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THE EFFECTIVENESS OF NGO-SPONSORED INSET ON THE CLASSROOM PRACTICES OF PRIMARY SCHOOL MATHEMATICS EDUCATORS: A CASE STUDY OF MCPT.

Amritha Valerie Ramsingh

A research report submitted to the Faculty of Education, University of Witwatersrand, Johannesburg, in partial fulfillment of the requirements for the Degree of Master of Education

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ABSTRACT

In this research report, the effectiveness of NGO-sponsored mathematics INSET on the classroom practices of primary school educators is investigated. The study analyses the classroom practices of ten Mathematics Centre for Primary Teachers (MCPT) trained educators. This analysis takes place from the stated goals of the MCPT programme on the one hand, and from a theoretical analysis of the construction of knowledge on the other.

This qualitative study, which made use of structured observation schedules and interviews of ten MCPT-trained educators, revealed interesting trends in their practice in relation to MCPT training.

While educators reflected ranging strategies, direct teaching and repetitive practices were marginalised, raising important issues for curriculum reform in South Africa. When employing more open methods, limits to educators' content knowledge and indiscretion in the use of resources were revealed.

In a context of limited resources in South Africa, and the significance of NGO sector, in assisting with curriculum development and change, these insights have significance beyond MCPT.

Keywords: INSET, primary, Foundation Phase, mathematics, Curriculum 2005, Outcomes Based Education, NGO, constructivism

DECLARATION

I declare that this research report is my own, unaided work. It is submitted for the degree of Master of Education in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

A.V. RAMSINGH

17th day of December, 1999

To my husband, Rabin,
My children Diksha and Bhavesh,
My mum Vidhya
With sincere thanks
for their love and encouragement
during the writing of this thesis.

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List of Acronyms

African National Congress	ANC
Committee for Teacher Education Programmes	COTEP
Education Labour Relations Council	ELRC
Further Diploma in Education	FDE
Gauteng Department of Education	GDE
Independent Development Trust	IDT
In-service Education	INSET
Joint Education Trust	JET
Language of Teaching and Learning	LOLT
Mathematical Literacy, Mathematics and Mathematical Sciences	MLMMS
Mathematics Centre for Primary Teachers	MCPT
National Education Policy Investigation	NEPI
Non Governmental Organisation	NGO
Pre-service Training	PRESET
President's Education Initiative	PEI

Apartheid Education Departments:	
Department of Education and Training (African)	DET
House of Assembly (White) (ex Model C)	HOA
House of Delegates (Indian)	HOD
House of Representatives (Coloured)	HOR

List of Tables

Table 1	Presentation of Data
Table A	Teaching Methods
Table B	Availability and Use of Resources
Table C	Group Teaching and the Role of Learners during the Mathematics Lesson
Table D	Educators' Content Knowledge and Confidence
Table E	Planning and Preparation of Lessons
Table F	Outcomes Based Education Methodology

List of Appendices

1. Interview One
2. Interview Two
3. Observation Schedule

Abstract ii
Declaration iii
Dedication iv
Acknowledgements v
List of Acronyms vi
List of Tables vii
List of Appendices viii

Table of Contents

1.Chapter One INTRODUCTION and SITUATIONAL BACKGROUND 1

1.1 Introduction 1

1.2 The Situation In South Africa regarding the Teaching of Numeracy in the Foundation Phase: The Legacy of Apartheid 2

1.2.1 Under-qualified educators-Poor Knowledge Base 3

1.2.2 Crowded Classrooms 3

1.2.3 Poor Resources 4

1.2.4 Related Practices: Traditional Teaching Styles and Learning by Rote 6

1.3 The Government's Position in addressing these Inequalities 7

1.4 NGOs in Apartheid South Africa 8

1.5 The Position of NGOs in 1996 9

1.6 The Mathematics Centre for Primary Teachers 9

1.6.1 What were MCPT's plans for Change in the then current situation? 10

1.6.2 What Approaches to the Teaching of Mathematics did MCPT use to this end? 11

1.7 The Relevance of the interim Mathematics Syllabus 11

2 Chapter Two THEORETICAL BACKGROUND 14

2.1 MCPT's Approach to Teaching Within the Context of Curriculum 2005 14

2.2 What are the Main Focuses of Change in MCPTs' Practice 15

2.3 Constructivism 18

2.3.1 Radical Constructivism 18

2.3.2 Sociocultural Constructivism 22
Speech is Key
The Educator's Role
Zone of Proximal Development
Opportunities for Learners to Participate

2.3.3 Radical or Socioculturalism? 27

2.4 Teaching Methods 29

2.4.1 Active Learning 29

2.4.2 Traditional Teaching as a Teaching-Learning Approach 31

2.5 Availability of Resources 33

2.6 Group Teaching and the Role of Learners during the Mathematics Lesson 36

2.6.1 Peer Teaching 38

2.6.2 Scaffolding Between Peers 39

2.7 Educator's Mathematical Knowledge and Confidence 41

2.8 Outcomes Based Education Methodology 45

2.8.1 Teaching Mathematics in a Way that Relates to Learner's Everyday Experiences 45

2.8.2 Problem Solving and Calculations 47

2.9 Language of Learning and Teaching 49

2.9.1 LOLT Issues in South Africa are Complex 50

3. Chapter Three RESEARCH METHODOLOGY 52

3.1 Population 54

3.2 Sampling 54

3.3 Data Collection 55

3.3.1 A List of the Classroom Practices that MCPT hoped to shape in Educators 55

3.3.2 Observation Schedule 55

Summarised Presentation of Data Collected 56

3.3.3 Interviews 58

3.4 Design 58

3.4.1 Piloting 58

3.4.2 Observations 59

	3.4.3	Interviews Interview of Key Personnel from MCPT Educator Interviews	59
3.5	Data Analysis		60
	3.5.1	Validity Descriptive Validity Interpretative Validity Theoretical Validity	60
	3.5.2	Reliability	61
	3.5.3	Generalisability	61
3.6	Limitations Time Scope		62
4. Chapter Four	**ANALYSIS**		63
4.1	Teaching Methods		64
	4.1.1	The Dilemmas of Change Management	67
4.2	Availability and Use of Resources		68
4.3	Group Teaching and the Role of Learners During the Mathematics Lesson		72
	4.3.1	Learners working in Groups	73
	4.3.2	Peer Teaching	75
	4.3.3	Activities of Learners While Educator is Busy with a Group	76
	4.3.4	Management of Groups	78
	4.3.5	Learner-learner Interaction without the Educator	80
4.4	Educators' Mathematical Knowledge and Confidence		83
4.5	Planning and Preparation of Lessons		86
4.6	Outcomes Based Education Methodology		89
	4.6.1	Teaching Mathematics in a Way that Relates to Learners Everyday Experiences	90
	4.6.2	Problem Solving	91
	4.6.3	Calculations	92

5. Chapter Five CONCLUSIONS and RECOMMENDATIONS 95

5.1 Teaching Methods 95

5.2 Availability and Use of Resources 96

5.3 Group Teaching and the Role of Learners During the Mathematics Lesson 96

5.4 Educators' Mathematical Knowledge and Confidence 97

5.5 Planning and Preparation of Lessons 97

6 Appendices 99

7 References 115

CHAPTER ONE

1.1 Introduction

This study is a case study. It investigates the impact of NGOs[1] on the classroom practices of mathematics educators and focuses on one NGO, namely MCPT[2].

This study began in 1996, with data collection during that year. Since then, there have been dramatic changes to the mathematics curriculum in South Africa in the form of Curriculum 2005 and the OBE[3] approach. Implementation of OBE in the Foundation Phase began in 1998. Due to my position in the GDE[4] I had to postpone research analysis and as I return to it now, MCPT itself has undergone dramatic changes. This report, thus, discusses MCPT's project as it was in 1996. It is important to add that this study is not an evaluation of MCPT. Its intent is to understand mathematics INSET[5] activity through NGOs, using MCPT as a case.

In this chapter, I will outline the present status of mathematics education in the majority of South African primary schools. I will then look at the position of the government, as well as that of NGOs, in addressing the needs of mathematics education in this country. The Interim Mathematics Syllabus, together with the position that MCPT adopted in addressing these needs in 1996, will be perused. The reason for perusing the Interim Mathematics Syllabus lies further in the fact that Curriculum 2005 bases its Numeracy learning programme primarily on the teaching of the knowledge and skills inherent in the Interim Mathematics Syllabus.

South Africa has a well-developed NGO sector that was born from antagonism to the apartheid government of the past. An amount in excess of R500 million (Vinjevold et al., 1995:5) had been invested by donors, both local and foreign, into NGOs, the aim having been to improve the level of education of those people of South Africa who had been

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[1] Non-Governmental Organisation
[2] Mathematics Centre for Primary Educators
[3] Outcomes Based Education
[4] Gauteng Department of Education
[5] In-service Education

disadvantaged by the apartheid education system. Now, with apartheid statutorily being a thing of the past, the place of NGO-supported INSET is being questioned. The most urgent priority for NGOs, for the immediate future, is to demonstrate their quality and impact and to show how they are able to complement the government's resources in making a difference in addressing the development and support needs of educators and schools. This report aims to look at the effectiveness of NGO-sponsored mathematics INSET on the classroom practices of primary school teachers and focuses on MCPT as a case.

1.2 The Situation in South Africa Regarding the Teaching of Numeracy in The Foundation Phase: The Legacy of Apartheid

The situation at ex-DET[6] schools in this country still remains very different from that which is experienced by the other ex-departments and is an indication of the experiences of the vast majority of the school-going population. A poorly structured school day, disruptions, boycotts, educator strike action and other factors compound the difficulties learners have in performing optimally at school. Of all subjects taken, mathematics requires particular attention, in view of the fact that it is widely known that this subject has a poorer pass rate than any other school subject. In 1991, only 30% of African students took mathematics as a subject in matric (Grade 12). The poor preparation of students for the final examinations resulted in a 7% proportional pass rate (South African Institute of Race Relations, 1994). This translates into a ratio of 1 out of every 312 African learners who entered Sub A in 1980 gaining a matric exemption with both mathematics and science, as opposed to 1 in every 5 learners amongst White South Africans.

This situation has still not improved. The 1998 matric results were the lowest recorded since 1979. For every 100 learners who wrote matric exams in 1998, only 45 wrote mathematics. Of these learners, the majority wrote mathematics on the standard grade, and a 42% absolute pass rate was achieved. This translates into a ratio of roughly 21% of all learners who wrote the matric examinations in that year passing mathematics on either higher or standard grades (Shindler and Bot, 1999). These results are

[6] Department of Education and Training

disconcerting in view of the fact that skills in mathematics and science have now become indispensable in the wider socio-economic context.

The following can be seen as key contributing factors to these poor results.

1.2.1 Under-qualified educators - poor knowledge base

According to South African Institute of Race Relations, (1994), the poor results in mathematics and science could be attributed to insufficient and poorly-qualified primary school educators who had been unable to lay the proper foundations for learning this subject (p. 715). Secondary school education, as well as the college education of many educators, has been of such a poor quality that they now lack sufficient command of the subject matter to teach effectively. Teacher-educators in colleges, and to some extent universities, are inadequately and inappropriately qualified and are often not suitably experienced for the role of teacher educator. In an audit commissioned by the education ministry (Bot, 1996), it was found that 90% of the country's colleges of education failed to train educators adequately. Although the quality of mathematics teacher education at colleges varies considerably, in the main, colleges are

> "very poor and heavily reliant on teacher-centred approaches, with lecturers having little if any school experience and providing poor role models....Few teachers emerging from the system could be regarded as ...mathematically...literate. Further, the divide between theory and practice in didactics courses generally did not prepare student teachers for the realities they would face in the school system" (Arnott et al., June 1997:3).

Evaluations of INSET programmes indicate that educators wanted assistance in completing and teaching the syllabus existing at that time (Vinjevold et al, 1995), which would indicate an awareness of their incompetencies. The Report of the President's Education Initiative Research Project (Taylor and Vinjevold, 1999 a: 131-162) proclaims that teachers' conceptual knowledge, four years down the line, is still very poor.

1.2.2 Crowded classrooms

In 1993 the learner/educator ratios in formerly African schools in South Africa (including the ten homelands) was 43:1 as compared to 18:1, 21:1 and 26:1 for White, Indian and

Coloured learners respectively, while in non-independent homelands a ratio of 61:1 was not uncommon (South African Institute of Race Relations, 1993). "An analysis of ..., seven provinces[7] found that in 1995, 68% of maths classes...had more than 40 pupils to a teacher" (Arnott et al., 1997:2). An improvement in the learner/educator ratio to 40:1 would require an additional 2052 mathematics educators in those seven provinces (ibid).

Learner/educator ratios of 40:1 (primary) and 35:1 (secondary) have been proposed by The Committee to Review the Organisation, Governance and Funding of Schools (Bot, 1996). In reality, however, these learner/educator ratios have not applied. While parent funding in ex-Model C schools has helped to keep classes smaller than 32:1, many state schools still have classes in excess of 40:1.

1.2.3 Poor resources

"For every R1,00 spent per learner by the African education departments, R4.60 was spent by the White department, R3.20 by the Indian department and R2,60 by the Coloured department." (Bot, 1994: 3). Thus at most ex-DET schools there is a dire shortage of materials available and those that are available are often outmoded, irrelevant and have racist underpinnings. This was the legacy left by apartheid. In addition, educators lack "material skills" i.e. they are unable to make optimal use of resources which are available (Adler et al., 1999).

To compound matters, control over resources at ex-DET schools was either very poor or lacking. Of the more than 800 000 books delivered to secondary schools in Johannesburg in 1991, only 400 000 were returned in time for the 1992 school year (South African Institute of Race Relations, 1993: 599). The situation has still not changed. Some district offices in Gauteng are currently planning and running a series of workshops on "Management and Control of Learner Support Materials".

Although the government is committed to redressing the inequalities of the past, the leveling of the playing fields in terms of resources will take a very long time. In 1997, the GDE allocated an amount of R120,00 per learner in Grade 1, to be spent on OBE

[7] Northern Cape, Free State, KwaZulu Natal, Mpumalanga, Northern Province, Gauteng, North West.

resources. This allocation was available for all learners from previously disadvantaged[8] schools. However, many schools did not make the best decisions in terms of the materials they ordered for the following reasons:

- Educators at previously disadvantaged schools who had never before received such a large sum of money to spend, did not know how to make informed choices. Most schools spent most of their money on consumable wares, such as workbooks. These workbooks could be used for one year only. No planning took place to ensure that Grade 1 learners in the following years could also benefit from the materials ordered.

- Problems with the way in which the catalogue was compiled link directly to the lack of expertise on the part of evaluators. The decision by the GDE to allow all and sundry to evaluate materials was part of a process aimed at empowering educators and the building of capacity within districts. Almost all educators who applied to evaluate materials were allowed to do so, despite their lack of skills. Consequently many good items were rejected, merely because the Specific Outcomes (SOs) were not indicated on the materials. On the other hand old materials which were merely given a facelift in the form of having "Curriculum 2005" printed on the front cover, were accepted.

- Educators who were still unsure of their training in OBE had hoped that the *Educator's Guides* and accompanying *Workbooks* supplied by publishers would enhance their understanding of Outcomes Based Education. A poorly compiled catalogue contributed to confusing educators further.

The problems listed above are only a few of those associated with the process of evaluating Learner Support Materials. In reality, district officials acknowledged numerous problems and lodged a formal complaint to the Head of Provisioning in the GDE. In an attempt to address this problem, the Gauteng Institute of Curriculum Development (GICD) had established a task team to look into the best way to evaluate materials in the future. It had consequently been decided that an 'open system' will exist, whereby schools could purchase any materials they found suitable, provided that these are acquired from a registered supplier. At the time of writing this report, the

[8] ex-DET, ex-HOR and ex-HOD schools

situation had not improved. Schools were allocated vast amounts of money which they "had" to spend within a limited time span on unfamiliar materials listed in an incomplete catalogue.

