develop this knowledge if they can be provided with the documents such as the institution's rules and syllabuses booklet and course outlines. As for PCK, the knowledge of the four domains of knowledge that I have described above will form the basis for the development of BTEs' PCK. What will be left will be for the BTEs to have mentors who will observe their lectures with the aim of giving them constructive feedback. The mentors should also help the BTEs on how to interpret the syllabus descriptions and to develop their own course outline. I however have to acknowledge that the issue of helping BTEs on how to develop course outlines is a contentious issue as I have not come across any guidelines in the literature or at my institution on how to develop course outlines. Most people just adopt or adapt previous course outlines (personal communication). I however want to highlight that there are lots of benefits for BTEs if they can go through the process of developing their own course outlines. In this study, when I went through the process of designing a course outline which included a critique of the course outline by colleagues, I became aware that teaching is just one of my many responsibilities. I have many other roles and responsibilities beyond teaching (which I was not aware of) which include designing of the curriculum, evaluation of the curriculum and also solving of curriculum problems. Therefore, going through the process of developing a course outline for one's course, may not only help BTEs to become aware of the content

knowledge they need to teach and why they have to teach it but may also expose BTEs to their other roles and responsibilities as teacher educators.

As highlighted in chapter four, having the course outline critiqued by colleagues has other benefits beyond induction and PD. When our course outlines are critiqued by colleagues, we avoid situations where individuals would choose content that they are comfortable to teach or content that interests them and leave out important content. Involving colleagues also ensures that all members of a subject become aware of the content that is taught in other courses; the vertical curriculum (see chapter 2 section 2.6.2). This will prevent situations where content is repeated or left out.

The framework that I have described above is represented in Table 14 below. The framework focuses on the induction and PD of new teacher educators and BTEs in a faculty or school of education.

Table 14: Framework for induction of BTE and for the PD of new lecturers*

Knowledge required	**Content for the domains** (lists not exhaustive)	**Methods**	**Resources**
Knowledge of context	Structure of the faculty where the BTE or lecturer belongs School structure Department structure The curriculum and its broad aims Class sizes Available resources e.g. audio visual equipment, printing facilities etc	Workshops	-Senior Faculty members -Booklets with the relevant information -Appointed mentors
Knowledge of students	Socio-economic backgrounds, linguistic abilities, academic backgrounds, their prior knowledge of specific subjects and courses etc.	-Presentations by the Teaching and Learning committee -Individual enquiry	-Biographical questionnaires filled in by the students -Pre-tests
Pedagogical knowledge	Ideas on ways of teaching pre-service teachers	-Workshops -Mentorship -Action or self-study research	
Knowledge of content	Content for relevant courses	Individual agency Mentorship	University's syllabus booklets Previous course outlines Research literature and relevant books

* For the induction and PD activities to be effective, time for these activities should be factored into the BTEs' workloads

8.4 How my practice as a teacher educator transformed as I examined and reflected on my teaching of genetics to pre-service teachers

In section two above, I described what I should know as a teacher educator in order to effectively teach a content course to pre-service teachers and how the knowledge that I gained can be utilized as a basis for induction and PD of BTEs. In this section, I articulate how my practice was transformed by examining and reflecting on my teaching of the genetics course to pre-service teachers. I present the discussion under the following two headings:

- The power of "noticing" and a caring attitude towards students
- Constructivism as an overall approach to my teaching

8.4.1 The power of noticing and a caring attitude towards students

In a teaching situation, things happen that activate one's sensitivities (thoughts, feelings and emotions) what Mason (2002) described as noticing. The more we respond to those sensitivities, the more we are able to notice what happens in our classrooms. Ability to notice and to respond to what happens in our classrooms is an effective way of showing students that we care about them. In chapter five, I described the changes that activated my sensitivities during my teaching as trigger incidents. Noticing the trigger incidents, examining them and reflecting on them with critical friends became a basis for learning about the power of a caring attitude in a teaching and learning situation and how we can show students that we care about them. A caring attitude positively impacted students' attitude towards me as their lecturer and everything that was happening in the course which in turn promoted lecture attendance, participation and learning. By examining and reflecting on the trigger incidents, I became sensitized to some subtle 'things' that happen in my teaching of pre-service teachers that I then identified with the help of my critical friend as aspects of caring. I discuss these subtle things below.

The **first** subtle feature was the realization that students do have different learning styles and that they may switch off during the use of teaching styles that are not aligned to their learning styles. I therefore now make an effort in my teaching to use teaching styles that cater for a wide range of learning styles and to accommodate students when I am using teaching styles that do not correspond to their own learning styles. For example, I prepare a variety of tasks that cater for different learning styles; modelling genetics phenomena, oral presentations and written questions that they need to respond to.

The **second** subtle feature is that during teaching, students' short memory can get overloaded and if I do not allow for processing and transfer to long term memory, students may switch off and start day-dreaming (Bligh, 1998). Therefore, it is important to allow short intervals of processing the new information and transferring it to long-term memory. Processing of new information can be achieved by asking students to discuss, to draw, to summarise or think in silence about the content learnt. I now deliberately include short intervals in my lectures during which I allow for processing and transfer of information to long term memory by asking students to discuss, to think in silence, to draw or to summarise.

The **third** feature is the anxiety that some students experience as a result of their poor English proficiency which is the language of instruction and the fear that their peers will see them as mediocre if they give wrong answers during lectures. One way to help such students to overcome their fear is to give them tasks that help them to prepare for lectures, tutorials and practicals in advance. The use of a quiz show also helped students in this study to participate without anxiety.

The **fourth** feature is that a trusting relationship between a teacher educator and the students matters in teaching. In this study, by developing trust, students developed confidence in what I was teaching them, believing that it was relevant which then motivated them to learn. Just as affirmed by Loughran (2006), trust also motivated students to come forward with issues and questions knowing that I would take them seriously.

The **fifth** feature is that there is more than one interpretation to students' behaviour. Responding to students' behaviour by going to the student to investigate what is happening instead of reasoning and interpreting the student's bahaviour from a distance is a form of student centeredness that enables a teacher educator to know students better. When as a teacher educator you get to know students individually, you are able to respond appropriately to their needs

The **sixth** feature is that seeing students as individuals is caring for them and caring for students is a form of student centredness. Caring for students can be achieved by (among other things) knowing the students by name and noticing their performance. Noticing a student's good performance and acknowledging it is likely to motivate students to keep working in order to maintain that performance. Likewise, noticing poor performance and talking about it with the student is also likely to motivate the student to work towards improving that performance. As discussed in the paragraph above, caring for students can

also be achieved by learning to notice their behaviours and appropriately responding to those behaviours.

8.4.2 Constructivism as an overall approach to my teaching

The basic tenets of the learning theory of constructivism are that individuals learn by building on what they already know. Before embarking on this study, I was aware of this basic tenet of constructivism but I was not aware that it is the one that drives my teaching. A reflection on trigger incident one (see chapter 5) with the help of a critical friend was the catalyst that helped me to understand what I was doing in my teaching. An analysis of my teaching in chapter six then confirmed that I was implicitly using the theory of constructivism. What is powerful about this discovery is that I have been able to formulate my teaching philosophy as I was now clear on what my approach to teaching is. With a clear statement of my teaching approaches, I now find it very easy to formulate goals and objectives when planning my lectures and to remain connected to those goals during my teaching. My teaching is now deliberate as I know exactly what I am doing and why. I now have clear personal standards, personal pedagogies and personal ways of self-expression. All these aspects make me to enjoy my teaching.

8.5 Students' experiences of my teaching and lessons learnt

8.5.1 Students' experiences of my teaching

My analysis of students' interviews showed that students' experiences came from almost every aspect of my teaching practice: what happened before the lectures (planning, preparation and pedagogical reasoning), what happened during the lectures, in practicals and in tutorials (the physical happenings like use of T/L aids and the behavioural aspects of my practice e.g. punctuality and enthusiasm) and what happened at a distance (e-learning).

The first aspect of my teaching that was reflected in students' experiences was the teaching phenomena that they encountered in my teaching (the encountered teaching phenomena). Students used their senses to capture whatever they saw, heard and touched in the teaching and learning environment. The second aspect that came out of analyzing students' experiences is that students did not passively receive and store what was captured by their senses during the teaching and learning process; they processed the information resulting in the generation of cognitive, affective and conative experiences. Below I propose how

students' experiences are generated and how that knowledge can be used to improve our teaching of content courses.

How students' experiences are generated

The first aspect that contributed to the generation of students' experiences was the **context**. The context here refers to the teaching and learning environment which was my teaching environment. The second aspect was the capturing of the teaching phenomena through students' **senses** (mainly the eyes and the ears). What happened in the context (the encountered teaching phenomena) was captured by students' senses. The third aspect that contributed to the generation of students' experiences was **mentation.** I took this word straight from thesaurus as the definition given captures what I mean; the process of using your mind to consider something carefully. Students used their minds to process what was captured by their senses in the teaching situation. Mentation was influenced by students' **beliefs** (fourth aspect) about teaching and learning, their **prior knowledge** (fifth aspect) about teaching and learning and their **identity** (sixth aspect). Students' beliefs about teaching and learning include how they think they should be taught as pre-service teachers or at HE institutions and prior knowledge refers to students' knowledge of school contexts, of school learners, PK and knowledge of content as shown in the conceptual framework. Identity refers to what students see themselves as when they are in the context i.e. do they see themselves as learners, as third year students or as teachers. The six aspects described above interact to generate students' experiences of the teaching and learning process. Figure 45 is a diagrammatic representation of how I think students' experiences were generated.

Students' experiences included cognitive experiences, affective experiences, conative experiences and feelings of self-esteem. Students' cognitive experiences comprised what students thought were the purposes of the encountered teaching phenomena and their evaluations of the encountered teaching phenomena. For example, Agnes viewed the purpose of using **T/L aids** as to provide them with concrete examples of phenomena under discussion. For Placki, the purpose of **visual aids** was to help students to visualise and to picture the phenomena being described and Munya reasoned that the purpose of **planning** was to enable a teacher to clarify any misconceptions or challenges during teaching.

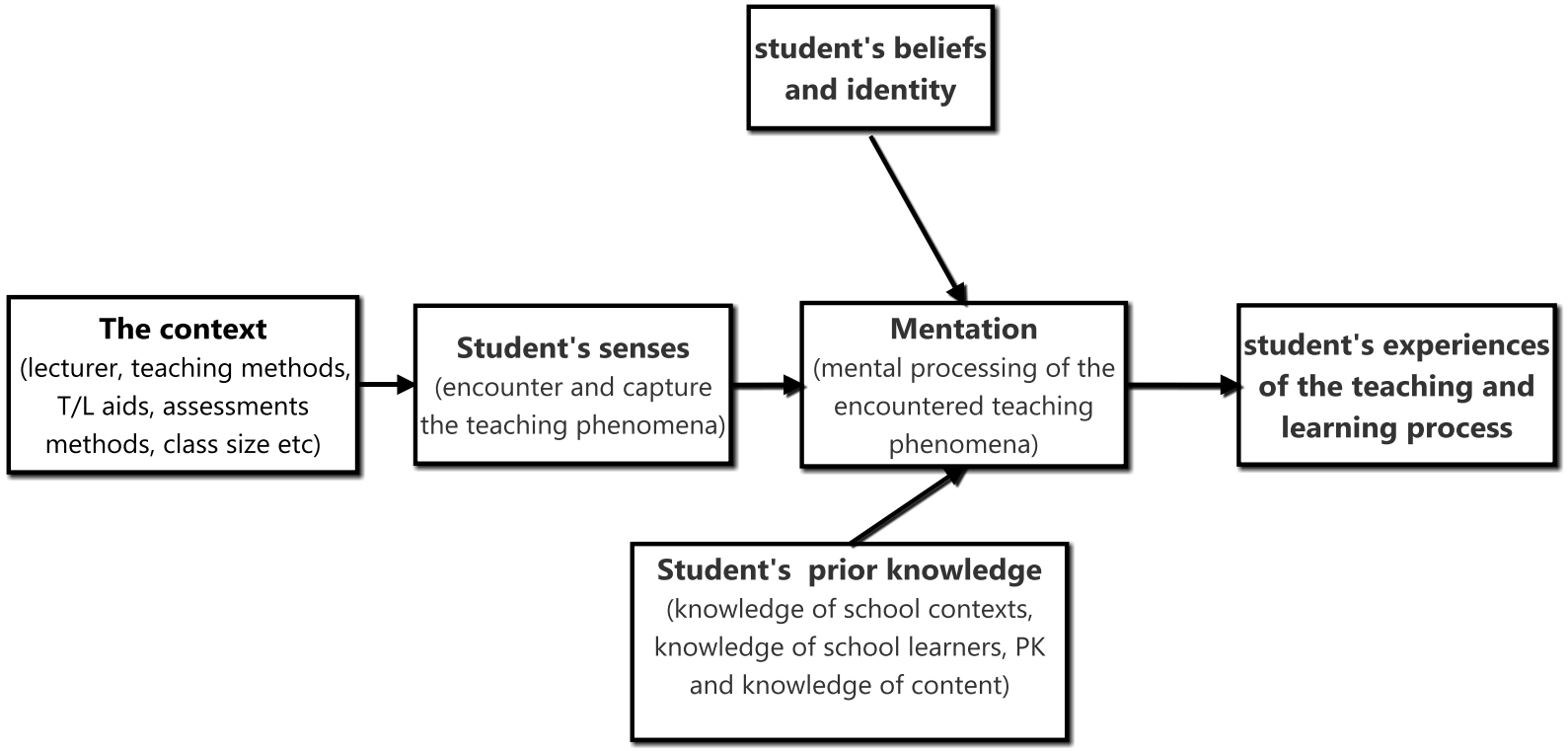


Figure 45: How students' experiences are generated[18]