1.2.4 Related Practices: Traditional teaching styles and learning by rote.

"Traditional" teaching styles are captured in phrases like "educator-dominated", "authoritarian", "transmission teaching", "rote repetition" and "chalk and talk mode". In practice, this means that the educator occupies centre stage from where he/she lectures to learners, and that which needs to be accessed easily is repeated orally over and over again until it is committed to memory and can be repeated verbatim. A considerable amount of teaching that takes place in the mathematics classroom today is based on the view that it is possible to transmit knowledge perfectly from educator to learner. Yet, educators now acknowledge that this is not possible because this method does not necessarily result in permanent learning, as the knowledge was never comprehensively grasped in the first place. Educators have also realised that learning by rote can easily be forgotten and that it does not promote flexibility of thinking.

In their attempts to approach new methods of teaching, many educators have taken up small group organisation of their teaching, but according to Peacock (Vinjevold et al., 1995) the way in which group work is done is such that "[m]ost children most of the time do nothing...and certainly nothing as cognitively demanding as individual reading and writing" (p. 23).

Difficulties in implementation of group teaching can be traced to inadequacies in educator training, as well as to physical problems such as shortages of space. Because mathematics is often perceived as a difficult, abstract subject, it places greater demands on the educator than most other subjects. Thus, the educator's knowledge base will determine whether he/she can do group work successfully. Many educators' attempts at adopting new "forms" of teaching, such as group work, exemplify what is referred to as "form substance tension" (Adler et al., 1999). This form-substance tension arises when new forms/methods of teaching are

> "not accompanied by what we call the *substance* of learner centred-teaching, which is genuinely taking the perspectives of the learners into

> account when planning teaching and assessment and when interacting with learners in the classroom." (ibid: 10).

In addition to difficulties with teaching methods, educators also have difficulty in appropriately pitching the levels of their teaching to the needs of their learners. "Tasks are set at low levels of challenge" thus making low-level cognitive demands which require no more than recall of simple information (Taylor and Vinjevold, 1999a: 159).

Outcomes Based Education propounds a shift from traditional to learner-centred classroom practices. The question which now surfaces is whether the retraining of educators in OBE for Curriculum 2005 will have any impact in encouraging educators to examine their practices in any meaningful way.

1.3 The Government's Position in Addressing these Inequalities

Prior to the government's efforts "to improve the provisioning of educational facilities and to redress inequalities" (South African Institute of Race Relations, 1993: 576-7), unbanned political groups, business and worker organisations, non-governmental organisations and a range of parent and student associations were already involved in formulating their own proposals for an alternative education system. Curriculum changes in formal schooling were to be implemented in terms of the manpower needs of the country. The low levels of numeracy and literacy hindered the productive utilisation and training of the work force. According to (South African Institute of Race Relations (1993/4: 679), NEPI (1993) cited a good quality general schooling for all as being of the highest priority for economic growth and redistribution. In the same publication, Cosatu recommended that in restructuring the education system, the improvement of the curriculum, as well as the lowering of the learner/educator ratio should be given high priority. Subsequent changes made to the syllabus were aimed at removing racial and outdated material. According to Professor Bengu[9], the revised curriculum aimed at providing for a "child-centred approach, especially in the primary phases, emphasising development, encouragement and progression, rather than creating fear of failure and the feelings of discouragement" (Bot, 1996:4).

[9] Then national minister of education at that time

A question which arises is whether the Electoral Labour Relations Council's proposed ratio of 40:1 at primary level and 35:1 at the secondary level is conducive to the "child-centred approach" being advocated. In addition to the lack of space, resources, and expertise on the part of educators, large learner/educator ratios could also contribute negatively towards the implementation of the new approach.

With the findings of the National Teacher Education audit revealing the poor level of educator training in this country, it is clear that something has to be done. Because of the dire shortage of mathematics, science and technology educators, the audit recommended that incentives be given to students who study to teach in these areas (Bot, 1996: 9) This sentiment is echoed by Professor Kader Asmal in his statement, which indicated that that in terms of pre-service and in-service training,

> "special attention will need to be given to the compelling evidence that the country has a critical shortage of mathematics, science and language teachers and to the demands of the new information and communication technologies" (Ministry of Education, 1999: 13).

1.4 NGOs in Apartheid South Africa

With the problems caused by apartheid education, the authoritarian and bureaucratic nature of our education systems, the poor working conditions of educators and inadequate resources at schools, the morale of educators and learners dropped rapidly, culminating in the tragedy of events in Soweto and elsewhere in 1976 (Vinjevold et al., 1995: 13,19). Private agencies, then realising the inadequacies of the government's contribution towards education for the country as a whole, entered into the field of in-service education and training. Of the 99 organisations offering in-service educator development, only 7 had existed prior to the 1976 uprising (ibid: 19). Local corporate funders (17%), foreign funders (25%), the IDT[10] (31%), and JET[11] (27%) are the chief funders at present involved in educator development and support (JET, 1995a: 7), which in terms of the RDP's objectives should provide economic growth and development (Vinjevold et al., 1995: 3). The greatest challenge facing INSET today is to

[10] Independent Development Trust
[11] Joint Education Trust

> "develop strategies which provide incentives for *educators disadvantaged by past education policies* to participate in, and drive, programmes which are concerned with the *institutional* development of schools and the *professional development* of educators and are *in the best interests of the* learners" (Vinjevold et al., 1995:16).

NGO teacher-education providers offer various combinations of short courses, school-based courses, classroom support, materials and information. Because NGOs were the only providers of INSET in township and farm schools in any sustained way, their impact and effectiveness became vitally significant.

1.5 The Position of NGOs in 1996

With the inequalities of apartheid being addressed by the government, donors were opting for directing money to state departments. The guarantee and distribution of further foreign funding of NGOs for education were being questioned. Indications were that funds would be cut considerably. Thus, different NGOs competed for whatever resources were still available. An audit had been commissioned by The National Department of Education in order to prove the viability of different NGOs. Those NGOs that were able to prove that they were making an impact and were supporting the government in addressing the needs of the education system, were better placed for future funding.

1.6 The Mathematics Centre for Primary Teachers (MCPT)

In attempting to investigate the issue of the effectiveness of NGO sponsored mathematics INSET on the classroom practices of primary school teachers, I will focus on one NGO, namely (MCPT)[12]. MCPT, which began during the apartheid era, merits

[12]As indicated above, this research was conducted in 1996. This research will, therefore, be set against the backdrop of MCPT as it existed at that point in time. Subsequent changes of MCPT's portfolio will not be taken into account in the writing of this report.

special attention because of its vision in preparing itself to lead the way to influence the policy of the "Provincial and National government in their responsibility for dispensation of the daily education delivery" (MCPT, 1995: 2). In focusing on improving the mathematics teaching skills of foundation phase educators, particularly of educators from Gauteng and Mpumalanga, the MCPT offered their own teaching materials that were to be used in conjunction with lectures and video presentations. In addition, workshops, courses and seminars were conducted with the objective of improving the knowledge and skills base of a large number of educators. The development and production of affordable materials contextualised in South Africa (the use of which will be discussed in the next chapter), together with whole school development policies, were all part of MCPT's long term objectives (MCPT, 1995).

1.6.1 What were MCPT's plans for change in the then current situation?

From a long list of future plans and objectives, the following key goal is relevant to this study:

> "To increase the number of Mathematics Teachers who are competent in their knowledge and skills base" (MCPT: 4).

This goal will be investigated under the following themes

- Teaching Methods
- Availability and Use of Resources
- Group Teaching and the Role of Learners During the Mathematics Lesson
- Educators' Mathematical Knowledge and Confidence
- Outcomes Based Education Methodology (Teaching Mathematics in a way that relates to Learners Everyday Needs, Problem Solving and Calculations)
- Planning and Preparation of Lessons
- Language of Learning and Teaching (LOLT)

1.6.2 What Approaches to the Teaching of Mathematics did MCPT use to this end?

In order to investigate the above issue in an illuminating way, I need to firstly answer the question of how one learns and teaches mathematics.

Mathematics, perhaps more than any other school subject in South Africa, served as a gatekeeper to progress, and has always been taught in a very traditional way, as discussed earlier. In order to now try to rectify the situation of the "inbuilt maldistribution of cultural and economic goods" in this country (Volmink, 1993: 7) and to empower people to become active participants in the choices that affect their lives, mathematics has to be taught in a more user-friendly way, and where better to begin than at grassroots level? It is for this reason that the MCPT is focusing on the teaching and learning of mathematics at the foundation phase level, where it hopes to guide children into the habit of thinking mathematically without being intimidated by the processes involved. The MCPT essentially makes use of a combination of the learner-centred/constructivist approach and the traditional approach to achieve this aim. These approaches will be elaborated upon in Chapter Two.

1.7 The Relevance Of The Interim Mathematics Syllabus

Part of the Reconstruction and Development Process has been the development of a new curriculum. This new curriculum gives rise to The Interim Mathematics Syllabus which was functional at the time of this research. The Interim Mathematics syllabus (Department of Education, 1995) incorporates societal aims which are directed at empowering all individuals of South African society by providing them with equal opportunities and choice to contribute towards the widest development of the society's cultures in a democratic, non-racial, non-sexist learning environment, while at the same time creating an awareness of and a responsibility for the protection for the total environment.

Curriculum 2005 has subsequently set out Specific Outcomes for Mathematical Literacy, Mathematics and Mathematical Sciences (MLMMS). In terms of C2005, learners will

need to demonstrate an understanding about ways of working with numbers, as well as an understanding of the historical development of mathematics in various social and cultural contexts. They would need to manipulate numbers in different ways, as well as to measure with competence and confidence in a variety of contexts. Learners should be able to critically analyse how mathematical relationships are used in social, political and economic relations. They will be required to be competent at using data from various contexts to make informed judgements, use mathematical ideas to communicate mathematical ideas, concepts, generalisations and thought processes. In addition, they will be required to use various logical thought processes to formulate, test and justify conjectures. Learners will need to be able to describe and represent experiences with shape, space, time and motion, using all available senses. Furthermore, learners will be required to analyse natural forms, cultural products and processes as representations of shapes, space and time (Department of Education, 1997b).

Given the above, it is clear that The Interim Mathematics Syllabus, which was a precursor to Curriculum 2005, was aimed at becoming more practical and useful in our daily lives. It attempted to present mathematics as a subject unaffiliated to the elitism by which it was characterised in the past, where only the intellectually gifted could be successful. Hence, the status of the educator, as the giver of knowledge, needed to desist. Traditional teaching methods no longer suffice in realising the learning outcomes as set out, firstly by The Interim Mathematics Syllabus, and now by Curriculum 2005. Educators will need to be retrained on how to teach in a 'hands on' environment. Learners, too, will need to undergo a paradigm shift as the mathematics they will learn will no longer continue to uphold its status of being a subject which is 'out there'. It is geared to become an integral and integrated part of every learner's day to day living.

The South African National Department of Education has embarked on a nation-wide educator retraining mission. This retraining mission will of necessity need to be long term. The natures of teaching practices in 1996 still pertain today and are furthermore important indicators. The first cohort of Grade One learners was exposed to Curriculum 2005 from the beginning of 1998. The task of retraining educators is monumental and efforts from NGOs to assist in this respect will be viewed favourably. Those NGOs that will contribute towards the shaping of educators' classroom practices in a positive way, in terms of the direction that is envisaged by Curriculum 2005, will be invaluable in the transformation of South African education.

MCPT's assurance of having begun effecting change in the classroom practices of mathematics educators in the direction desired by Curriculum 2005 could be very useful. Likewise, NGOs with an approach similar to that of MCPT would be similarly advantaged. This investigation, therefore, focuses directly on the classroom practices of educators who have received INSET from MCPT. The focus of this investigation is confined to classroom observations of educators and an examination of their views regarding the impact of the INSET that they received.

The next chapter of this research report provides a theoretical analysis of the teaching methods and skills which are an outcome of NGO-sponsored mathematics INSET on the classroom practice of primary school educators. This outcome is based on the documented goals of MCPT.

Chapter Three outlines the research approach and methods employed in the study to investigate general trends in classroom practices of educators who have received INSET training from MCPT, as well as their perceptions of these developments (if any).

Chapter Four sets out the data obtained during my classroom visits. This data, which constitutes observed practices and reflections (interviews), is analysed and discussed in terms of the goals of MCPT, the theoretical background established in Chapter Two and its resultant advancement of the Interim Mathematics Syllabus, together with the critical cross-field and specific outcomes of MLMMS, as documented in Curriculum 2005.

Chapter Five answers the key question of whether and how the NGO-sponsored mathematics INSET provided by MCPT has been effective. This will be done in the light of the findings that emerged from the investigation, as well as of the changes and developments that are underway in curriculum development at the time of writing this report, namely, the Numeracy learning programme as outlined in Curriculum 2005. This chapter also presents implications and recommendations for the future practice of NGO-sponsored mathematics INSET.

CHAPTER TWO

THEORETICAL BACKGROUND

This chapter sets out a theoretical analysis of mathematics teaching practices advocated by the Mathematics Centre for Primary Educators and argues that a combination of the constructivist and traditional approaches is ideally suited for the delivery of the Numeracy learning programme as outlined in Curriculum 2005. This argument emerges from the view that most NGOs ascribe to a similar teaching-learning philosophy in their educator development programmes.

In this chapter I will summarily explore the work of Piaget as a basis for the radical constructivist approach to learning, while the theories of Vygotsky will be examined to understand the basis for the sociocultural perspective of constructivism. Through the lens of sociocultural constructivism in particular, I will then theorise key aspects of MCPT's programme, which provide a conceptual framework for the study. The work of Mercer (1995), Copeland (1984), Szendrei (1996), Adler (1998), Grouws (1992), Confrey (1993, 1994), Lerman (1996) and Cobb (1994), who provide insight on disparate key aspects of MCPT's programme, will be reviewed.

2.1 MCPT's Approach to Teaching Mathematics within the Context of Curriculum 2005

The definition of the learning area Mathematical Literacy, Mathematics and Mathematical Sciences as described in the Senior Phase Policy Document (Department of Education, 1997c) is given below.

> "Mathematics is the construction of knowledge that deals with qualitative and quantitative relationships of space and time. It is a human activity that deals with patterns, problem-solving, logical thinking etc., in an attempt to understand the world and make use of understanding. This understanding is expressed, developed and contested through language, symbols and social interaction."

Curriculum 2005, which encompasses Outcome Based Education, presupposes "active learners" who learn through "critical thinking, reasoning, reflection and action". The curriculum calls for "an integration of knowledge (with) learning (being) relevant and connected to real-life situations". This "learner-centred" approach sees the role of the educator as being that of facilitator who "constantly uses group work and teamwork to consolidate (the) new approach" (Department of Education, 1997a:.1).

MCPT's claim that its teaching methodology is aligned to the learner-centred / constructivist methodology called for in Curriculum 2005, is illustrated by the directors' words below:

> "Every bit of work that the Mathematics Centre does is outcomes- based already. So we don't need to do a transfer from teacher-directed, didactic type of methodology. We are already in tune with the 1998 Areas of Learning (Curriculum 2005)" (From interview with director of MCPT).

From the position of "already being in tune with " (ibid) Curriculum 2005, MCPT also claims that its practice makes use of both the traditional and constructivist approaches to teaching. This is borne out by the words of the director in which she claimed:

> "Mathematics Centre for Primary Teachers does not push constructivist philosophy, or investigative philosophy as the only way to teach. We value teachers and we know that there is a place for didactic teaching" (From interview with director of MCPT).

but a little later in the interview added "...[o]f course we promote constructivist investigative work..."

The teaching-learning philosophies MCPT ascribes to will therefore form the backdrop against which its practice will be examined. This will be done within the context of Curriculum 2005.

2.2 What are the main focuses of change in MCPT's practice?

With classroom practices which are "learner centred, non-authoritarian, and which encourage the active participation of students in the learning process" (ANC, 1994:69) being a requisite, the place of an exclusively traditional, educator-dominated classroom needs to soon become a memory.