[18] I got the ideas on how to structure the model in Figure 5 fromProsser and Trigwell (1999)

Agnes evaluated the Reebop activity and evaluated the thinking behind the activity as good but found the actual activity as inappropriate for a third year student. The affective experiences included feelings of enjoyment. Margie said she liked the T/L aids and Percy liked the pop quiz and the flash cards. Naison experienced feelings of wonder. He was amazed by the way I was delivering my lectures; the confidence, the enthusiasm and organization. Many students experienced germane feelings; feelings that what they were learning about content, and about teaching, was personally relevant to them as future teachers. Students also experienced salient feelings such as feeling that the information they were getting was important to them as future teachers and as individuals. Conative experiences manifested when students could describe the practical usefulness of what they had experienced. Chipo for example expressed that the resources that I used exposed them to the resources that they will be able to use in future even in poorly resourced schools such as charts and pictures. Self-esteem manifested when students could describe with confidence what they felt they would be able to do in future as teachers.

8.5.2 How the knowledge about students' experiences can be used to improve our teaching of content courses

As explained above, students' experiences are shaped by the context, the identity that students take on during the teaching and learning process, students' beliefs and their prior knowledge. Taylor (2013), identified context and identity as some of the aspects that influenced the kind of teachers early career physical sciences teachers in her study became after qualification. For three of those early career teachers however, their experiences in the teacher education programme were the core contributors to who they became as teachers. Therefore, what we do in our teaching can generate defining experiences that shape our students' future identities as teachers. We should therefore take advantage of our positions of responsibility as teacher educators and privileged spaces in the classroom to generate experiences that are core to producing the kind of teachers that we wish for in our schools. Below are some suggestions on how as teacher educators we can promote the generation of positive experiences about teaching and learning in our pre-service teachers.

Suggestions on how to promote positive experiences about teaching and learning in our pre-service teachers

I present my suggestions in form of a list of statements. I formulated these statements from the themes that came out of the analysis of students' interviews that I presented in chapter seven. The themes and statements are presented in Table 15 below. Note that the themes and statements are not presented in any order of importance.

Table 15: Suggestions for promoting positive teaching and learning experiences in our students

Theme	Identified component from the theme	Suggestion: Show pre-service teachers that we care about them by
Pre-service teachers are motivated to attend lectures and to learn when teaching practices and the content of a course bring personal relevance to them as students and as future teachers	**Personal relevance**	Presenting content and using teaching practices that bring personal relevance to them as individuals, as students and as future teachers.
Students' prior knowledge about teaching helps students to find meaning and relevance in the teaching practices that are employed in a course and to learn about teaching.	**Prior knowledge**	Showing them that their prior knowledge is important. This is achieved by considering it in our teaching. Prior knowledge about content and about teaching helps students to find meaning and relevance in the teaching practices that are employed in a course and to learn about teaching
It is important to develop trust in our students that we take their questions, issues and concern about their learning seriously and also trust that what we teach them is appropriate and relevant.	**Caring for students**	Taking their questions, issues and concerns about their learning seriously and by preparing what we teach them thoroughly. These practices build trusting relationships between us and the students and are indicators that we care about their learning.
Observing basic pedagogical practices (planning, good organization, punctuality, and enthusiasm) can motivate students to attend our lectures.	**Modelling good teaching practices**	Modelling good teaching practices. Modelling good teaching is a way of teaching students to appreciate and to love teaching as we will be showing students how teaching can be done. Modelling good teaching practices can be achieved by observing basic pedagogical practices in our teaching such as planning, good organization, punctuality, enthusiasm and use of visual aids. These practices motivated students in this study to attend lectures and positively influenced both their learning of content and learning about teaching.

The identity lens that students take on during the teaching and learning process influences the way they see the T/L activities and what they learn from them.	**Feeding students' multiple identities**	constantly reminding them that they should take on all the three identities of a learner, a university student and a future teacher for them to derive meaningful lessons and maximum benefit about teaching and learning from the T/L activities that they encounter in the teacher education programmes.
There is a need for us as teacher educators to be more overt about our teaching practices including the teaching activities that we engage students in and the content that we teach them	**Being more overt about our teaching practices**	being more overt about our teaching practices including the teaching activities that we engage students in and the content that we teach them in order to help them to understand and to appreciate (as learners, as students and as future teachers) what we do in our courses.
Learning and gaining knowledge about the four domains of a teacher's knowledge develops confidence in students as future teachers.	**The four domains of a teacher's knowledge**	Teaching them about their future contexts, their future students and PK as part of the teaching of a content course as this study showed that learning and gaining knowledge about the four domains of a teacher's knowledge develops confidence in students as future teachers.

The suggestions outlined above have the potential to promote positive teaching and learning experiences in pre-service teachers which in turn may positively impact the kind of teachers they become. There is however need for further research to test and ascertain the effectiveness of these suggestions.

8.6 Methodological findings

In this self-study, I demonstrated how research literature and colleagues can be powerful discussants in a self-study project. I discussed how I used these two discussants earlier in section 8.3.1. In this study, I also demonstrated that when teaching a content course to pre-service teachers, it is important to combine teaching for understanding of content and for teaching. A useful method of combining teaching for understanding of content and for teaching is through being a role model. One way of developing oneself as a good role model for effective teaching is to embark on a self-study research project. In this study, I was able to successfully demonstrate the effectiveness of using a self-study methodology to improve one's teaching in the way I taught the genetics course.

In this study, I used mainly video-recording, interviewing and journaling to collect data about my teaching. I found these methods of data collection to be very powerful in self-study as I explain below.

8.6.1 Video-recordings

Video-recordings captured my teaching and made it possible for me to relive what was happening in my teaching and to reflect with critical friends and to learn. In addition, video-recording my lectures helped to capture what acted as evidence of what students were describing as their experiences of my teaching in the interviews. Therefore, video-recording our teaching provides evidence which may strengthen the trustworthiness of a researcher's claims in a self-study. Furthermore, video-recording of my lectures had a ripple effect in that the videos are now available for further use. For example, after my course, I prepared short video clips of 5 to 6 minutes where I was explaining concepts and posted them on the University's e-learning system. Students were therefore able to access my explanations of concepts beyond the course in preparation for exams. I also made use of both the video clips and the video audio transcripts as resources in the methodology courses that I was teaching. Critiquing my teaching together with the students was a powerful way of teaching about teaching as I was able to make accessible the pedagogical reasoning behind my teaching.