As alluded to in Chapter 1, the learner-focused view centres on the learners' active involvement in doing mathematics by exploring and formalising ideas. It is, therefore, the instructional model most likely to be upheld by those who have a problem-solving view of mathematics and see mathematics as a dynamic discipline, dealing with self-generated ideas involving different methods of inquiry (Ernest, 1988). From this perspective of teaching, the teacher is viewed as facilitator and stimulator of student learning, posing interesting questions and situations for investigation, challenging students to think and helping them to uncover inadequacies in their own thinking, with the aim that students should ultimately become responsible for judging the adequacy of their own ideas (Kuhs and Ball in Thompson, 1992).

The use of manipulatives, contextualised problems, small group work and coordination of actions, operations and representations have been effective tools in challenging the passive mode of learning (Confrey, 1993: 8). Constructivists reject the view of children's minds being blank slates. They attest that there must be significant discussion and interaction around the variety of strategies that students propose (Confrey, 1993: 3). They emphasise the importance of children's active participation in the building up of concepts.

According to Cobb and Steffe (in Koehler & Grouws 1992), educators should make a conscious attempt to continually empathise with their learners by seeing the actions of the learners from the learner's perspective. Mathematical learning is not a process of internalising carefully packaged knowledge, but is a matter of reorganising activity, where activity is broadly interpreted to include conceptual activity or thought (ibid). Therefore, the teacher must structure, monitor and adjust activities for students to engage in. Similarly, Koehler and Grouws (1992) write that "teaching is viewed as a continuum between negotiation and imposition, and the teacher's role is to find and adjust activities for students" (p.123).

Constructivism, thus, rejects the notion that the child's mind is a direct copy of experience, or that it was preformed in a child at birth. Further, a constructivist theory of learning argues that it is not possible for knowledge to be imparted intact from one person to another. Consequently, knowledge of how children learn is essential in teaching of mathematics.

The constructivist's view of mathematics is typically learner focused, i.e. mathematics teaching that focuses on the learner's personal construction of mathematical knowledge. The learner is not given knowledge but he/she actively constructs the knowledge him-/herself. The acquisition of knowledge is seen to be a process of adapting one's view of the world as a result of this construction.

A primary contribution of the constructivist approach is to encourage diversity among individuals as a fundamental part of learning. An answer is neither accepted as correct nor rejected as incorrect on the grounds of the educator's perception of what the correct response ought to be. All answers are accepted, provided that the learner is able to support his/her viewpoint. Thus, in the constructivist perspective, the interaction between the teacher and the learner forms the primary mathematical interaction in mathematics teaching (Steffe and Killion in Nickson, 1992: 106). In other words, the teacher imparts the intended meaning to the learners, who interpret and adjust it according to their schemas, thereby constructing their knowledge.

There is much emphasis in the Outcomes Based Approach advocated in Curriculum 2005, on children being able to use and apply the mathematics they are learning. It is recognised as essential for children to be able to talk about their own ideas, describing and explaining their current thinking, as well as making and testing predictions based on personal experience. Children are, therefore, clearly required to understand the mathematics they do. Mechanical manipulation of numbers and symbols can no longer be considered sufficient. Children need to be afforded the opportunity to discuss and to reflect upon their experiences so that they are able to make sense of the mathematics they meet. Thus, the educator needs to plan for groups of children to come together to share and to compare their ideas and perceptions. During these exercises, the educator's role is to exploit and refine the ideas offered by the children so that they are able to negotiate a fuller understanding of the underlying mathematics. It is clear that the educator's role as mediator in the 'discussion-based'-constructivist style of teaching requires a different set of skills and organisational strategies from the more familiar traditional approach (Ball, 1990, p. vi).

2.3 Constructivism

Constructivists in mathematics education are divided into two major camps. The first group, known as radical constructivists, ascribes to the philosophy and development theory of Piaget in which the primary focus is placed on the individual. The second group, known as sociocultural constructivists, ascribes to a Marxist-socialist construct of society where the sociocultural context of the individual is paramount. Here the primary focus is placed on social life.

At the time of writing this report there is ongoing debate about the inter-relationship between radical and sociocultural constructivism, a debate beyond the scope of this discussion. The theoretical dichotomy is essentially that for radical constructivists development leads learning while the opposite is true for sociocultural constructivists. A position, once adopted, clearly has implications for the role of the teacher. The educator's role is made clear later in this study.

Theoretical assumptions of learning in MCPT's practice can be seen to draw eclectically on both radical and sociocultural constructivism. In its practical form the dichotomy of these philosophies will be shown in MCPT's practice.

2.3.1 Radical Constructivism

Radical constructivism, which is neo-Piagetian in its orientation to learning and development, has been widely discussed in mathematics education, by von Glasersveld in particular, since the mid-1980s. This philosophy focuses on the individual as a self-organising system, and works its way out towards the conception of a classroom and a society. For Piaget the notion of biological activity is central to the understanding of the unfolding intelligence of the child. Learning is seen as the interaction between a child's schemas and new ideas. *Schemas* are segments of interrelated ideas in the child's mind. This interaction between schemas and new ideas involves *assimilation* and *accommodation and equilibration. Assimilation* entails setting new concepts into existing schema. It occurs when a new idea is incorporated directly into existing schema, resulting in expanding existing concepts. *Accommodation* occurs when previous ideas remain intact and new ones are added. It is the result of new concepts being different

from existing schemas, and while the schemas may be relevant, they are not adequate for assimilation.

Equilibrium is the biological driving force behind cognitive development. This driving force compels the individual into a pattern of life-sustaining cognitive activity without which he / she would die. Piaget calls this force *equilibration* (self-regulation by a biological system). Equilibration is, therefore, the fundamental drive, which engages psychological and other development in the child. When new knowledge is assimilated the equilibrium is disturbed and thus a new equilibrium is sought. (Olivier, 1989:11).

Piaget further avers that cognitive activity and resultant cognitive transformations can only be explained in terms of the biological nature of the total human organism. He describes this as follows:

> "The development of knowledge is a spontaneous process of *embryogenesis*. Embryogenesis concerns the development of the body, but it concerns as well the development of the nervous system and the development of *mental functions*,...a total developmental process, which we must restitute in its general biological context" (Piaget, 1964:8).

Because Piaget sees cognitive growth as an aspect of the biological adaptation of the child to its environment, he hypothesises that psychological states also correspond to states of equilibrium between the developing organism and its environment. He attests that all children pass through the following stages of development in a common and obligatory sequence, namely:

- sensorimotor thought
- preoperational thought
- concrete operational thought
- formal operational thought

Piaget postulated that "children's intellectual development is very much driven from within the individual, and that children's capacity for understanding is determined essentially by the "cognitive level" that they have reached as an individual" (Mercer, 1995: 72). The child's activity at any point in time would therefore, be typical of its stage of development. For example, he states that:

> "the child can receive valuable information via language or via education directed by an adult only if he is in a state where he can understand this information. That is, to receive the information he must have a structure which enables him to assimilate this information. This is why you cannot teach higher mathematics to a five year old. He does not have the structures which enable him to understand" (Piaget, 1964: 13).

Thus, in designing activities for learners, the teacher must ensure that the complexity of subject matter is appropriate for the learner being taught. Moll (1989: 715) establishes that "Good teaching in a Piagetian view involves presenting children or adults with environmental or instructional situations which are geared to the stages of development in which their knowledge is constructed".

From this perspective, the role of the teacher is to assess the child's level and quality of cognition, essentially through observation in an educational context. She must then design an appropriate classroom environment which matches the child's level of cognition. The child would then engage in experiments, manipulate objects and symbols and answer questions (provided by the teacher), all of which are consistent with the child's dominant cognitive activities at that point in time. In this context the role of the teacher is that of facilitator, offering intervention where appropriate.

MCPT's reference[13] supports Kamii's radical constructivist view that first grade mathematics should throw out all traditional instruction and use should only be made of situations experienced in daily living and in games to develop mathematical concepts. Consequently, if a child believes that "8 + 5 = 12" (MCPT's reference: 166), he should be encouraged to defend his viewpoint until he finds a better solution. In order to help the child to generalise the mathematics that he has discovered, he will first need to be exposed to a wide variety of materials. Only when the child's existing knowledge is sufficiently rich and varied, and when he begins to ask questions which require new input of concepts, is the time right for injecting new ideas (MCPT's Reference). In this way he can ascertain the applicability of the newly learned principle to unusual situations by himself.

[13] Material supplied by MCPT – source unknown. For the sake of convenience it will be assumed that the author is male.

Radical Constructivism thus emphasises creative constructivism in which the individual is primary. The individual learns by being active with resources. Everything is moulded by how the learner constructs it. Knowledge therefore, is seen as what one makes up in one's mind and is not the objective observation of the individual. Two individuals can, consequently, never have the same knowledge. In this way "[r]eality is unknowable in that one can never know that what one perceives as reality is anything other than one's construction" (Lerman , 1996: 140).

Jaworski contemplates the merit of this radical position in suggesting "that we can never know objective truth, even if it exists - all we can do is struggle to explain what we observe, to observe theories that fit our observations" (in Pimm, 1989: 293).

Bishop (1984), however asks that given that each individual constructs his own mathematical meaning, how can we share each other's meanings? He sees it as a problem for children working in groups, and for teachers trying to share their meanings with the children individually. If meanings are to be shared and negotiated, then all parties must communicate. He reminds us that "communication is more than just talking! It is also about relationships" (Bishop, 1984: 40-41).

Piaget argues that despite cognitive development being accelerated or retarded according to a child's sociocultural environment, the fact that it matures in the same sequence in any social context shows that the social environment cannot account for everything (Piaget, 1964).

The debate continues. What is agreed is that mathematics learning is essentially a constructive activity, instead of an absorptive one. It is becoming increasingly argued to be an inherently social, as well as a cognitive activity (Schoenfeld, 1992). As Bishop (1984) has argued, learning and social interaction are what form consciousness, and learning leads to development. This view has led to a turn away from a radical constructivist perspective to a sociocultural perspective, a perspective informed by the developmental work of Vygotsky. Vygotsky sees consciousness as coming about through communication, through mediation, and through language in particular, and hence is social in nature.

2.3.2 Sociocultural Constructivism

Vygotsky, one of the key proponents of sociocultural constructivism, has the following contention against radical constructivism:

> "Our disagreement with Piaget centres on one point only, but an important point. He assumes that development and instruction are entirely separate, incommensurate processes, that the function of instruction is merely to introduce adult ways of thinking, which conflict with the child's own and eventually supplant them. Studying child's thought apart from the influence of instruction, as Piaget did, excludes a very important source of change and bars the researcher from posing the question of the interaction of development and instruction peculiar to each age level. Our own approach focuses on this interaction." (Vygotsky, 1962: 116).

In contrast to the position adopted by the radical constructivists, the sociocultural approach upholds the value of socialisation, and speech in particular, in learning. Sociocultural constructivism defends the position that knowledge is not passively received from the environment but that it is actively constructed by the learner. This construction of knowledge is dependent upon the mediative role of the educator in the educative process-with the educator providing opportunities for learning to take place within the zone of proximal development. The various components of this position are further elucidated below.

Speech is Key

Vygotsky (1979), who places greater emphasis on communication over action sees speech as playing an essential role in higher psychological functions. He further sees language as the link between the interpersonal and the intra-personal spheres (1962, 1978). It is the bond between the internalisation of the social-instructional environment and the capacity for self-direction or self-regulation through inner speech.

Vygotsky sees development as being dependent on the internalisation of speech. He says that observations have revealed that children not only act, but also speak in order to achieve a goal. As the goal becomes more difficult to attain, this egocentric speech takes on even greater importance. It increases and becomes even more persistent.

The role of the child's speech, therefore, is not only to talk about what he/she is doing, but also, together with the action, is "part of one and the same complex psychological function, directed towards the solution of the problem at hand" (Vygotsky, 1979: 25).

Sometimes the role of speech becomes so important that if it is not permitted, the child cannot accomplish the given task. Vygotsky points out that children solve problems not only with their speech, but with their eyes and hands as well. "This unity of perception, speech, and action, which ultimately produces internalisation of the visual field, constitutes the central subject matter for any analysis of the origin of uniquely human forms of behavior" (Vygotsky, 1979: 26). The child who uses speech, divides the activity into two consecutive parts, namely, in planning the strategy for solving the problem and, in carrying the prepared solution through overt activity. The child's egocentric speech (which is the basis for inner speech) should be regarded as the transition between external and internal speech (which is embedded in communicative speech) (ibid:27). This mixture of speech and action has a very specific function in the child's development.

Bennett and Dunne alert us to the thinking of Bruner, who also comes from a social-constructivist orientation. They point out that most learning in most settings is a communal activity, a sharing of culture. The child, in addition to making the knowledge his own, must do so in a community of those who share his sense of belonging to a common culture (Bennett and Dunne, 1994:52). He claims that social interaction, which is assigned a central role in facilitating learning, can be with anyone - peers, educators, parents, etc.

Mercer alerts us to Vygotsky's views on the value of talk between learners. While in the traditional classroom talk between learners is treated as disruptive and unacceptable, the value of talk between learners in the child-centred classroom cannot be underestimated. As argued above, language has a strong influence on the structure of thought and, in talking through their actions, learners are helped to put their mathematical actions into words. Learners should, therefore, be allowed to verbalise their ideas in the mathematics class (Mercer, 1995: 71).

Mercer (1995: 94) refers to Barnes and Todd's suggestion that children are more likely to engage in open extended discussions and argument when they are talking with peers

outside the visible control of the educator, and that this encourages them to take a more active and independent ownership of knowledge. Murray supports "the view that discourse with peers provides a better support system or vehicle for learning than teacher support" (1992: 3).

This opinion is echoed by Brodie (1995) who cites the following comment by Edwards and Mercerand Barnes:

> "More general research has shown that the teacher's control over knowledge and discourse in classrooms can be detrimental to learning, and suggests that peer groups, which provide more equality and allow learners more control, may be preferable to teacher directed learning" (Brodie,1995:1).

Educators should therefore, as part of their teaching practice, create opportunities for learners to communicate their thoughts with each other during the mathematics lessons.

While the above evidence supports the view that talk, particularly between peers, is essential, Atkinson (1992) reminds us that mathematical language and not pencil and paper exercises are the main tools for the learner and the educator. The educator must employ all her knowledge and skill to make appropriate interventions, which should encourage her learners to talk about what they are doing. The sociocultural constructivist approach to learning, therefore, places great value on the *role of the educator.*

The Educator's Role

Vygotsky (Mercer, 1995: 71-90) views the educator as a *mediator* and, therefore, as being at the centre of both learning and development. The role of the educator is not to simply tell, but also to provide scaffolding, appropriate activities and apparatus. In shifting to a learner-centred approach the role of the educator does not disappear, leaving the learner to discover everything by him-/herself. The learner-centred classroom requires of the educator an even higher level of expertise than that required within a traditional setting.

The role of the educator is that of organiser of frameworks of knowledge. Within the learning situation, the verbal formulations that an educator employs will become the

internalised speech of the learner. The culmination of the learning process is when the learner starts to use the formulations as his or her own. A good educator uses conversational methods in the classroom to provide learners with new conceptual language. These new concepts are then internalised and become the basis of higher forms of cognitive activity. Knowledge is seen to be constructed within the social relationship between the educator and the learner.

Given that teaching is understood to be a social activity within which meaning is mediated to and negotiated with the learner, the educator's role is seen as that of identifying the learner's level of understanding and then mediating new knowledge to him/her as a conscious social agent. Mercer (1995) agrees with Vygotsky's view that learning with assistance or instruction is a normal feature of human mental development and that the limits of a person's learning or problem-solving ability can be expanded if another person provides the right kind of cognitive support. Mercer sees this learning, which takes place within the *zone of proximal development*, being instrumental in making mediation possible. It provides a conceptual mechanism for explicating learning possibilities.

Zone of Proximal Development

Vygotsky (1978: 86) defines the zone of proximal development (ZPD) as

> "...the distance between the actual developmental level as defined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers"

He suggests that this ZPD is a clearer indication of the child's potential than an evaluation of functions that have already matured. The zone of proximal development awakens in the child "a variety of internal developmental processes". Subsequent to instruction, either through reflection or even perhaps through subconscious activity, much construction of knowledge takes place. The educator needs to provide appropriate scaffolding that allows each child to progress in his unique way. While "[t]he actual developmental level characterises mental development retrospectively... the zone of proximal development characterises mental development prospectively" (Vygotsky, 1979: 86-7). Vygotsky sees "good learning" as being that which is in advance of

development. He criticises any instruction that lags behind development and argues that "[t]he only good kind of instruction is that which marches ahead of development and leads it; it must aim not so much at the ripe as the ripening functions" (Confrey,1993: 14).

Vygotsky asserts that the crucial determining influence behind a child's development must consist of relationships within the social domain. The driving force of cognitive growth is to be found within society or, more specifically, within the social relationships specified by the ZPD. The child does not construct his/her own complexes freely but does so within the process of understanding others' speech. The educator as a significant mediator must be conceived of as responsible for the production of cognitive development (Vygotsky, 1962).

In order to help learners make sense of mathematics, the educator needs to effectively communicate the curriculum to ensure that learners produce their best possible examination results. This must be done in light of the fact that their futures may depend upon these results.

Opportunities for Learners to Participate

Paradise (Mercer, 1995: 22) suggests that the more passive the role the adult plays in shaping the learning of the child, the more active the child becomes in managing and taking responsibility for his own learning as well as in maintaining a higher level of motivation. Mercer (1995) further points out that traditionally, educators have held the position of being gatekeepers to curriculum knowledge and evaluators of learning and have provided learners with only limited opportunities to express themselves. When asked a question, a learner would often provide an answer which he/she believed the educator was looking for, rather than to challenge the educator or express an opinion. In a typical initiation-response-feedback exchange the educator asks the question, the learner responds and the feedback from the educator is either acceptance or non-acceptance of the answer. Because educators are able to tolerate only short silences after asking a question, only a few learners are able to answer within the allocated time span. In a situation where the learner has answered incorrectly, the educator would normally then ask another learner whom he believes is better equipped to answer

correctly. Further analysis of a correct response is usually lacking and, where the response is incorrect, an investigation into the thinking behind the incorrect response is also absent. While this type of teaching-learning strategy has its place, the only opportunities for learners to express themselves are seen in relation to questions the educator asks. Any gaps in a learner's understanding of a topic are not given a chance to surface.

In a traditional classroom, the educator usually asks close-ended questions, i.e. she usually has a closely worded question to which she already has an answer in mind. Typically, she either accepts or rejects the learner's response, and even though several learners may be involved in this question-answer scenario, no real discussion takes place (Ball, 1990:8).

Mercer points out that " the construction of knowledge requires that people put some things into words, even mathematical procedures which do not seem 'linguistic', so that they can be shared" (Mercer, 1995:77). The point of this argument is that in verbalising their thoughts (even to themselves), the educator is able to detect inaccuracies in the child's thinking and intervene timeously.

2.3.3 Radical or Sociocultural Constructivism?

I have briefly described assumptions in radical constructivism, and more on sociocultural constructivism. These theoretical orientations to learning and development have been argued as compatible (Confrey, 1994 and Cobb, 1996) through to incompatible (Lerman, 1996). It is not my purpose here to resolve this theoretical debate, but to provide descriptions of each and their differences, so as to illuminate MCPT's intentions and practice.

The MCPT approach as described in Chapter 1 can be seen as drawing interpretations for practice based on assumptions in both a radical constructive perspective and a social constructive perspective. Perhaps this is a pragmatic feature of actual practice. While outcomes based education stresses the shift from the educator-centred to the learner-centred approach, the foremost consideration is that the role of the educator has not disappeared.

In the remainder of this chapter I will discuss the key features of the MCPT approach, namely:

- Teaching Methods
- Availability and Use of Resources
- Group Teaching and the Role Learners during the Mathematics Lesson
- Educators' Mathematical Know dge and Confidence
- *Planning and Preparation of Lessons*[14]
- *Outcomes Based Education Methodology* and
- Language of Teaching and Learning (LOLT).

I will relate these key aspects to the theoretical discussion above and to literature and research in the field. It is through these key features that I can illuminate the effectiveness of MCPT's mathematics INSET on the classroom practices of primary school educators.

[14] *Planning and Preparation of Lessons* and *Outcomes-Based Methodology* are two aspects that have inadvertently emerged as points for discussion in Chapter Four. They have not been expounded upon in Chapter Two, but have surfaced as important indicators of MCPT's practice.

2.4 Teaching Methods

MCPT views its practice as mathematics based on understanding. It uses what it describes as a balanced approach using both traditional and new methods. Though MCPT claims to make use of a range of strategies, it does in contradictory terms align itself to constructivism. Again these words of the director reflect MCPT's position:

> "Mathematics Centre for Primary Teachers does not push constructivist philosophy, or investigative philosophy as the only way to teach. We value teachers, we know that there is a place for didactic teaching" and a little later in the interview adds "of course we promote constructivist, investigative work." (From interview with director of MCPT).

In MCPT's claimed affiliation to constructivism, it is clear that MCPT leans heavily towards sociocultural constructivism, where the role of the educator in developing the learner within his/her zone of proximal development is paramount. This position is illustrated when, for example, a child gets the answer to a question right "then the teacher would encourage the child to do more, give something more difficult, more challenging" (From interview with director of MCPT).

Given the above, sociocultural constructivism and aspects of traditional teaching, such as repetition (drilling) and direct teaching, will form the backdrop against which I will investigate MCPT's practice.

2.4.1 Active Learning

Copeland (1984), who works within a Piagetian framework, avers that knowledge is actively constructed by the learner who is trying to make sense of his/her everyday experiences. The child is seen as an active participant in the construction of his/her own knowledge, where instruction only affects, but does not determine this construction. New knowledge is interpreted, understood and organized by the learner in terms of already existing schema.

Mathematical knowledge cannot be transmitted by social transmission alone i.e. learners cannot grasp concepts from seeing and hearing alone. They need to physically manipulate objects in order to fully understand concepts. For example, the necessary

mathematical structures have to be invented by the child himself. Knowledge of 15 + 3 + 2 = 20 is not sufficient. The child needs to discover for him/herself exactly how that answer was arrived at, as opposed to rote learning (committing facts to memory) which does not lend itself to generalisation of strategy (Copeland, 1984).

Copeland maintains that

> "[a] student who achieves a certain knowledge through free investigation and spontaneous effort will later be able to retain it; he will have acquired a methodology that can serve him for the rest of his life" (Copeland, 1984: 367).

Sociocultural theory concurs with a conception of knowledge acquisition being a constructive and not simply a transmission type of activity. Vygotsky warns that

> "[d]irect teaching of concepts is impossible and fruitless. A educator who tries to do this usually accomplishes nothing but empty verbalism, a parrotlike repetition of words by the child, simulating a knowledge of the corresponding concepts but actually covering up a vacuum" (in Clements and Battisa, 1992: 432).

Similarly, Copeland (1984) too, cautions educators to steer away from the tradition of suggesting to learners that being good implies that they should not question ideas put forth by the educator, and that they should only do what the educator says. He maintains that as mathematics is a study of relationships, learners should spend more time in each mathematics lesson establishing those relationships independently, than they should in reading and writing.

Both perspectives thus offer a contrast to the traditional classroom where the role of the educator was to set problems, dictate the method of solution and tell the learners if they got the right answer. The educator's role in the constructivist classroom is one of facilitator or helper. The educator helps learners to clarify what the problem is and supports their efforts at finding solutions. An answer is correct if the children agree that it works in practice. Where the two approaches differ is in the role of intervention and mediation by the teacher. Radical constructivism will argue for a more facilitative and less interventionist role than sociocultural constructivism.

According to Mercer the construction of knowledge as being based on discovery learning and problem-solving is characterised by working with the ideas of others as well one's own. He reminds us that for educators the issue of maintaining a balance between

offering learners the opportunity of answering open-ended questions and completing the prescribed syllabus timeously presents a major challenge (Mercer, 1995: 29).

2.4.2 Traditional teaching as a teaching-Learning approach

Educators of young children will know that teaching based on discovery learning alone can indeed take a very long time. MCPT's Reference therefore, argues that direct teaching is sometimes more efficient in terms of quality and breadth of learning. While the discovery method might occasionally be appropriate, meaningful verbal learning also has its place. Thus Mercer, from a sociocultural perspective, maintains that educators should avoid having to make stark choices between the "traditional" and the "progressive" approaches to teaching (Mercer, 1995: 66). He sees it as not being necessary for *all* knowledge to be acquired through a process of discovery. Good expository teaching, which is more economical in terms of time taken, should ensure that the new knowledge is linked to existing ideas. As children are capable of making new ideas their own, even when these ideas are transmitted to them, it is not necessary that the whole of knowledge should be reconstructed by each individual. MCPT's reference supports the work of Ausubel in which he (Ausubel) asserts that the idea of each individual constructing the whole of knowledge, is not only unnecessary, it is also ridiculous. He therefore alludes that a combination of repetitive chanting and drill exercises linked to a constructivist approach could be the most effective means for the construction of knowledge. (MCPT's reference:165).

Pimm highlights the tension in current discussions on the teaching of mathematics

> 'which has been polarised into a conflict between 'understanding' (adopting a so-called 'meaningful' approach) on the one hand and obtaining automation and fluency at 'doing' on the other (using what are pejoratively and undiscriminatingly labeled 'rote' methods)' (Pimm, 1995:8).

A common view is that learners should always understand before being asked to apply knowledge to a task. This raises Douglas's concern that "...the pressure of the doctrine of 'always understanding before doing' results in learners missing out on what ritual can offer" (Pimm,1995:9). Pimm maintains the value of rituals such as chanting in enhancing fluency, claiming that "...until very recently learners were required to do

calculations quickly and effectively" (ibid), and that their successes stemmed from rote practices. He now raises the question of how learners can automate again, so that they free up their conscious attention to concentrate on more pressing issues at hand. Pimm strongly supports the view that "...some so-called rote methods, including group speaking and chanting, [are still]...very powerful techniques" (ibid:8) and should not be refuted as a method of teaching and learning.

MCPT's support for making use of a combination of approaches for the teaching of mathematics, highlights the need to focus on both '*inventions*' and '*conventions*' in the teaching of mathematics (Lampert, 1991). While the constructivist approach paves the way for the learner to construct and hence invent his own mathematics, traditional teaching methods highlight the need for transmission of conventions. This eclectic perspective will be analysed in practical terms in Chapter Four.

In order for meaning to be made in the classroom, Potenza and Manyokolo (1999: 231) claim that, three pillars of learning need to be in place. These are the teacher development, curriculum development and resources. Therefore, I will now look at the place of resources within the MCPT context.

2.5 Availability and Use of Resources

Discussion on resources is typically not evident in debate between radical and sociocultural constructivism. A constructivist perspective, as argued in the previous section, implies activity, which in turn implies objects to act with and on. Resources are key. As Adler et al. argue "...[r]esources are fundamental to learning. They are not add-ons, to bring in to the occasional lesson. They are an extension of the teacher" (Adler et al., 1999: 3). In line with this perspective, MCPT is adamant that it is not possible to teach good mathematics without the use of resources. In the words of the director of the MCPT:

> "If she (the educator) chooses not to use any of those (resources), then for the vast majority of children maths is a very scary, very boring and very demotivating kind of learning, and it cannot be done. It just cannot be done." (From interview with director of MCPT).

MCPT supports their reference's view that mathematics is a powerful tool for interpreting the world and therefore should be rooted in real experience across the curriculum. In order to develop mathematical concepts in the class, use should as far as possible be made of situations experienced in daily living and in games to develop mathematical concepts. Mathematics must be brought out of the child's everyday situations e.g. in sharing of a biscuit, taking turns, deciding what is fair, solving problems, etc. Consequently, if a child believes that a particular answer to a mathematical problem is correct, he should be encouraged to defend his viewpoint until he finds a better solution.

Lampert (1991) supports Green's and Scheffler's argument that:

> "If students are to learn that mathematical principles are true, not by virtue of the teacher's authority, but by virtue of reasoned argument in a community of discourse, then they need experience with mathematical forms of legitimation. Posing problems in a domain whose constraints are familiar (like coins) provides an environment in which students can find out for themselves whether their answers are correct" (Lampert, 1991: 128).

It therefore follows that in order to help the child to generalise the mathematics that he has discovered, he will first need to be exposed to a wide variety of materials including manipulatives.

Szenderi points out that manipulatives help learners develop and understand the concepts, procedures, and other aspects of mathematics, as well as to develop skills that are not equally well-developed through out-of-class experience (Szendrei, 1996: 426/7). She elucidates three threads of concrete materials essential for the learning of mathematics (p. 418-419). They are *common tools*, *educational materials* and *games*.

- *Common tools* are those freely available materials commonly used in out-of-school life such as beans, acorns, matchsticks, appropriate waste materials, seashells, etc. Szendrei supports Paolo Boero's plea for the use of common tools in which he argues that "[c]oncepts that are developed by using common tools allow both a positive resonance with out-of-school experience and an immediate transfer to the use of mathematics in real life situations" (ibid:422).

- *Educational materials* (ibid: 418) such as Dienes blocks and Cuisenaire rods are materials specifically constructed for school purposes for the teaching of mathematical concepts. However, it must be remembered that educational tools do not facilitate an immediate transfer of classroom mathematics to real life situations as effectively as common tools do.

- *Games,* too, can develop mathematical skills. Szendrei, however, stresses that games in themselves are not enough for mathematical development of children. They can and should be used as tools or resources to enhance mathematical learning within an educational process planned by the educator (ibid:421).

Research tells us that there is an increasing understanding in the field of the relationship between the availability and use of resources. Adler (1998: 6) warns that while concrete materials help to facilitate understanding by providing the means for learners to construct their own knowledge, it is vital for the educator to recognise that classroom resources cannot in themselves achieve the teaching of mathematics. Mathematical meaning comes through the mediated use of these resources. The educator's skills in using mathematical resources in his/her classrooms will determine the quality of learning that takes place. While some concrete materials are quite simple to use, requiring no further training for the educator, others are not self-explanatory objects, and require structured training on how to use them properly.

In line with this view, Szendrei cites international research in mathematics education concerning the issue of using concrete materials in the classroom, namely:

> "Concrete materials in the classroom require that its organisation be well designed. ... The role of educator training at any level is not only to teach the content and introduce the various manipulatives but to develop good classroom organization skills as well. Cultural and language differences may give a high priority to certain materials or limit their use as tools" (Szendrei, 1996: 433).

Furthermore, Adler sees learner-centred strategies necessitating the handing over of resources to the learner. The educator does not "monopolise the resource, using it in a highly directed way to demonstrate an action or task." (Adler, 1998: 6). Instead, learners are provided with the opportunity to interact with the materials themselves, and in this way construct their own mathematical knowledge. Adler points out that in the mathematics classroom resources need to be both *visible* and *invisible and* "[l]earners need to be aware of them and at the same time they need to illuminate the mathematics" (ibid: 10). Adler claims that whenever a resource is drawn on in class it becomes visible, the object of attention. This is particularly true when novel resources are introduced. Learners will need time to become acquainted with the resource and how it is operated. Once it is no longer the object of attention, the resource is regarded as invisible. She points out that "[l]f the resource is to enhance and enable mathematical learning, then at some point it will need to become invisible - no longer the object of attention itself, but the means to mathematics." (ibid: 10).

The above argument indicates that the educator should use manipulatives in order to bridge the gap between knowledge acquired at school and the broader life of an individual. This is borne out by Lampert and Schoenfeld, who propound that learning in an environment where mathematical knowledge can be learned in ways congruent with the learner's out-of-school culture, will enable the learner to solve many diverse problems and to gain new knowledge (in Schoenfeld, 1992). It is for this reason that MCPT considers the making and use of resources as one of their key roles (From interview with director of MCPT). Learners will need to use these resources in different contexts - as a class, as individuals, in pairs or in groups. While the Piagetian perspective advocates activity with objects, the Vygotskian perspective favours mediation with tools.