8.6.2 Interviewing students

One weakness of using interviews is the possibility of reactivity (Mouton, 1996). In this study, reactivity manifested when I was piloting the interview process. Because the focus of the

interview was my teaching, students were not responding in detail to the interview questions that I was asking them arguing that I knew the answers to the questions. It was therefore essential in this study to find ways of minimizing the likelihood of that reactivity. It was therefore necessary to make use of someone who was not familiar with what had transpired in my lectures. I was able to successfully make use of someone and also to adapt the group interview method of interviewing to collect data in a self-study. I however had to make sure the person I engaged had the skills that have been described as necessary for a successful interview such as the ability to maintain control, to probe gently and to present an assurance of confidentiality (Opie, 2004b). I therefore hired Dorothy, a research assistant who had done interviews before and looked at some of the interview transcripts to assess the quality of the interviewing including probing. Dorothy was also someone who would be able to organize everything, the interviewees, the times, the venues and the transcription of the audio recordings. I did this to maintain confidentiality. By keeping my distance in the interview process, students freely shared their experiences of my teaching with the interviewer in great detail.

8.6.3 Journaling

Journaling is extensively used in self-study (e.g. Garbett, 2012; Keast & Cooper, 2012). This study confirms journaling as a powerful method of data collection in self-study. Journaling facilitated reflection as it forced me to revisit and to think deeply about what I was doing and what I was observing in my lectures and in other teaching and learning activities. Journaling also helped me to provide full accounts of my feelings, thinking and emotions to critical friends for feedback. Through journaling, I was able to effectively make use of the concept of trigger incidents to record data from my classroom observations in the form of narrative texts.

8.7 Reflections on the methodology of self-study

8.7.1 Getting hands dirty

Doing a self-study can be described as ‘getting your hands dirty’ (Samaras, 2011). The metaphor brings out the idea that when you do a self-study, you have accepted that you are accountable for what happens in your classroom. You therefore do not shout strategies from a distance. You get directly involved, you make an effort and you work hard to bring about the change that you wish to see in your classroom, in teacher education and in education as a whole. In this study, I got my hands dirty by reading literature, exposing my practice to

others for scrutiny and by taking risks with simple but innovative approaches. The paragraph from Tidwell, Heston, and Fitzgerald (2009), that I quoted in the preface to this thesis captures what I experienced and have come to understand from doing this self-study:

In pursuing self-study, even familiar and comfortable practices become suspect. We cease to be naïve about our practice and increasingly recognize our individual and collective roles in the success or failure of teacher education. External factors (e.g. the students, the curriculum, the administration, colleagues, government mandates, socio-cultural contexts) can no longer excuse us from being responsible for our impact, and thus we are called to change.

8.7.2 The challenges of doing a self-study

Doing a self-study was very challenging for me firstly because my immediate community of researchers does not know much about the notion of self-study, its nature and its purposes and as a new person in the field, I also wrestled to define it for them. Self-study has characteristics that are similar to other research paradigms such as teacher inquiry, reflective practice and action research (Samaras & Freese, 2006). This inclusive nature of self-study makes it very difficult to define self-study and calls for a continuous communal dialogue which was not available at my institution. Attending the American Educational Research Association helped me to develop a better understanding of self-study. I also established communication with other self-study researchers both inside and outside South Africa.

The second challenge is that the methodology of self-study requires one to work with someone else; a critical friend. A critical friend is supposed to be a trusted colleague who is able to *mediate, provoke and support new understandings* (Samaras, 2011, p. 5). It is however not easy to get someone who can fulfill the role of a critical friend firstly because it is a very challenging role and secondly, it is very demanding in terms of time. In this study, it was very difficult to find critical friends who understood this role and were willing to commit themselves. Although colleagues got to understand a critical friend's role, they could only be available sometimes and not every time. I therefore had to ask four of my colleagues to be my critical friends so that at any given time I would have someone to critique my work. In addition, I worked with two friends who were also doing their PhD studies. The other challenge that I faced was that the critique was sometimes 'too gentle' and sometimes 'too harsh'. An example of too gentle a critique was when a critical friend gave feedback about my teaching which focused only on saying your teaching was good without spelling out why

she thought that it was good. An example of a harsh critique was in response to my presentation of my research design when a responded said to me: *you don't seem to understand what you are doing because what you are doing is action research not self-study*. The respondent could have been more supportive and gentle by saying for example: *Your research design does not clearly bring out the characteristics of self-study. As it is, it sounds more like action research. Or you have not adequately brought out the characteristics of self-study.* The comment however motivated me to go back and make sure I clearly understand the differences between action research and self-study. The effect of both too gentle and/or too harsh forms of critique was counteracted by the use of more than one critical friend and by presenting my ongoing work at different fora like conferences and research school seminars.

The other challenge was how to deal with the feedback from my supervisor. While he was guiding and critiquing my work as a supervisor, I would after each feedback session go back and reflect on the feedback and journal my thoughts in a similar way to what I was doing with critical friends. Therefore, as explained in chapter three, I eventually considered my supervisor as having played two roles of supervisor and critical friend.

As I was reflecting on the methodology of self-study, I thought about the declaration that I would have to make about this thesis which reads in part that *I declare that this thesis is my own unaided work*. I feel that this declaration does not hold true for a self-study like mine as I had to work with others (critical friends, colleagues and the research community as a whole) throughout the research process. Therefore, while it is a requirement to make that declaration, I acknowledge the many hours that were put in by my critical friends in critiquing my work.

Epilogue: The 'joys' of my PhD journey

In the introduction to this study, I described how I became dissatisfied with my teaching of a genetics course to pre-service teachers. I also explained how my supervisor introduced me to self-study after reading about my concern in my one page proposal and sensed my passion for teaching genetics. The irony was that my supervisor didn't know much about self-study but he did not hesitate to send me into the world of self-study where we both didn't know much about anything and anyone. My supervisor gave me a primer on self-study that was written by Samaras and Freese (2006) to read and see if I would be interested in doing a self-study. The ideas of self-study as described in the primer fascinated me especially the realization that self-study was going to allow me to combine my passion which is teaching

with my PhD study. Studying for a PhD takes time so doing it within the context of what I am passionate about was going to be a rewarding experience. Therefore, I agreed to do a self-study for my PhD. That was the beginning of a **beautiful nightmare**. This sounds like an oxymoron but it is not. I explain what I mean below.

I see my PhD journey as a nightmare because as a self-study, it required openness to ideas from critical friends and from others. Unfortunately, because many people still don't understand the methodology of self-study, during the times when I was presenting my work to others especially at research schools and conferences, the critique of others was not always gentle or helpful. Sometimes it was harsh to the point of being 'provocative' and 'brutal'. I however see the study as a beautiful nightmare because as is expected of self-study research, it brought immediate improvement to my practice as a teacher educator and that won me an award for teaching excellence (see below).

Dear Eunice, It is with real pleasure that I write on behalf of the Dean to inform you that your nomination for the Faculty of Humanities Teaching and Learning Award, Undergraduate, has been successful. Indeed, the Committee was unanimous in its decision to award you this honour noting in particular your efforts to enhance student learning through your research led approach, the reflexive nature of your methods, and the interdisciplinary nature of your approach, were laudable. Many congratulations again on this most deserving achievement. The Faculty of Humanities takes pride in your commitment and interest in student learning, particularly at the undergraduate level. Yours truly,

David J Hornsby, PhD (Cantab)
Assistant Dean of Humanities, Teaching and Learning
University of the Witwatersrand

I dedicate this award to Professor Tony Lelliott my supervisor who decided not to lead me but to walk with me during my PhD journey. As we were walking along this journey together, he did not show me the way; he showed me how to find the way. If he had chosen to show me the way, we would have walked along the path that he knows, a path that he has walked before. He however chose to show me how to find a way so that I could chart my own path. Walking the way and charting my own path were the **joys** of my PhD journey.

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Appendices

Appendix A: List of critical friends

Pseudonym	Description
Tony	My supervisor
Michigan	Colleague in the Science department (Biology)
Alaska	Colleague in the Science department (Biology)
Georgia	Colleague in the Science department (Biology)
Belinda	Colleague in the Science department (Biology)
Kansas	Colleague in the Electrical Engineering faculty
California	Fellow PhD student and colleague in another faculty (Geography)
Virginia	Fellow PhD student and colleague from another institution (Science)
Nico	Colleague at another institution (English)

Appendix B: Information on interviewees

Code	Gender	Pseudonyms	Race	Mark Category	Groups	Date	Time
S1	F	Agnes	Coloured	2^+	1 (S1-S3)	22/04/2013	10:15h
S2	F	Margie	Black	2			
S3	M	Servie	Black	2			
S4	M	Percy	Coloured	2	2 (S4-S6)	22/04/2013	13:10h
S5	F	Ngoni	Black	2			
S6	F	Mufaro	Black	2			
S7	F	Placki	Indian	2+	S7	22/04/2013	14:00h
S8	F	Chipo	Black	3	S8-S11	06/05/2013	13:35h
S9	M	Ephy	Indian	2-			
S10	M	Munya	Black	3			
S11	M	Admire	Black	2-			
S12	F	Tendai	White	3	S12-S13	03/06/2013	13:30h
S13	M	Naison	Black	2+			

7 females: 4 blacks, I Indian, 1 coloured, 1 white

6 Males: 1 coloured, 4 Blacks and 1 Indian

Key to Mark Category Coding:

- 0% – 50% average = **1**
- 50% - 59% average = **2-**
- 60% – 69% average = **2**
- 70% - 75% average = **2+**
- 75% - 100% average = **3**

Appendix C: My final course outline

Week 1: An exploration of students' prior knowledge of genetics. Basic structures of genetics (nucleotides, DNA, genes and chromosomes)

Week 2: Meiosis

Week 3: Mendel, monohybrid inheritance, genetic diagrams, Punnett squares

Week 4: Co-dominance, Incomplete dominance and Multiple alleles

Week 5: Sex determination and sex-linkage

Week 6: Mutations, genetic disorders, genetic testing and counseling

Week 7: Dihybrid inheritance?

Appendix D: The Reebop Activity

University of the Witwatersrand

Division of Science and Technology Education

Life Sciences III (EDUC 3084)

Date – 26 March 2013

Practical 7: Create a REEBOP-Pulling it all together

This exercise must be done in groups. The exercise is meant to help you understand the connection between mitosis, gene expression, cell differentiation, meiosis, gametes, sexual reproduction and inheritance, and the cause of variation. **Enjoy**

What you need: A small plastic packet with REEBOP chromosomes and materials for the REEBOP body parts:

Key

Body part	**Material**
Body segments	Large marshmallows (pink for female and white for male)
Tail	Paper clips
Humps	Map pins
Nose	Push pins (red, blue or yellow)
Eyes	Drawing pins
Antennae	Sewing pins
Long or short legs	Bambo skewers (full length or broken)
Joints	Toothpicks

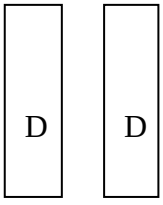
Key to traits

Sex	:	XX: Female (pink body segments)		XY: Male (white body segments)
Body segments	:	DD or Dd: Three body segments		dd: Two body segments.
Tail	:	TT or Tt: Curly tail		tt: Straight tail
Humps	:	MM or Mm: Two humps		mm: Three humps
Nose	:	QQ: Red nose	Qq: Blue nose	qq: Yellow nose
Eyes	:	EE or Ee: Two eyes		ee: Three eyes
Antennae	:	AA or Aa: Antennae present		aa: Antennae absent
Legs	:	LL or Ll: Long legs		ll: Short legs

Instructions

Take out the chromosomes from your packet. Use colour of chromosomes to arrange them in homologous pairs. Same colour denotes homologous pairs. *Remember one chromosome in each pair came from the REEBOP's mother and the other from the REEBOP's father. These chromosomes combined at fertilization and have been removed from the REEBOP zygote.*

1. Write down the genotype that is shown by each of your homologous pairs e.g. If a homologous pair is as shown below, the genotype will be DD



What do the letters represent? [1] Can you see that they occupy the same positions on the chromosome. What is the name of that position? [1]

2. Use the genotypes you have listed in 2 above to list the traits of the REEBOP that will develop as the zygote develops. After listing the REEBOP traits use the key to body parts above and the materials you have been provided with to create your REEBOP. Use the diagram in Fig 1 below as a guide. **Can you identify the biological processes that are represented by what you are doing now as you create your REEBOP? [4]**

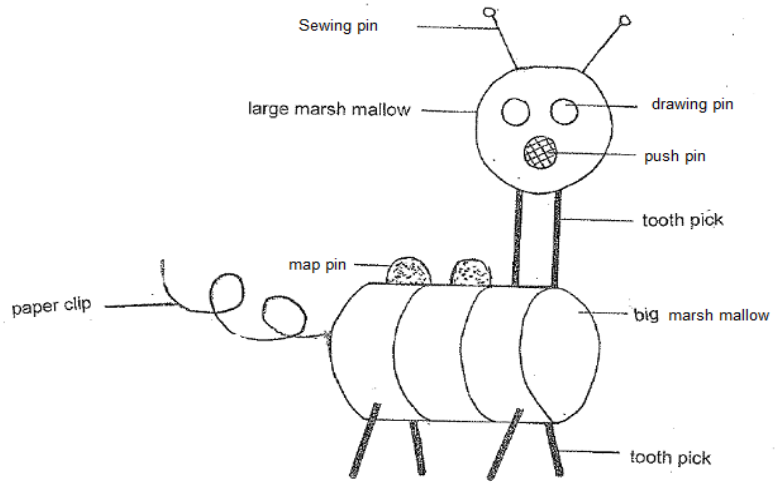


Fig 1: Diagrammatic representation of a REEBOP

3. Now compare your REEBOP with the other REEBOPs. **Are there any two REEBOPs that look alike? Why do the REEBOPs look alike? [2] Why do the REEBOPS look different? [2]**