2.6 Group Teaching and The Role of Learners during the Mathematics Lesson

As indicated earlier, MCPT advocates that group work is an integral part of teaching and learning. MCPT sees group work as being particularly useful in large classes, where it is difficult for the educator to address the needs of all her learners at the same time. In the words of the director of the MCPT:

> "...We don't pretend that a teacher can cope easily with a large class.....if the teacher can rationalise [the management of the pupils, lesson, resources and overall management of learners in terms of the physical space] , then, and then alone she will be able to use something like *group work*, something like differentiated tasks....We recommend group work" (From interview with director of MCPT).

In conducting group work the teacher works with one small group at a time while the rest of the class works independently on other tasks or activities called *independent work* which is set by the educator.

In terms of The National Qualifications Framework Working Document (Department of Education, 1996), *essential outcomes* (subsequently known as critical cross-field outcomes) are defined as "...cross-curricular, broad outcomes that focus on the capacity to apply knowledge, skills and attitudes in an integrated way". This document further cites one of the *essential outcomes* as being the ability to "work effectively with others as a member of a group e.g. a team, society, etc...." (p.7). This essential outcome has forced educators to review their classroom management styles and ensure that opportunities are provided for learners to work in groups.

There is substantial evidence in the field of mathematics education research, and particularly research informed by constructivist perspectives, that indicate that learning best takes place in small-group settings. Good, Mulryan & McCaslin (1992) cite research by Slavin, Davidson, Johnson & Johnson, Sharan, Slavin and Slavin et al., all of which indicate that small-group instruction can, under certain conditions, facilitate achievement and effective gains. As sociocultural constructivist orientations have become more prevalent, we are now beginning to appreciate that given the appropriate context, the child is more a competent, intelligent social operator than a 'lone scientist' coping with a world of unknowns (Bennett and Dunne,1994: 52). Learning which takes

place in a social setting, particularly between the learner and a more knowledgeable other, is optimised when co-operatively-achieved success is a major aim. Slavin mentions some of the benefits of co-operative learning to include enhanced "...intergroup relations, acceptance of mainstream academically-handicapped students by their classmates, self-esteem, enjoyment of class or subject, and general acceptance of others" (Good, Mulryan & McCaslin, 1992: 172). He suggests that heterogeneous groups of about six members should be encouraged to help each other to learn.

Moreover, Pepitone (Good, Mulryan & McCaslin, 1992) argues that the focus of group goals as used in group dynamics theory should be directed towards the activity that the group wishes to accomplish, and as such should be decided on by the learners and not assigned by the educators. She distinguishes between three major sources of skills and relevant characteristics that are needed in competitive and cooperative situations, namely:

- task activity requirements,
- task role requirements and
- group role requirements.

Pepitone further argues that the concept of group roles, which has largely been neglected in cooperative learning, is of paramount importance because "no group can make much progress unless its members are willing to break the ice, mediate disputes and generally work to maintain the group itself" (Good, Mulryan & McCaslin, 1992: 172). The use of group goals and individual accountability is essential for skill acquisition. If these two factors are lacking, learners have no interest in one another's work and will therefore not provide one another with the rich explanations necessary to understand material and to achieve. When there are group goals but no individual goals, more-able learners may do all the work and feel reluctant to explain subject matter to struggling counterparts, because the value of each individual's knowledge acquisition is not clearly visible.

Ball (1990) similarly sees careful planning, the availability of materials and the encouragement of learner responsibility as important considerations in the development of an effective learning environment. She sees games built around an activity as being a very effective way of getting learners involved in doing, talking and recording. In this

way learners would be meaningfully occupied with work which does not require the immediate attention of the educator, leaving her free to engage in discussions with groups in the class. The educator must plan for this and the materials needed must be readily on hand to give rise to opportunities for the educator to move on to other groups of children.

It has become apparent that in a mathematics lesson doing and talking are of the greatest value. While recording does have its value, it should never be seen as the sole purpose or outcome of any activity (Ball, 1990). However, class management can be aided if learners are directed to 'record' the work they have been doing. Learners should be allowed to develop informal, personal methods of recording calculations with pencil and paper in a variety of contexts and a variety of ways. Atkinson maintains that children who are shown how to record may reveal only their compliance, rather than their understanding of operations and symbols (Atkinson, 1992: 74).

One drawback of small groups is that high-status students tend to dominate the groups, while low-status students remain relatively non-participant. Thus, appropriate tasks (from suitable areas of the curriculum), requiring multiple abilities and contributions for task completion, are likely to advance cooperative performance and collaboration by each member of the group. It would therefore follow as a necessity, that the educator must plan his/her lessons creatively, in order to gain maximum advantage from the various grouping strategies available to him/her.

2.6.1 Peer Teaching

As discussed earlier, from a sociocultural constructivist perspective, the value of talk between learners in the child-centred classroom cannot be underestimated. Vygotsky (Mercer, 1995: 71) argues that language has a strong influence on the structure of thought and that in talking through their actions, learners are helped to put their mathematical actions into words. Communication, as part of the learning activity should not be limited to that which takes place between educator and learner. Communication between peers also plays an important role (Mercer, 1995:94). Learners should therefore, be allowed to verbalise their ideas in the mathematics class. Barnes and Todd (Mercer, 1995: 94) suggest that children are more likely to engage in open

extended discussions and argument when they are talking with peers outside the visible control of the educator, and that this form of exchange encourages them to take a more active and independent ownership of knowledge.

Discussion, communication, reflection and negotiation are key to learning. Vygotsky (in Khisty, 1995: 281) sees the function of the "enabling other" being one in which the learner models his behavior upon that of the more experienced person. Bruner (in Mercer) uses the concept scaffolding to highlight the way in which one person can become intimately involved in the learning of someone else. He describes *scaffolding* as

> "the steps taken to *reduce the degrees of freedom* in carrying out some task so that the child can concentrate on the difficult skill she is in the process of acquiring" (Mercer, 1995: 73).

Scaffolding in schools can take the form of the educator offering sensitive and supportive intervention to a learner who is involved in a specific task, but is not quite capable of accomplishing the end by himself/herself. An important aspect of scaffolding is that the support and guidance must be increased or withdrawn in response to the developing competence of the learner.

2.6.2 Scaffolding between Peers

Scaffolding between peers can take the form of explaining to less competent peers or even explaining one's way through to a peer of matched ability. The sharing of ideas can help a child to achieve more generalisable kinds of understanding if he/she is actively helped and encouraged to do so. Scaffolding in terms of peer teaching and learning often coordinates with learner-learner interaction without the educator, as both these aspects are determined by the type of teaching and learning climate that the educator wishes to create in her class.

In order to deliver the mathematics curriculum optimally, the educator needs knowledge of how learning best takes place. Her classroom organisation would either be one of whole class teaching, group work, pair work, of even activities for individual learners. The educator must possess the pedagogic skills necessary, in order to manage her teaching methodology, learners, infrastructure, resources, time, etc., so that the needs of

every learner in her class are addressed. In addition to these requisite teaching skills, the educator must also of necessity possess sound mathematical content knowledge.

2.7 Educators' Mathematical Knowledge and Confidence

Regarding what she saw as the key roles of MCPT, the director responded

> "..powerful teachers developing powerful learners. And to develop such classroom practices (in teachers) which help children to understand how to manipulate mathematics, how to internalise their learning...From the *teacher's point of view it is a one-to-one intensive facilitation* so that the teacher becomes a reflective practitioner - the type of questions she asks and the kind of activities that she constructs, the kind of dialogue that he or she engages in with the children, the kind of listening that is required in order to understand what particular stage of mathematics is the child at." (From interview with director of MCPT).

Inherent in this response is preparing educators adequately for the delivery of the mathematics curriculum by improving and deepening their subject knowledge base. This understanding of "what particular stage of mathematics is the child at" (ibid) presupposes an insight, on the part of the educator, of the various stages through which the learner grows in order to reach his or her mathematical goals. While balancing the educator's mathematical knowledge and teaching skill is an issue in teacher development, there is fierce agreement that a strong knowledge base is vital.

Research in the field of socio constructivism alert us to the implications, the quality of an educator's content knowledge has in her practice. Fennema and Franke suggest that in order to be effective, teachers of mathematics "must have in-depth knowledge not only of the specific mathematics they teach, but also of the mathematics that their students are to learn in the future" (1992:147). In so doing educators are able to provide the means for teachers to structure their teaching so that learners continue to learn.

Hasweh (Fennema & Franke; 1992: 151) asserts that teachers who are confident in their subject knowledge are able to enrich their lessons by discussing topics in greater detail.

Beliefs previously held were that a educator's mathematical knowledge should "not be merely a day ahead of his learners but at least a year..." so that learners can get "full justice" (Alletson,1962: 16). Curriculum 2005 challenges this belief by suggesting that all foundation phase educators have a sound knowledge of the 7 critical cross-field outcomes as well as of the 66 specific outcomes, so that they are able to teach with the full erudition of the knowledge, skills, values and attitudes that the learner must acquire in each learning area within the phase. In line with this conception Fennema and Franke (1992) suggest that to be effective, educators of mathematics "must have in-depth

knowledge not only of the specific mathematics they teach, but also of the mathematics that their students are to learn in the future" (Fennema and Franke, 1992: 147). This would provide the means for educators to structure their teaching so that learners continue to learn. A firm grasp of the underlying concepts is an important and necessary framework for any educator to posses. Unfortunately, many mathematics educators simply do not know enough of the subject.

Brown et al. are cited to have reported that most pre-service elementary educators are not adequately equipped to teach mathematics. They found that in those areas of the syllabus where educators are more knowledgeable, instruction and subsequent learning of subject matter is richer.

The proficiency of an educator's knowledge can be translated to other areas of his/her practice. Hasweh provides evidence that educators' knowledge of subject matter contributes largely to the transformation of written curriculum into an active curriculum. Educators who are confident in their subject knowledge are able to enrich their lessons by discussing topics in greater detail and linking the topic to other discipline concepts (Fennema & Franke, 1992: 151). This skill is imperative for the integrated type of teaching called upon in Curriculum 2005. In contrast, educators who are not working in an area of their expertise, follow the text chapters more closely and fail to exclude inappropriate sections. When setting exam questions educators generally set open-ended questions in areas where they are more knowledgeable as opposed to the close-ended questions set in areas where their knowledge is limited.

From the constructivist perspective " *mathematics teaching* consists primarily of the *mathematical interactions* between a teacher and children" (Nickson,1992:106). The educator imparts an intended meaning to the learners who interpret and adjust it according to their schemas, thereby constructing their own knowledge.

Imperative to the educator's mathematical knowledge and teaching skill is his/her knowledge of how learning takes place. Olivier (1989) refers to Piaget's conceptions of assimilation and accommodation but auds that when new ideas are so different from existing schemas that neither accommodation nor assimilation can take place, the learner often tries to memorise the idea. Because this memorised or rote learning is not

linked to any previous knowledge it is not understood, it is isolated and is difficult to remember. Hence, it is often the cause of misconceptions in mathematics.

More knowledgeable educators deal with learners' misconceptions in an enriched manner as opposed to when they are expected to teach in areas in which they were less knowledgeable". Hasweh found that less-knowledgeable educators either did not recognise the misconceptions, agreed with the students, or chose not to deal with the misconceptions" (Fennema & Franke, 1992:151).

From the constructivist perspective, errors and misconceptions should be understood as the learner's own efforts to construct her/his own knowledge out of his/her correct but incomplete previous knowledge. It should be seen by the educator as an opportunity to enhance learning and not as an opportunity to expose inadequacies within the learner.

Though misconceptions can influence learning in a negative way, they are crucial in the child's construction of his/her own knowledge. Errors and misconceptions must be accepted as an essential part of the learning process, so that the learner will be freed from the fear of criticism and will more readily experiment with mathematical language.

In line with the constructivist approach to learning, learning leads to changes in our schemas. The heart of such an approach lies in the educator's awareness of the "interaction between the child's current schemas and learning experiences" (Olivier, 1989: 12), and the educator then placing him/herself in the shoes of the learner and considering the mental processes by which new knowledge is being acquired. Leinhardt and Smith (Fennema & Franke, 1992:153) found that more experienced and competent educators not only knew the procedural rules for solving problems with fractions, for example, but also understood the interrelationships of the procedures. Being a mathematics educator "...involves taking complex subject matter and translating it into representations that can be understood by the learners" (ibid: 153). In accounting for misconceptions it is necessary for the educator to look at the child's current schemas and how they interact with each other, with instruction and with experience.

However, Olivier warns us that concepts cannot be taken directly from experience since "a person's ability to learn from and what he learns from an experience depends on the quality of the ideas that he is able to bring into the experience" (Olivier, 1989: 11).

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However, Olivier warns us that concepts cannot be taken directly from experience since "a person's ability to learn from and what he learns from an experience depends on the quality of the ideas that he is able to bring into the experience" (Olivier, 1989: 11).

Hence knowledge is not seen as arising from experience alone but is a product of the interaction between experience and the learner's current knowledge structures.

The mathematical content knowledge of the educator is directly related to the structure of their classrooms. Fennema and Frank (1992) contend that there is a growing support for the idea that the educator's conceptual understanding of mathematics influences instruction in a positive way. Studies have confirmed that:

> "...when teacher knowledge of content has been defined in a way that is congruent with the nature of mathematics and/ when a conceptual organization of knowledge was considered, a positive relationship was found between content knowledge of educators and their instruction" (Fennema & Franke, 1992:152).

Bearing this in mind, Leinhardt et al (Fennema & Franke, 1992:161) point out that expert educators tended to organise their subject knowledge into a hierarchical structure, to use a richer system of representations, and to present more detailed conceptual and procedural knowledge. This knowledge of subject matter has an impact in several ways. Research tells us that educators with a strong content knowledge base have richer mental plans than do educators with less knowledge. In addition they are able to use more representations and richer explanations in their teaching, and offer richer responses to students' comments and questions during instruction (ibid:161).

From either the radical constructivist or sociocultural perspective the value of the educator's knowledge base remains paramount. The educator's role will require her to mediate between inventions and conventions. While she will be required to understand and probe inventions by learners, she will also need to know the mathematical conventions that she will teach her learners. Thus activity-based learning presupposes that educators possess a solid mathematical knowledge base.

2.8 Outcomes Based Education Methodology

With the implementation of Curriculum 2005, the need to focus on Outcomes Based Education methodology is vital for effective teaching and learning to take place. As indicated earlier in this chapter, MCPT claims that they "don't need to do a transfer from teacher-directed didactic type of methodology to outcomes based methodology" because "every bit of work the Mathematics Centre does is outcomes based already" (From interview with director of MCPT). Curriculum 2005, which encompasses Outcome Based Education, presupposes "active learners" who learn through "critical thinking, reasoning, reflection and action...connected to real-life situations". (Department of Education, 1997a: 1).

Within the context of the mathematics classroom, outcomes based methodology would manifest itself in three key components of classroom practice, namely:

- Teaching Mathematics in a Way that Relates to Learners' Everyday Needs,
- Problem Solving and
- Standard and Non-Standard Calculations

Literature tells us that these components translate into effective meaning making by learners. Indeed, there is a wealth of literature in mathematics education on problem solving in general, and specially literature related to everyday experiences and novel problems. This literature is drawn on here in a very limited way in order to illuminate MCPT's practice. In other words, the discussion here does not do similar justice to these fields as in earlier sections. This is a function of priorities in MCPT as scope of report. How these aspects relate to MCPT's goals are defined below.

2.8.1 Teaching Mathematics in a way that relates to Learners' Everyday Experiences

At the time of conducting this research, one of the specific aims of mathematics education, as stated in the Interim Mathematics Syllabus was, "to enable pupils to apply mathematics to other subjects and in daily life". Educators were being challenged to find a means of translating the then-existing mathematics syllabus into ways that related to

the learners' everyday experiences. This belief is again echoed in Curriculum 2005, where Specific Outcomes 1, 5 and 9 of *Mathematical Literacy, Mathematics and* Mathematical Sciences (MLMMS), all highlight the need to teach mathematics in a way that bridges the gap between classroom mathematics and the mathematics of real life. MCPT, therefore, urges educators to steer away from the practice of teaching mathematics as if it is "something that you perform within the classroom" (from *interview with director of MCPT*). *Instead educators* should constantly encourage learners to see the relationship between the mathematics that is being taught in the classroom, and mathematics of the real world.