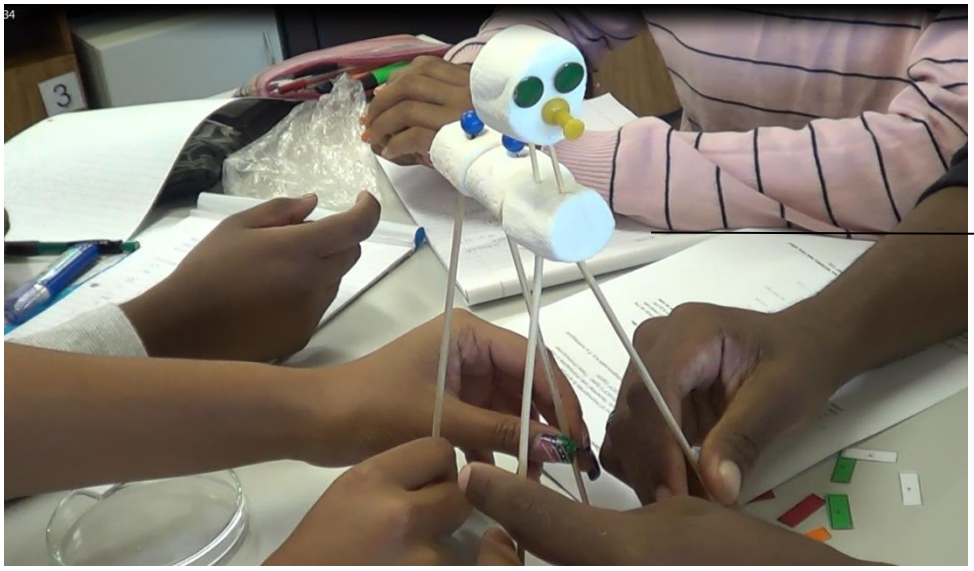
4. Now introduce your REEBOP to a member of the opposite sex. Let them fall in love, gaze at one another and do a little mating dance around one another. Randomly select one chromosome from each pair of the male chromosomes and put to one side to form a half set of chromosomes. This half set represents a sperm. Now, like wise randomly select one chromosome from each pair of the female chromosome and put them together to form a half set. This half set of chromosomes represents an egg/ovum. Now join the 'sperm' and the 'egg' to form a full set of fourteen chromosomes.

   - **Which process in real life is represented by the formation of the sperm and egg? [1]**
   - **Which process is represented by your random selection of a chromosome from each pair and not simply choosing the first chromosome? [1]**
   - **Which process is represented by the joining together of the sperm and egg? [1]**
   - **What 'structure' is formed when the sperm and egg join?[1]**
   - **What does this structure develop into? [1]**
   - **What therefore, is the role of sperms and ova in inheritance? [2]**

5. Set out the genotype of the baby REEBOP using the chromosome cards.

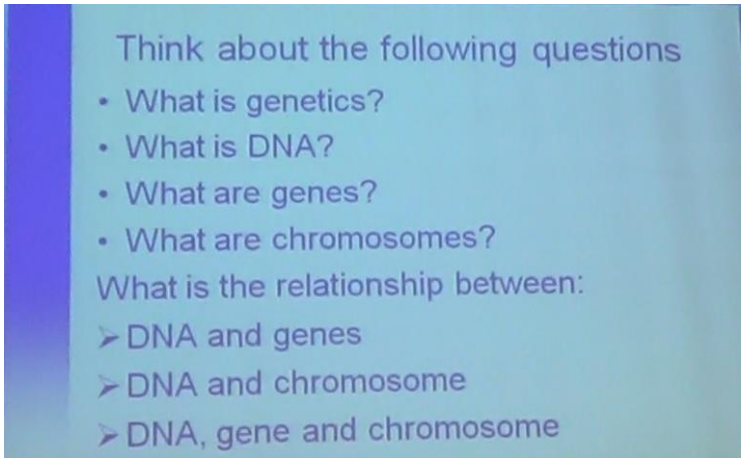
6. Now as caring parents construct your baby REEBOP using your genotypes as a guide. **Describe your observations with regards to the appearance of the baby in relation to the parents.[2] Explain fully your observations. [3]**

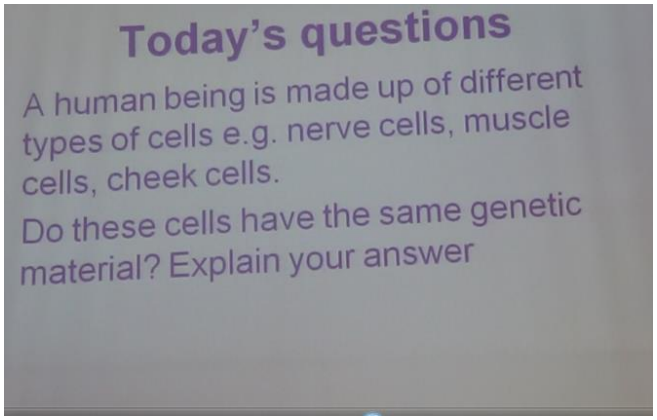
7. Identify one common misconception that is likely to be reinforced by this practical exercise

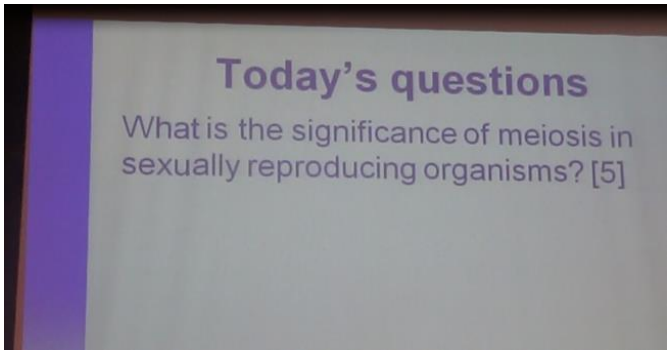


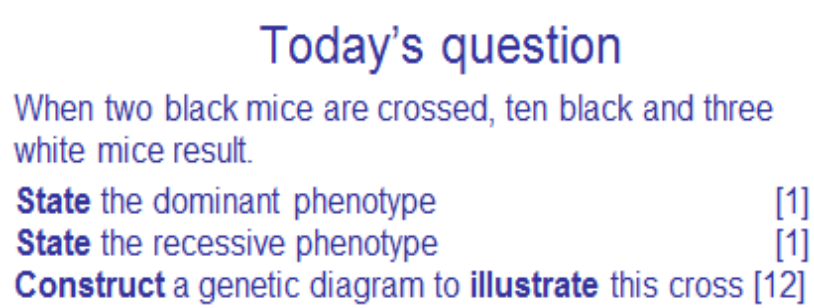
Built reebop

Appendix E: Examples of "Today's questions"

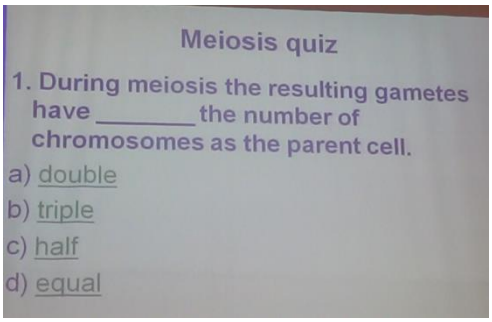
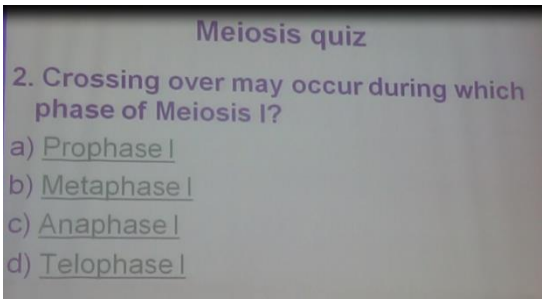
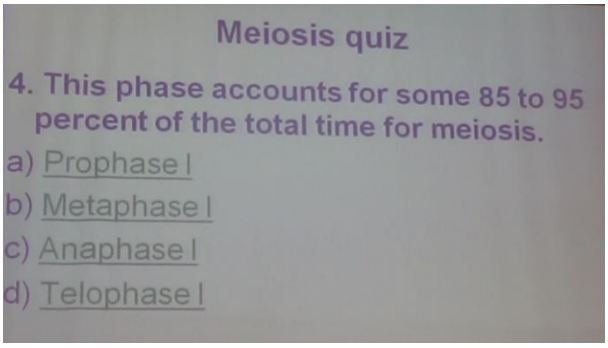








Appendix F: An excerpt of a quiz show

Lecturer	Now, so how much have you understood? Let's see.  Right, write down the answers. *(Quiz)* Right. Sh! I didn't say talk. This is individual work, so no discussion. I don't expect to hear any discussion. Hello! It's individual work.
Students	(W*ork in* silence).
Lecturer	Let's go on to number two. 
Students	*Continue to work in silence*
Lecturer	Can we move on to the third? What is cytokinesis?
Students	*Continue to work in silence*
Lecturer	Next one. Which phase accounts for ninety percent of the time that meiosis takes place?  The longest phase. If you go through the events of each phase, you will be able to identify the phase.

Appendix G: Codes created from the analysis of interview transcripts

1. **Preparation**
2. **Teaching procedure**
3. Description **teaching and learning aids (T/L)**
4. Description of purpose of a T/L aid- **purpose**
5. **outcome of my teaching practices-understanding**
6. Evaluation of high school teacher- **evaluation of high school teacher**
7. **Description of CCK**
8. Description of the conduct displayed by the lecturer-**lecturer's conduct**
9. Evaluation of high school teacher's teaching- **evaluation of high school teacher's teaching**
10. Evaluation of the lecturer-me- **evaluation of lecturer**
11. Description of another format of teaching-**other teaching format**
12. Evaluation of another format of teaching-**evaluation of teaching format**
13. Description of an outcome of teaching format-using practicals-**outcome-learning**
14. Description of self as a teacher**- identity**
15. Description of lessons learnt –**lesson learnt**
16. Description of a teaching strategy-**teaching strategies/overall approaches to teaching**
17. Description of teaching activity –**teaching activities**
18. Evaluation of teaching strategy-**evaluation**
19. Description of a teaching tool-**teaching tool**
20. Description of T/L resources posted on SAKAI-**T/L resources**
21. Description of the importance of posting resources on SAKAI- **importance of SAKAI**
22. Description of assessment activity- **assessment activity**
23. Reasons for wanting to adopt the assessment activity as a teacher-**purpose and lesson learnt**
24. Evaluation of assessment activity- **evaluation**
25. Evaluation of T/L activity- **evaluation**
26. Evaluation of the genetics **course-evaluation**
27. Evaluation of other courses**-evaluation**
28. Evaluation of science programme- **evaluation**
29. Evaluation of my teaching as a whole-**evaluation**
30. Description of new content encountered-**new content**
31. Description of the effect of encountering new content –effect of **new content**
32. Description of high school T/L activities- **high school experiences**
33. Description of student's reaction to learning new content-**reaction to new content**
34. Evaluation of the experience of learning new content-**evaluation**
35. The description of the outcome of being taught new content-**outcome**
36. Evaluation of high school textbooks-**evaluation**
37. Description of high school teaching activity-**teaching activity**
38. Description of content that was not covered in depth in high school-**content**
39. Description of how the content was taught in high school-**content**
40. Description of how I taught the content-**content**
41. Description of outcome of teaching activity-**outcome**
42. Evaluation of lecturers' approach to teaching-**evaluation**
43. Evaluation of my teaching-**evaluation**
44. Description of student conduct-**student conduct**
45. Description of a feeling
46. Description of new knowledge gained-**new knowledge/awareness**

47. Outcome of teaching about genetic disorders-**outcome**

Appendix H: Ethics clearance letter

Wits School of Education

27 St Andrews Road, Parktown, Johannesburg, 2193 Private Bag 3, Wits 2050, South Africa
Tel: +27 11 717-3064 Fax: +27 11 717-3100 E-mail: enquiries@educ.wits.ac.za Website: www.wits.ac.za

Student Number:
Protocol Number:
2012ECE071

Date: 14-Jun-2012

Dear Eunice Nyamupangedengu

Application for Ethics Clearance:

Thank you very much for your ethics application. The Ethics Committee in Education of the Faculty of Humanities, acting on behalf of the Senate has considered your application for ethics clearance for your proposal entitled:

Insights into the teaching of genetics to pre-service teachers: A teacher educator's approach to transformative practice through a self-study

The committee recently met and I am pleased to inform you that clearance was granted. The committee was delighted about the ways in which you have taken care of and given consideration to the ethical dimensions of your research project. Congratulations to you and your supervisor!

Please use the above protocol number in all correspondence to the relevant research parties (schools, parents, learners etc.) and include it in your research report or project on the title page.

The Protocol Number above should be submitted to the Graduate Studies in Education Committee upon submission of your final research report.

All the best with your research project.

Yours sincerely

MMabeta

Matsie Mabeta
Wits School of Education

011 717 3416

Appendix J: Request for permission to do my study at WSoE

RE: Request for permission to do my study at Wits School of Education

My name is Eunice Nyamupangedengu. I am a PhD student at Wits University, Faculty of Humanities undertaking a study on genetics teaching and learning. I am also a senior tutor in the Division of Science and Technology Education responsible for teaching Life Sciences courses. The objective of this study is to conduct a self-study in which I look at how I teach genetics and the depth of understanding that my teaching promotes. Genetics is an area of biology that is important for everyone to know and understand and for this reason, the topic of genetics forms part of the biology curriculum in South Africa. At Wits School of education genetics is a topic that is done in the 3rd year Life Sciences (Life Sciences III) course of the new B Ed programme.