MCPT echoes Szendrei's (1996) and Paolo Boero's (in Szendrei) sentiments, mentioned earlier, in suggesting that educators use carefully selected resources from the environment (waste materials) in the mathematics classroom to help learners to establish links between what is happening in the mathematics classroom and their activities in the real world. Suggestions as to how links can be made are:

> "If it's a township classroom...then we would recommend very...easily available apparatus such as empty yoghurt cartons, lolly sticks, cardboard counters, use of stones, use of matchsticks....And this helps the teacher to concretise whatever concept she wants the children to engage in. So that the children don't see triangles, and squares and circles as triangles, squares, circles. They see them as shapes that are present all around them, shapes that have functions, shapes that have meaning. Triangles hold up bridges." (From interview with director of MCPT).

In addition to using contextualised materials within the mathematics classroom, MCPT also encourages educators to take learners out on excursions to local businesses or industries, where they can learn about the mathematics in constructions, shopping, baking, etc. Learners "must (be encouraged to) see maths as something that will help them to perform (in their daily lives) in a meaningful way" (ibid).

Closely linked to teaching mathematics in a way that relates to learners' everyday lives is the ability of learners to solve problems and perform calculations in a manner meaningful to them.

2.8.2 Problem Solving and Calculations

MCPT advocates that in teaching of problem solving and of calculations, the educator should emphasise independent reasoning by asking questions which push learners' thinking. Types of questions that the educator could ask are:

> "What did you do? What was your guess? What was the estimate? What do you think will happen if you do this? Have you tried this kind of method? Etcetera. Lots and lots of questions from the teacher and the children, rather than a child asking a question and the teacher giving a straightforward answer. That is not MCPT's method " (From interview with director of MCPT).

MCPT's approach to problem solving is very much in line with that of Atkinson (1992: 137), who states that in real problem solving the educator's role is that of facilitator or helper, whereby he or she helps the learner to clarify what the problem is, and supports the learner's efforts in finding solutions.

MCPT advocates that tasks should include non-routine problems, which require learners to think about how they will work them out. In this way the educator encourages learners to become independent thinkers. MCPT maintains that learners should be encouraged to use their own methods for calculating and to experiment with different ways of finding the answer. The educator should not resort to drilling and repeating as if there is only one method (her method) for calculating.

> " I would expect teachers to move onto more and more complex investigation where less and less teacher direction and teacher instruction is given. More and more the child is expected to use the mathematics that they have learnt to select the mathematics that they need to solve a problem....The teacher tries in terms of facilitation and in terms of intervention to get the child to a point where the child constructs his or her own knowledge" (From interview with the director of the MCPT).

This view echoes Kamii's proposal that if new information is to become an integrated part of the structure of knowledge held by the learner it has to be constructed (or reconstructed) by the learner himself. Because each learner will construct his unique model of reality, no two learners will have acquired exactly the same knowledge (MCPT's reference).

The erudition echoed above is located within the aim of the constructivist approach that learners should reach well-founded convictions based on their own perceptions and not blindly take on ideas transmitted by the educator.

In conclusion, it can be said that MCPT favours independent problem solving, with learners using both standard and non-standard methods for calculations, related to issues in their daily lives.

2.9 Language of Teaching and Learning (LOLT)

In a pedagogy informed by constructivism, where speech, group work and peer teaching and learning are key, communication is of vital importance. In the context of South African schools, communication is impacted upon by the languages participants have access to. The language of communication at each institution presents its own idiosyncrasy. MCPT's philosophy is that the teaching of mathematics should build on the child's home language, and gradually and with great care, introduce the more formal and special language of mathematics. The director of MCPT describes their approach as follows:

> 'Up to Grade 2 we are totally keen, totally committed to using the child's home language in terms of constructing concepts and teaching and planning and everything.. All our teachers, I hope you will find, teach in a bilingual mode.....For Standard One we begin to encourage teachers, particularly those (children) who have come up with us from Grade 1 and Grade 2 to be using English more and more often (From interview with director of MCPT).

This position resonates with the Language Policy outlined by the of South African constitution, which states:

> "In terms of the new Constitution of the Republic of South Africa, the government, and thus the Department of Education, has to promote multilingualism, the development of the official languages and respect for all languages in the country.....An important underlying principle is to maintain home language(s) while providing access to the effective acquisition of additional languages" (Department of Education, 1997a: 22).

An interpretation of the above, for foundation phase learners translates to read:

> "In terms of A Policy Framework for Education and Training in Early Childhood Educare, children must be enabled to explore the world fully in languages they are familiar with. If the language of wider communication (e.g. English) is not the home language of the learner, then this language should be introduced gradually. The reason for this is based on research evidence which strongly suggests that the conceptual development of children is facilitated by initial learning in home language" (ANC, 1994: 64).

Research tells us that children do have considerable mathematical language and skill before they come to school. Because this skill and understanding uses the everyday, informal language of the home and the child's familiar world, it is often referred to as

their 'home' language and the more formal language of school mathematics (both as spoken at school and in written standard symbols, e.g. 2 + 2 = 4)" could hold "..the key to why so many children perform so poorly in mathematics tests" (Atkinson, 1992:15). It therefore seems logical to conclude that if we want to improve the performance of our learners in mathematics, that its language should be shaped to become more assessable to learners (ibid).

While Atkinson focuses on the *Language of Mathematics*, the *Language of Learning and Teaching* is of particular relevance to this study.

The value of speech, and hence language, within the sociocultural constructivist approach, as underscored by Vygotsky has been elucidated earlier in this chapter. Emerging from this reality, language is seen as a resource for teaching, hence the use of *mother tongue* and *code-switching* are espoused in order to enhance conceptual understanding.

2.9.1 LOLT Issues in South Africa are complex

Although my intention at the beginning of the study was to also investigate language usage in the mathematics classroom, the question is no longer feasible within the scope of this study. Between the times of designing the observation instrument and the writing of this report, the real complexities regarding language issues have only just begun to surface. The issues relate to the variety of models used by different educators in order to facilitate learning. Some of the models currently used for dealing with language issues in South African schools are listed below.

- "[C]lassrooms where the primary language is the medium of instruction throughout the Foundation Phase;
- classrooms where the primary language of most learners is the medium of instruction and those learners whose primary language differs from the medium of instruction are immersed in their additional language in the classroom, among friends and at home;
- situations where the teacher and the learners may have different primary languages and the target language in the classroom is an additional language for all concerned;

- classrooms where primary language is used for a certain period and then a switch to an additional language is made, assuming that all the skills acquired in the primary language will automatically be transferred to the additional language;

- programmes where all the skills in the primary language have been addressed before an additional language is introduced;

- classrooms where code switching is the norm: the teacher uses one language as the medium of instruction but she and the learners revert to primary language to clarify concepts and to confirm comprehension;

- situations where primary language only is used and learners become proficient in reading and writing in the language most familiar to them only to find materials in their language becoming unavailable beyond a certain level;

- bilingual classrooms where two languages are being developed simultaneously; and

- classrooms where the only time the additional language is heard is at school" (GDE/GICD, 1998a: 31-2).

Though the above are only some of the models identified in South African schools, they do highlight the diversity of classroom practice in terms of language usage. Given that the major debates regarding the use of language are only beginning to take place, it is not appropriate to investigate NGO practice from a language perspective at this stage. I believe that the question on language usage falls beyond the scope of this study. Thus, I have decided to exclude "Language of Teaching and Learning" as a question to be addressed within this research.

In this chapter I have described radical constructivism and sociocultural constructivism to show that MCPT draws from both philosophies. Further, I have discussed key aspects of MCPT's practice in the light of this theoretical debate and research literature in the field.

In the following chapter I describe how I investigate MCPT's practice with this informed theoretical informed backdrop.

CHAPTER THREE

Research Methodology

In order to examine the practices of MCPT, it was important that I was able to describe and analyse how they worked in relation to the following key features theorised in Chapter Two.

- Teaching Methods
- Availability and Use of Resources
- Group Teaching and The Role of Learners during the Mathematics Lesson
- Educators' Mathematical Knowledge and Confidence
- Planning and Preparation of Lessons[15]
- Outcomes Based Education Methodology[16]
- Language of Teaching and Learning (LOLT)[17]

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[15] *Planning and Preparation of Lessons*: Information gathered during class visits and interviews provide convincing evidence that planning and preparation of lessons, which impact directly on the effectiveness of the delivery of lessons, is relevant to this study. It is due to this fact that 'Planning and Preparation of Lessons' has emerged as an aspect to be included in the analysis of MCPT's practice. Because MCPT places significant importance on this aspect of their practice, my findings, both in terms of informal observations and interview responses have begged that this aspect be included for analysis. It is for this reason that although Planning and Preparation of Lessons has no theoretical support in Chapter Two, it emerges as a point for discussion in Chapter Four.

[16] *Outcomes Based Education Methodology*: When I began this research, I investigated various aspects of classroom practice in line with MCPT's teaching-learning philosophy. However, since the implementation of Curriculum 2005 in 1998, it has become [illegible] that particular aspects of teaching, peculiar to Outcomes-Based Education, need to be highlig[illegible]t makes this research more topical. It is for this reason that Teaching Mathematics in a [illegible] to Learners' Everyday Needs, Problem Solving and Calculations have been clust[illegible]ased Methodology" and are analysed in Chapter Four.

[17] As indicated in Chapter Two, [illegible] of Language of Teaching and Learning is beyond the scope of this study, and hence will [illegible] further.

In addition, the above key features were also used to inform the instruments for examination of MCPT's practice. It was, moreover, important that I understood, from the educators' perspectives, their understanding of MCPT's practices.

The method of investigation that I employed for this research was a case study, by which I mean that I typically observed the characteristics of an individual unit, namely MCPT (Cohen and Manion, 1980: 99). My reason for selecting this research methodology was that it provided ways of illuminating various aspects of the case and in this way helped me to answer the questions of:

1. Have the classroom practices of educators developed in the direction MCPT intended them to?
2. What are MCPT's perceptions of the value of the envisaged classroom practices of educators in advancing the new mathematics syllabus?
3. What are the educators' perceptions of these practices?

In terms of the definition of a case study as given by Cohen and Manion (1980)

> "[t]he purpose of such observations is to probe deeply and to analyse intensively the multifarious phenomena that constitute the life cycle of the unit with the view to establishing generalisations about the wider population to which that unit belongs" (Cohen and Manion, 1980: 99).

By researching the impact that MCPT had on the classroom practices of mathematics educators, I hoped to throw light on the question of how NGOs generally impacted upon the classroom practices of mathematics educators.

I focused only on the development of the classroom practices of educators, which is one key aspect, and not all of MCPT's work with teaching. The findings emanating from this research will indicate the extent to which MCPT met its goals in terms of the classroom practices of mathematics educators at the time of me doing the research i.e.1996 and hence on aspects of NGO INSET, in particular.

3.1 Population

The population for this study comprised MCPT trained educators from Soweto, Mpumalanga, East Rand and Witbank. Only Grade 2, 3 and 4 mathematics educators (from the specified population), who had been involved with the MCPT INSET course for some time were investigated. My motive for limiting the sample to Grades 2 and above, was that from this level onwards, at least half of the classroom instruction was to be in English[18] with code-switching[19] serving the purpose of clarifying what has already been said.

3.2 Sampling

Maxwell confirms that

> "The sort of sampling done in qualitative research is usually "purposeful"...to make sure one has adequately understood the variation in the phenomena of interest in the setting, and to test developing ideas about that setting by selecting phenomena that are crucial to the validity of those ideas" (Maxwell, 1992: 293).

In order to understand direction of change, and because MCPT has a range of educator involvement, from the population, a sample of ten educators was selected as follows: four from Groups Two and Three respectively (below) and two from Group One.

Group One Educators who had been involved in the programmes since its inception

Group Two Educators who had only joined MCPT recently

Group Three Educators whose experience with MCPT lay somewhat in between the two others.

Each educator was observed for three lessons.

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[18] This limitation exists because I have difficulty in understanding most African languages. In terms of past policy the practice at ex-DET schools is that the language of teaching and learning changes during the foundation phase as follows:
Grade 1: Mother-tongue
Grade 2: 50% mother-tongue and 50% English
Grade 3: English with occasional code-switching

[19] Educator switches to the mother tongue of learners either when learners do not understand what had been said in English or to facilitate conceptual acquisition.

Due to the fact that the observations took place in the latter part of October and early November (a time of the year when educators are often busy revising with their learners or writing examinations themselves), there was some difficulty in obtaining the random sample I had originally intended. All educators who were willing to be observed and fell within the predetermined categories (mentioned above) became possible candidates. Educators were therefore also selected based on their accessibility.

In selecting my sample in this way I made use of a combination of *Cluster Sampling* and *Opportunity Sampling*. Cohen and Manion describe *Cluster Sampling* as taking place "[w]hen the population is large and widely dispersed, [and] gathering a simple random sample poses administrative problems". (Cohen and Manion, 1980: 76). Because Soweto educators were accessible I made use of cluster sampling by which I mean that all Grade 2, 3 and 4 MCPT-trained educators in Soweto were potential candidates. On the other hand, *Opportunity Sampling* takes place when the researcher "seizes the opportunity" (Brown and Dowling, 1998: 29). In those schools where educators were willing to be observed, the maximum number of possible candidates were observed.

3.3 Data Collection

3.3.1 A list of the classroom practices in educators that MCPT hoped to shape

To answer the question of whether the classroom practices of educators had developed in the direction MCPT intended them to (Question 1), I firstly had to determine what the nature of the educators' classroom practices that MCPT hoped to establish were (Question 2). To do this I undertook an analysis of documents from MCPT in which the long-term goals of the project were outlined. In addition, I interviewed a member from the key personnel of the MCPT to determine what classroom practices the project saw as being important at that time. (for list of Interview Questions see Appendix 1.) From this information a list of all possible teaching criteria, peculiar to the MCPT's approach to teaching, had been constructed.

3.3.2 Observation Schedule

After establishing the criteria for effective teaching and learning, as described by MCPT, an observation schedule was drawn up in which educators' classroom practices could be

identified and commented on. Elements of content on the observation schedule included the six key features of MCPT's approach mentioned at the beginning of this chapter, viz.

- Teaching Methods
- Availability and Use of Resources
- Group Teaching and the Role of Learners during the Mathematics Lesson
- Educators' Mathematical knowledge and Confidence
- Outcomes Based Education Methodology
- Language of Teaching and Learning (LOLT)

Each of these features was further divided into observable criteria. Each criterion was evaluated on a 3-point scale, with a score of 3 indicating practice closest to MCPT's desired goals. (For observation schedule see Appendix 3).

Summarised Presentation of Data Collected

In order to present data collected during classroom observations and educator interviews, I needed to make use of tabular summaries. Th manner in which educators have been represented on the tables for analysis in Chapter Four is illustrated in the following table.

Educator Number	Year in which he/she received INSET training from MCPT	No. of years since training (in column 2) and data collection (1996 included)	Classification of educators: Old (O) Intermediate(I) New(N)	Grade Teaching
1	1988	9	O	4
2	1991	6	O	4
3	1993	4	I	3
4	1993	4	I	3
5	1993	4	I	4
6	1994	3	I	4
7	1995	2	N	2
8	1995	2	N	3
9	1996	1	N	3
10	1996	1	N	2

Table 1

In Table 1 each educator was allocated a number from 1 to 10, with Educator Number 1 being the first educator to have received MCPT training (years ago), while Educator Number 10 having received very limited training the previous year (less than 1 year ago). The ten educators were then classified into Old (O), Intermediate (I) and New (N), where Old educators received training 6-9 years ago, Intermediate educators received training 3-5 years ago and New educators received training up to two years ago.

For the purpose of data analysis in Chapter Four, a table was compiled for each key area investigated. This table, together with the data from the observation schedules (containing written notes) and interview data informed my analysis. The format of the table in each key area is as follows:

Educator Number	Criteria observed in each key area			
....	....	....	....	....

Note: Numbers allocated to educators have been used for identification throughout the analysis, in order to protect the identities of educators involved.

3.3.3 Interviews

In order to assess unobservable data and to determine each educator's perceptions of the acquired skills (Question 3), and the extent to which these developments had been internalised, the observation schedule needed to be supported by a structured interview, which again probed in relation to the above (Cohen and Manion, 1980: 243). (For list of Interview Questions see Appendix 2.)

It must be noted that while interviews are a means of accessing unobservable data, there are problems inherent in the use of this research methodology. One is these, is the issue of invalidity. Cannell and Kahn claim that the cause of invalidity is bias, whereby interviewees have 'a systematic or persistent tendency to make errors in the same direction, that is, to overstate or understate the "true value" of an attribute' (Cohen and Manion, 1980: 251). It is also possible that interviewees would feel pressured into saying things that they believed the interviewer wanted to hear, in this case particularly in light of the fact that a report on the research was going to be shared with MCPT. It is for this reason that although the interview was used to source unobservable data, it was used with caution.

3.4 Design

3.4.1 Piloting

I attempted to complete a draft observation schedule while watching an MCPT video demonstration on the teaching of mathematics. Those aspects that were not possible to observe were excluded from the final observation schedule before commencing with the actual classroom observations. Thereafter, I spent the first lessons in each class observing mathematics lessons and completing an observation schedule. In this way I hoped that both educators and learners could get used to the presence of an observer in the classroom and that the educator could get accustomed to seeing me filling the observation instrument.

3.4.2 Observations

Observations were made over a period of three weeks i.e. two observations per day. All observations were carried out in the mornings during the mathematics periods. This was a non-participant observation by which I mean that during the lessons I did not participate in the teaching (Cohen and Manion, 1980: 101). Instead I observed the educators' classroom practices and completed the observation schedules.

To minimise the "observer effect" i.e. the tendency of educators and learners to role-play the lessons, each educator was observed for three lessons. The first lesson in each class was spent in easing educators and learners in getting used to having me in their classes. The results of the second and third classroom observations were used for the purpose of analysis.

Note: The observation schedule is not seen as quantitative, but qualitative in highlighting trends.

3.4.3 Interviews

Interview of key personnel from MCPT

An interview with a key personnel member of MCPT was undertaken in order to:

- Aid in the construction of the list of classroom practices that the MCPT hoped to develop in educators.
- To determine MCPT's perceptions of the classroom practices that they hoped to develop towards the advancement of the new mathematics syllabus (Question 2).

Educator Interviews

To answer Question 3, which aims at determining each educator's perceptions of her acquired skills and the extent to which her training had been internalised, a structured interview was constructed. This interview was conducted with each educator, after her third classroom observation. For Structured Interview with Educator, see Appendix 2.

3.5 Data Analysis

3.5.1 Validity

In a qualitative research validity involves looking for observable patterns of take up. Maxwell cites Hammersley et al who state that in a qualitative research, the validity of an account is located "in its relationship to those things that it is intended to be an account of" (Maxwell, 1992: 281). It "pertains to the data, accounts, or conclusions reached by using that method in a particular context for a particular purpose" (ibid: 284). It is relative to the purposes and circumstances of the investigation. In this research I have made use of three types of validity, namely, *Descriptive Validity, Interpretative Validity and Theoretical Validity.*

Descriptive Validity

Descriptive validity refers to what the researcher has seen or heard, using observation schedules, tape recordings, etc. (Maxwell, 1992: 286). I this research I recorded and described the data I collected by filling in observation schedules, making tape recordings of interviews and supporting these interviews with notes.

Interpretative Validity

Maxwell claims that in addition to "providing a valid description of the physical objects, events, and behaviors in the setting" qualitative researchers "are also concerned with what these objects , events and behaviors *mean* to the people engaged in and with them." (Maxwell, 1992:288). Accounts of meaning which must initially be based on the conceptual framework of the actors in question "are grounded in the language of the people studied and rely as much as possible on their own words and concepts" (ibid:289). Researchers therefore, describe participants' accounts on the basis of the participants' own descriptions and other evidence. (ibid: 290)

In this study I used the information obtained in the tables and quotes to interpret what I had seen and heard during my field visits.

Theoretical Validity

Theoretical validity "goes beyond concrete description and interpretation" and "refers to an account's validity as a *theory* of some phenomenon" (Maxwell, 1992: 291). In the case of this study, I used the theoretical lenses established in Chapter Two to talk about the data.

3.5.2 Reliability

A qualitative research, can never be repeated to extract exactly the same results. For this reason reliability is not an issue in qualitative researching. The main considerations when conducting a qualitative research are to work systematically and to keep the information consistent. In this research I endeavored to do this by carefully ascribing to the parameters defined by the criteria on the evaluation schedule, and supporting each rating with a written comment.

3.5.3 Generalisability

"Generalizability refers to the extent to which one can extend the account of a particular situation of population to other persons, times, or settings than those directly studied." (Maxwell, 1992: 293). In a qualitative research generalisability

> "usually takes place through the development of a theory that not only makes sense of the particular persons or situations studied, but also shows how the same process, in different situations, can lead to different results" (ibid: 293).

It is important to note that difficulties with interviews, alluded to earlier, do pose special problems with regard to generalisability. Maxwell cites Briggs and Mishler in reminding us that:

> "The interview is a social situation and inherently involves a relationship between the interviewer and the informant. Understanding the nature of that situation and relationship, how it affects what goes on in the interview, and how the informant's actions and views could differ in other situations is crucial to the validity of accounts based on interviews" (Maxwell, 1992: 295).

In the case of this study, interpretation of interview data was used cautiously in order to maximise validity.

In terms of generalisability, findings from this study could inform similar contexts and situations.

3.6 Limitations

Time

As indicated in Chapter One, the time lapse between my conducting of the research and writing of this report, has a limiting effect of the topicality of my findings.

Scope

The population available and samples selected, were limited for reasons indicated earlier in this chapter.

CHAPTER FOUR

Data Analysis

While data was gathered using a range of research methods, I have chosen to analyse this data in a selective way. In the main, my analysis of the data is based on classroom observations, occasionally drawing on interviewee responses.

These interviews were not given the same weighting as the classroom observations, since I believe that the social context of the interview worked against the educator's own judgements for critical reflection. Weaknesses in gathering information by means of interviews have been expounded in Chapter Three. What I clearly found during my interviews with educators, was that their responses largely mirrored MCPT's approach. In other words, they have learnt to "talk the talk". This would imply that they have internalised MCPT's goals as a conception of good teaching. Whether they practice what they say, becomes evident as this chapter unfolds.

In view of the fact that "Planning and Preparation of Lessons" has been added and that "Language of Teaching and Learning" has been excluded from the original list, the aspects under discussion are now:

- Teaching Methods
- Availability and Use of Resources
- Group Teaching and the Role of Learners during the Mathematics Lesson
- Educators' Content Knowledge and Confidence
- Planning and Preparation of Lessons
- Outcomes Based Education Methodology

4.1 Teaching Methods

As described briefly in Chapters One and Two, MCPT does not claim to promote any particular teaching philosophy, but instead advocates that an eclectic mix of methods is best suited for the delivery of the mathematics curriculum. However, as mentioned in Chapter Two, MCPT does, in contradictory terms, align itself to social constructivism. This dichotomy is indicative of the dilemma facing many educators today with regard to the teaching of mathematics. In an attempt to progress from the exclusive use of rote practices (as was customary in ex-DET schools), constructivism has become the desired alternative.

MCPT advocates that teaching methods should vary from topic to topic, as well as from class to class, depending on the needs of the particular mathematical context. MCPT sees it as sometimes being necessary for educators to employ different methods of teaching for different learners in the same class for the same lesson. As the director of the centre explained:

> 'If the teacher's understanding of differentiation is such that she understands that you don't simply differentiate tasks, you can also differentiate the management of the classroom, you can also differentiate the type of activities you provide for the children, she can then use something like group work in a very dynamic manner....There is a host of very complicated components of group work that we take teachers through....so that providing a challenge for those who are less able, and those who are very able, and the continuum in between, so that teacher's can look at group work in a very dynamic manner" (From interview with director of MCPT).

MCPT accepts that learners should be active participants in the construction of their own knowledge. Hence, discovery, manipulation of objects, estimation, construction, didactic teaching, pen and paper exercises, etc. should all be seen to be taking place in MCPT classrooms as a means of teaching. These teaching methods should be seen taking place in a variety of situations, such as whole class teaching and learning, group work, pair work, as well as individual work. These were evident during my data collection, as indicated in the table below.

	1 Using a variety of teaching Methods			2 Drilling/ Teaching by Rote		
EDUCATOR	3	2	1	3	2	1
1	✓					
2		✓				
3	✓					
4		✓				
5		✓				
6	✓					
7	✓					
8	✓					
9	✓					
10	✓					

Table A

During my observations, in the class of Educator Number 4, I found groups of learners 'making money' which they used in a shopping activity the following day. All the learners in the class of Educator Number 3 were involved in working out how to count on or backwards by using their number boards. Learners were also seen working from their MCPT workbooks or on worksheets produced by the educator. I observed two particularly interesting lessons. In the class of Educator Number, 1 each group of learners was required to formulate the definition of a given geometric shape. On the other hand, learners in the class of Educator Number 9, were required to calculate the relationships between the volumes of commonly used containers, for example how many cups are in a liter. They were required to first estimate and then physically verify their answers.

MCPT advocates that the learning strategy, where learners are actively involved, will take place with the knowledge that repetitive practices help to enhance performance.

Repetitive practices in MCPT classrooms should be seen taking the form of mathematical rhymes and songs, with the objective of committing already established facts to memory (from interview with director of MCPT). From the above argument it becomes clear that although MCPT has a leaning towards constructivism as a teaching philosophy, traditional teaching styles also have a place.

MCPT's ideology of the way in which mathematics should be taught is very much in line with views we see reflected in goals and developments in the wider field of theory and research. The arguments presented by Copeland (1984), Mercer (1995), MCPT's reference and Pimm (1993) in Chapter Two, all support the view that a combination of strategies is the way in which mathematics is most effectively taught. Further, the role of the educator is seen as that of facilitator and mediator or helper rather than that of the giver of knowledge.

As summarised in Table 1, where a score of 3 is closest to MCPT's goals, it can be seen that all educators in this study generally favour the use of a variety of teaching methods, with the practice being more consistent amongst the newer educators. Direct teaching of concepts by the educator as well as the construction of knowledge by the learners themselves was apparent in most lessons observed. Generally practical activity involving all learners, either in pairs or in small groups, was followed by written work. Practical activities involved the manipulation of apparatus in an attempt to arrive at a solution. Learners were generally allowed to choose the methods and apparatus that they preferred to use.

What was interesting was that the incidents of etherisation of repetitive learning practices for the teaching of mathematics was absent in all the lessons that I observed. Although MCPT regards rote learning/drilling as a method having some value, (particularly for the learning of bonds and tables) nine of the ten educators, when interviewed afterwards, said that they did not see the value of this practice. Learners were allowed to use apparatus for calculation at any time if they so desired.

In other words, almost all educators observed in this study have resorted to the exclusive use of discovery teaching, resulting in learners not knowing their bonds and tables any more. The exception was Educator Number 1, who claimed during the interview that "[t]he seniors want us to teach drilling because the pupils can't calculate

anymore. They always need counters." This educator had begun drilling of concepts which he felt would help learners to calculate more efficiently.

4.1.1 The Dilemmas of Change Management

The constructivist approach advocated by Outcomes Based Education places significant value on discovery learning. Hence in attempting to make a shift from traditional to more progressive teaching styles, educators have inadvertently 'thrown the baby out with the bath water'. As mentioned in the example above, intermediate phase educators have begun asking for the reintroduction of the drilling of bonds and tables in the foundation phase classes in order to help learners to calculate with greater speed and accuracy.

Since one of the objectives of learning mathematics is that individuals should become more efficient in their calculations, this objective is partially thwarted by learners constantly needing to revert to the use of concrete apparatus for calculations. Although educators felt that learners would outgrow their dependence on crutches when they were ready, some learners were hesitant to do so because calculating with counters and number boards was easier for them. Without encouragement from their educators for them to restrict their use of crutches, most learners were happy to delay this stage. As mentioned earlier, pressure from the intermediate phase educators for the reintroduction of the teaching of bonds and tables in the foundation phase, would suggest that learners' dependence on the use of concrete aids generally outgrew their level of mathematical skill.

It can therefore be concluded that the use of rote practices for the learning of some aspects of mathematics, for example number patterns, rules and definitions has a key role to play in making learners more mathematically efficient. Although MCPT holds this goal in high esteem, educators that I observed were not convinced of its value. Whether this method of teaching is practiced at any of the other MCPT schools that I have not visited cannot be confirmed by this study.

4.2 Availability and Use of Resources

To uphold the value, mentioned in Chapter Two, that MCPT places on the use of resources, prior to 1995[20], it was common practice for MCPT to distribute materials freely to educators and learners at the schools they worked with. However, due to financial constraints, this practice has since had to change. At the time of doing this study MCPT, was gradually removing its services from those schools which had already benefited from the system. It had recently begun supplying only one set of resources per educator per school and sufficient cardboard to make additional materials. This set of resources was to be used as an exemplar by educators and learners to make additional copies of resources for their use. In addition, MCPT claimed that it had trained educators on how to make use of waste materials from the environment for the purpose of mathematical development. Szendrei's "common tools", referred to in Chapter Two, should very much be a feature of MCPT classrooms. The director of MCPT claimed that:

> "We produce resources at one level which are completely contextualised in their (learners') classroom experience. If it is a township classroom then the type of things we would recommend, would provide teachers with, would be very basic, very simple, very easily available apparatus such as yoghurt cartons, lolly sticks, cardboard counters, use of stones...We teach them how to make their own (resources) from what we call household rubbish which they would throw...empty bottles, containers, everything, broken plates, and of course the beautiful designs of the beads and the Ndebele art and the baskets...All the time, we encourage teachers to make these posters themselves. They don't have to be fancy commercial posters. What difference does it make if 1-30 is written in Zulu by hand or 1-30 is written on a white glossy laminated poster? No difference at all." (From interview with director of MCPT).

Educational materials supplied by MCPT take the form of materials specially manufactured by Smile Educational Toys according to MCPT's specifications. In light of the arrangement of supplying educators with one set of apparatus and the materials and skills to produce more, MCPT claimed that all classes should have sufficient materials, most of which had been made by the educator and learners.

Learners would therefore be seen sharing and manipulating materials. My observations are reflected in Table B, below.

[20] Date acquired during conversation with administrator of MCPT

	1 Use of Resources by Learners			2 Manipulation of Resources by Learners			3 Availability of Contextually Produced Resources		
Educator	3	2	1	3	2	1	3	2	1
1	✓			✓			✓		
2			✓			✓			✓
3	✓			✓				✓	
4	✓			✓					✓
5	✓			✓					✓
6	✓			✓				✓	
7	✓			✓				✓	
8	✓			✓					✓
9	✓			✓			✓		
10	✓			✓			✓		

Table B

During my observations I found that learners in all classes, except for one, shared and used resources which they manipulated in groups or in pairs. Educator Number 4[21] made use of no teaching aids on the first two days of observation. On the day of the third observation learners were asked to bring in fruit, sweets, popcorn, etc. to use in a shopping game that they were going to play. They then marked the prices on the items that they going to sell. With paper they made money which they used to purchase items from other members in the group. Money forms part of the kit supplied by MCPT, but since this class did not use it I will have to assume that the money together with all the other apparatus was "lost" as the educator had indicated.

[21] The score allocated to Educator No. 4 is an indication of a weakness inherent in the use of this type of representation, namely that unevenness is hidden in the quantitative representation of a table. Due to the specified and very limited criteria used in drawing up an observation schedule, it is not possible for a table summary, like Table B above, to reflect nuances that clearly assort the practices of individuals. Closer examination of primary data collected would reveal significant differences not easily observed during a cursory glance.