My experiences as a genetics lecturer have shown that despite formal exposure to genetics at high school, some students still show a lack of the basic core knowledge of genetics that they are expected to have obtained from the high school biology curriculum. Since Life Sciences students will eventually carry the responsibility of teaching genetics to school children, they must have a robust understanding of genetics phenomena. Something needs to be done at university level to equip student teachers with adequate knowledge and understanding of genetics. Hence, my wish to conduct a self-study in which I look at how I teach genetics and the depth of understanding that my teaching promotes.

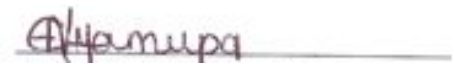
My research seeks to understand my own teaching and thereby, to adapt and develop course content and teaching to that which can help students to acquire more coherent and extensive knowledge of genetic phenomena that will equip them to not only teach genetics in schools but also to be able to comprehend, use and respond to genetic information and technologies that an individual may encounter in everyday situations. To this end, I would like to analyse performance on selected coursework tasks and tests of students during the course, and to seek students' experiences of the course by interviewing some of them for more in-depth feedback. The interviews will be done at the end of the course in the Laboratory (M145). The interviews will be 20-30 minutes long. Whilst the students' course sessions will be video-taped, the focus of the video will be on me the lecturer.

I would greatly appreciate your favourable response and am happy to discuss my project with you if you so wish. I will request permission from learners separately.
All the information will be treated according to the University ethical policy on confidentiality.
The study is being conducted for educational purposes and will cause no harm to the students.
Even if verbatim quotes from the students are used in the thesis write-up, they will be reported so that their identity is anonymous. The results of the study may be published, but the students' identities will be anonymous.

Everything the students' say will be kept confidential by the researcher. The students will only be identified by a pseudonym in the transcript.

For any clarifications please don't hesitate to contact me.

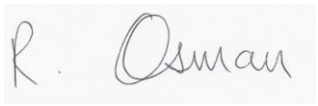
Yours sincerely



Eunice Nyamupangedengu

I Ruksana Osman, Head of Wits School of Education, grant Eunice Nyamupangedengu permission to do her research at Wits School of Education, Division of Science and Technology and to work with the Life Sciences III students, analysing their performance in coursework tasks and tests, and conducting interviews for a PhD study on "**Insights into the teaching of genetics to pre-service teachers: A teacher educator's approach to transformative practice through a self-study**."

Name: Professor Ruksana Osman
School: WSoE



Date: 6 June 2012

Appendix K – Ethics documents

Information sheet for students

Researching the teaching and learning of genetics in the new B Ed Life Sciences III course

Genetics is an area of biology that is important for everyone to know and understand and for this reason, the topic of genetics forms part of the biology curriculum in South Africa. At Wits School of education genetics is a topic that is done in the 3rd year Life Sciences course of the new B Ed programme. Life Science is taken by students either as a major or a sub-major subject. My experiences as a genetics lecturer have shown that despite formal exposure to genetics at high school, some students still show a lack of the basic core knowledge of genetics that they are expected to have obtained from the high school biology curriculum. Since you will eventually carry the responsibility of teaching genetics to school children, you must have a robust understanding of genetics phenomena. Something needs to be done at university level to equip you (student teachers) with adequate knowledge and understanding of genetics.

Given this scenario, I would like to do a self-study in which I look at how I teach genetics and the depth of understanding that my teaching promotes. My research seeks to understand my own teaching and thereby, to adapt and develop course content and teaching to that which can help students to acquire more coherent and extensive knowledge of genetic phenomena that will equip them to not only teach genetics in schools but also to be able to comprehend, use and respond to genetic information and technologies that an individual may encounter in everyday situations. To this end, I would like to analyse performance on selected coursework tasks and tests during the course, and to seek participants' experiences of the course by interviewing some of you for more in-depth feedback. The interviews will be done at the end of the course in the Laboratory (M145). Each interview will take 40 – 60 minutes each. Whilst your course sessions will be video-taped, the focus of the video will be on me the lecturer.

Data collected for the study will be viewed by me and colleagues who are lecturers in the Division of Science Education. All reporting and writing up from the research data will ensure your anonymity and confidentiality of the data.

Whilst coursework tasks and tests are compulsory as part of the course, I seek permission here for their use within my research project. I also seek permission for your participation through your emailing of your thinking and experiences regarding my teaching and you're learning of genetics. I emphasise that there will be no prejudice in terms of your progress should you choose not to participate in the research. You are of cause free to change your decision at any stage. I very much hope that you will enjoy the course and find it useful for broadening and deepening your understanding of genetics.

Informed consent form for interviews – Student

Research title: Insights into the teaching of genetics to pre-service teachers: A teacher educator's approach to transformative practice through a self-study

I, _____, a Life Sciences III student at _____ consent to participating in the study to be conducted by Mrs Eunice Nyamupangedengu for her research on the teaching and learning of genetics at Wits University, Johannesburg. I fully understand the following points

1. The study will cause no harm to me and that the study is being conducted for

   Educational purposes.

2. Even if verbatim quotes from me are used in the research report, they will be reported so that my identity is anonymous. I understand that the results of the study may be published, but my identity will be anonymous.

3. Everything I say will be kept confidential by the researcher. I will only be identified by a pseudonym in the transcript.

4. I participate voluntarily and understand that I may withdraw from the study at any time.

I am **happy to share / do not wish to share** my experiences of the genetics course with Mrs Nyamupa through interviews.

Name _____

Signature _____

Date _____

Subject/ phase specialisation:_____

Informed consent form for audio-recording – Student

Research title: Insights into the teaching of genetics to pre-service teachers: A teacher educator's approach to transformative practice through a self-study

I, _____, a Life Sciences III student at _____ consent to participating in the study to be conducted by Mrs Eunice Nyamupangedengu for her research on the teaching and learning of genetics at Wits University, Johannesburg. I fully understand the following points

1. The study will cause no harm to me and that the study is being conducted for Educational purposes.

2. Even if verbatim quotes from me are used in the research report, they will be reported so that my identity is anonymous. I understand that the results of the study may be published, but my identity will be anonymous.

3. Everything I say will be kept confidential by the researcher. I will only be identified by a pseudonym in the transcript.

4. I participate voluntarily and understand that I may withdraw from the study at any time.

5. Audio-recording will be done so that after transcription the record of interviews will be available for analysis later.

I **consent/ do not consent** to myself being audio recorded as part of the study.

Name _____

Signature _____

Date _____

Subject/ phase specialisation:_____