Educator Number 2 has decided to wean her Grade 4 learners off the use of aids for simple calculations and was able to support this decision by affirming that her learners were competent to work abstractly on the aspects which were being revised. How these learners had acquired this competence in the absence of rote learning practices of bonds and tables is unknown since I did not investigate the matter further. However, counters and other manipulatives were visible at all times for those learners who were unable to calculate abstractly. No learners were seen to make use of manipulatives during any of the three lessons I observed.

Concerning the use of resources it is clear that all the educators regard the use of manipulatives by learners as important for mathematical conceptual acquisition, as ninety percent of educators consciously encouraged learners to calculate with the use of them.

That MCPT has accomplished its goal in terms of learners sharing and using materials in groups or in pairs is unquestionable. All educators made use of some apparatus, either formally, informally or merely in the form of a reassurance to learners who might need them.

The availability and use of contextually produced resources was evident in three classes where educators used their own apparatus to teach concepts in the absence of appropriate apparatus being provided by MCPT. The contextually produced apparatus being used included containers of various shapes and sizes to measure capacity, 2-D and 3-D shapes, beads for stringing in patterns and toy cars to facilitate the learning of tables and playing cards for mathematical games.

Three educators taught their entire lessons with the use of MCPT materials alone, and claimed that they found the materials supplied by the NGO sufficient to teach all aspects of the mathematics syllabus.

Of the four educators not having sufficient resources for their lessons, three educators had received the MCPT kits for their entire classes. Of these, Educator Number 2 had phased her learners out of using crutches for calculating (as has been explained above), the second had lost most of her apparatus, and the third had had all her apparatus except for the workbooks packed away and was not seen to be encouraging her learners to make use of them. The fourth educator had received only one kit from MCPT, which

she had used as a model for making her own apparatus. At the time of the observations she had not made sufficient apparatus for the entire class and had mentioned financial difficulties as a problem in trying to acquire more apparatus.

Whether MCPT is succeeding in getting educators to contextually produce resources would at first appear to be doubtful. Educators numbers 10, 8 and 7, all of whom did not receive MCPT mathematics kits for their entire classes cited financial difficulties in trying to produce their own teaching apparatus. Oddly, educators numbers 2, 4 and 5 (all of whom received the MCPT kits for their entire classes) did not have sufficient resources available for effectively delivering their lessons on Numberlines, Money and Grouping respectively. The question, which now comes to the fore, is not whether educators are producing resources contextually but rather whether they are making optimal use of the resources made available to them by MCPT.

Closer examination of the data (interview) indicates that Educators Numbers 1-6 and number 9 each received sufficient MCPT materials for their entire classes, which could affirm that with the exception of Educator Number 9, this trend of receiving sufficient materials for their entire classes, has declined since 1995. Remarkably, Educator number 9 who received an entire complement of MCPT materials earlier in the year has produced a large proportion of her own apparatus.

The present trend at MCPT of educators not receiving customised teaching materials from the NGO for their entire classes any longer is not necessarily producing the effect of having educators produce their own apparatus. Hence, it would seem that whether or not educators are producing their own resources within the contexts that they are teaching would be a product of the educator's own initiative rather than the NGO's supply or withholding thereof.

4.3 Group Teaching and The Role of Learners during the Mathematics Lesson

In Group Teaching and the Role of Learners during the Mathematics Lesson, the aspects selected for observation were:

- Learners Work in Groups
- Peer Teaching
- Management of Groups
- Activities of Learners while Educator is busy with a Group
- Learner-Learner Interaction without the Educator

My findings regarding these aspects are reflected in Table C, below.

	1 Learners Work in Groups			2 Peer Teaching			3 Activities of Learners while Educator is busy with a Group			4 Management of Groups			5 Learner-Learner Interaction without the Educator		
Educator	3	2	1	3	2	1	3	2	1	3	2	1	3	2	1
1	✓			✓			✓			✓			✓		
2	✓			✓				✓			✓		✓		
3		✓			✓				✓	✓					✓
4	✓			✓					✓			✓	✓		
5	✓				✓				✓		✓				✓
6	✓			✓				✓			✓		✓		
7			✓			✓		✓				✓			✓
8	✓				✓			✓		✓			✓		
9	✓			✓			✓				✓		✓		
10		✓			✓		✓				✓			✓	

Table C

4.3.1 Learners working in Groups

MCPT's conviction that group work forms an integral part of teaching and learning harmonises well with the National Qualifications Framework Working Document (Department of Education, 1996), in which the ability to "work with others as a member of a group e.g. a team, society, etc.;" is listed as one of the critical outcomes of education for South Africa. The need for learners to interact with fellow learners as part of a group, forms an essential part of the child's education. Therefore, MCPT's emphasis on the importance of having learners engage in group work on a regular basis is well located within Curriculum 2005.

As can be seen in Table C above, at a simple observation level, most Educators organise classes into groups. In seven of the classes I observed, learners were seen discussing problems, questions and activities in groups, particularly during the practical sessions of group lessons. In one of these classes each group of learners was given a bucket of water and containers of various sizes. They were given worksheets that required them to relate the volumes of the containers by measuring the one in terms of the other. Questions, for example, were "How many yoghurt containers would fill a 2 liter ice-cream container?" or "How many glasses can you get out of a liter?" Learners were seen cooperating with each other and working as a team towards the completion of the worksheet. Educator Number 2 was doing revision. Consequently she had chosen to have all her learners seated facing the chalkboard. Educator Number 3 preferred to have her learners seated in groups but to work individually to facilitate discipline. Because Educators Numbers 2 and 3 had not planned any group work for the days on which I observed them, I explicitly requested that they should do so, in order to allow me to observe how this teaching strategy manifested in their classes. It became apparent, however, that Educator Number 3 was not adept at facilitating group work. This could possibly relate to her envisaged difficulty in managing her class of 51 learners, if the level of noise in her class increased. It was clear that she had not exposed her learners to opportunities to communicate mathematically, i.e. discuss problems, ask questions, etc.

Educator Number 10 had very recently been initiated into the MCPT way of teaching and was still finding her feet in terms of getting learners to form a partnership in learning. Although she had her learners seated in groups, they worked as individuals. It is

important to note that learners, seated in groups, but working as individuals, does not constitute group work in MCPT's view.

Educator Number 7 was supervising two classes simultaneously at the time of the observations. This was done because her colleague's classroom had been occupied by intermediate phase learners, who were writing examinations. She found the management of such a large number of learners (± 70) difficult in terms of her assessments of the learners' understanding of the concepts that they had just been taught. She therefore, asked her learners not to assist each other but to work independently instead. The learners were required to turn their pages over after their worksheets had been completed in order to prevent copying, so that the educator could assess each learner individually.

I established during my observations and confirmed during subsequent interviews that in all the classes, learners had been seated in groups during the major part of the year. At most times, groups constituted learners of mixed abilities. This was gleaned from the following comments. Educator Number 1 said that "each group has one very bright and one very weak child sitting next to him or her." Educator Number 8 added to this by saying that "groups have learners of mixed abilities, social groups."

As an extension of group work MCPT sees differentiated teaching (teaching at different levels) playing a major role. In differentiated teaching and learning, learners of matched ability (ability groups) work on differentiated tasks set at their level of competence. Here too, group work should be designed for groups of learners to work together as a team on one particular task. The Director of the Centre stated this objective as follows:

> "There is a whole host of very complicated components of group work we take teachers through, so that providing a challenge for those who are less-able, and those who are very able, and the continuum in between, so that teachers can begin to look at group work in a more dynamic manner. We would recommend group work (for different abilities) but before we recommend , we take teachers through the different strands regarding the different roles of different children in a group. And another way to cope, which we encourage very much, is peer teaching" (From interview with director of MCPT).

It can be surmised from the above that MCPT educators do generally regard group teaching as the most effective way of teaching and learning. Sometimes, however, other

methods are favoured when the situation so demands. MCPT has, therefore, managed to impact on educators' classroom practices in terms of encouraging group work.

4.3.2 Peer Teaching

An aspect of group work that is viewed favourably by MCPT is peer teaching. When learners of mixed abilities are grouped together, faster learners (whose own learning needs have been addressed) will support less-able learners. This technique is viewed as being particularly suitable for addressing the social and personal developmental needs of the faster learner.

Where learners share information with other learners of matched ability, MCPT sees the value lying in learners reinforcing their own knowledge and developing leadership skills. The educator's role in this would be to organise challenging and exciting tasks where learners can work with each other by listening and sharing ideas, so that they are able to create meaning.

From Table C, above, it is clear that half the educators observed, actively organised activities where learners worked with each other for the purpose of creating meaning together. Educator Number 1 summed up this approach in the following words:

> "All pupils are given a chance to be leaders. It is a serious responsibility. Usually the bright ones are the group leaders. They have to teach or discipline the others while I am busy."

In these classes, peer teaching usually took the form of learners working in groups, with the fastest learners in the group (often referred to as 'group leaders') assisting the educator in teaching slower learners. In the main, faster learners marked completed work of slower learners and assisted in areas of misconceptions and discipline of learners.

Of the remaining educators, all occasionally structured activities where learners worked together and benefited from each others' thinking. Learners compared answers with each other, and where there were differences, faster learners peer taught slower learners. Educator Number 8 confirmed this by saying that:

> " if the teaching of something is frustrating me, then I ask one of the pupils to try to teach that pupil. I find that it is easier for pupils to learn from their friend rather than from me."

Educator Number 7 did not encourage her learners to work cooperatively. She believed that learners would copy each other's answers if they assisted each other and that this would hinder independent effort. (This educator was supervising two classes simultaneously).

4.3.3 Activities of Learners While Educator is Busy with a Group

MCPT advocates that for the duration of the entire mathematics lesson, all learners will need to be meaningfully occupied with challenging mathematical tasks, while the educator herself will be busy teaching one group of learners at a time. It follows that MCPT advocates that, for group work to be successful, it is imperative that the educator plans and organises her lessons and resources meticulously beforehand. The Director states that:

> "In terms of coping with the large classes, we want the teachers to know that, if the resources are managed...the bright children can get on with the particular tasks themselves. If the teachers' understanding of differentiation is such that she understands that you (the educator) do not simply differentiate tasks, you (the educator) can also differentiate the management of the classroom. You (the educator) can also differentiate the kind of activities that you provide for the children, she can use something like group work in a very dynamic manner" (From interview with director of MCPT).

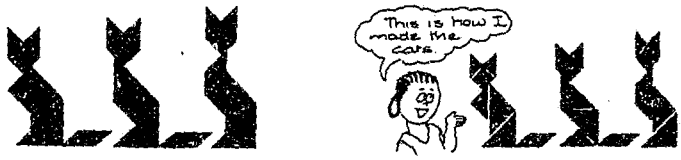
MCPT suggests that independent tasks, which are intended to keep learners meaningfully occupied, while the educator is busy with a group of learners, could either be the same for all the groups in the class, or they could be differentiated.

From Table C, above, it is clear that seven of the educators I observed, provided challenging tasks for their learners to work on, while they (the educators) were busy. However, only three of these educators provided sufficient work to keep all learners in the class occupied for the entire period, while the tasks provided in the other four classes were insufficient for the faster learners. Educators Numbers 1, 9 and 10 all provided their learners with suitable mathematical tasks that would keep them occupied for the entire period. These educators set tasks that became increasingly more

challenging and these took the learners longer to solve as they progressed further with their work. Educator Number 1, for example, gave each group a different activity on "Shapes". These activities were taken from the MCPT workbook "My Maths: Booklet 5, Shape".

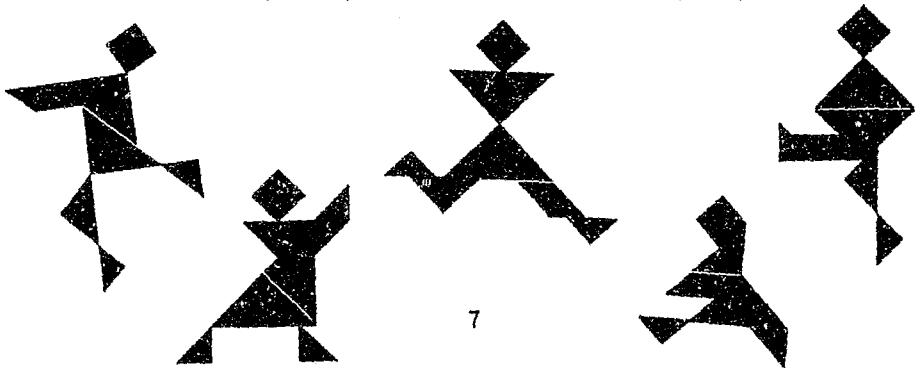
ACTIVITY 5: Cats

Use your tangram shapes to make these cats:
Each cat needs all 7 pieces.



ACTIVITY 6: More people

Use all your tangram pieces to make these people:



7

Educators Numbers 2, 6, 7, and 8 all provided the same type of independent tasks for all the groups in their respective classes. This resulted in the faster workers (group leaders) completing their tasks ahead of the slower workers. After conferring with the educator , the faster learners marked the work of those members of the group who had completed their tasks, and used the rest of the period to re-teach their less-able peers. While this peer teaching took place, the average learners who had completed their work, but were not group leaders, found themselves not having anything to do. This would indicate that although these educators were able to provide challenging independent activities for their learners, the quantity of work still needed to be addressed.

Educators Numbers 3, 4 and 5, all set independent tasks that did not comply with the goals as set out by MCPT. They set tasks that were simple and insufficient, aimed at the lowest level, at which almost the entire class could cope without facing any challenge. Interestingly, all three Educators received their INSET training in 1994, which might indicate that perhaps this goal was not communicated effectively in that year. This possibility has not been investigated.

With the exception of Educators Numbers 1 and 2, it is clear from the data that the educator's skills in setting independent tasks are inversely proportional to their experience since having received INSET training from MCPT. This could indicate that the newer educators are more attuned to the goals of the MCPT in terms of the setting of independent tasks i.e. it should ideally be differentiated, challenging and sufficient to keep all learners meaningfully occupied for the entire mathematics period.

The above data provides a convincing argument that MCPT is moving more in the direction of its goals in terms of empowering educators to provide learners with suitable independent tasks. However, what still requires attention is that earlier MCPT-trained educators would need to be trained on how to keep learners optimally occupied during group work. This could have implications in terms of future INSET programmes by MCPT.

4.3.4 Management of Groups

The critical outcome encompassing acting "in a manner which reflects respect for human dignity, justice and democratic values" (Department of Education, June 1996: 13) is easily nurtured during an individual's everyday experience in leadership roles. MCPT regards the development of leadership skills in every individual as being possible. It nurtures this potential by encouraging educators to provide opportunities for learners to explore and exploit their capabilities.

To facilitate the above, MCPT advocates that where all the groups work on the same type of learning activity, these groups should preferably comprise learners of mixed ability levels. MCPT emphasises that educators and learners should acknowledge that every learner has a role to play. Thus activities or tasks for mixed ability groups should

be designed to address the various roles learners can play within the group situation. The director of MCPT explains that:

> "If teacher's understanding of differentiation is such that she understands that you (the educator) do not simply differentiate tasks, you (the educator) can also differentiate the management of the classroom...."

MCPT's view on mixed ability groupings is embedded within Slavin's conception that a benefit of co-operative learning is that it enhances "... acceptance of mainstream academically handicapped students by their classmates..."(in Grouws, 1992:172)

Educators should, therefore, structure tasks requiring a whole array of skills, making it possible for very bright learners, as well as ABLD (Addressing Barriers to Learning and Development) learners, to participate within the same activity.

MCPT demands that leadership roles are rotated on a regular basis to facilitate the development of associated skills in every learner. All groups observed had learners of mixed abilities, and tasks were generally designed so that all could participate. Where learners were unable to cope, group leaders assisted.

During my classroom observations I encountered three educators who rotated their group leaders, so that every learner could have a turn at being a group leader. Two of these educators rotated group leaders on a daily basis, while one educator rotated group leaders on a weekly basis.

In five classes I found that the management of groups rested essentially in the hands of a chosen few. Often the role of the group leader had been to teach those learners who were having difficulty in understanding concepts that had just been taught by the educator. In addition, responsibilities assigned to group leaders had been to distribute materials as well as to ensure that the group was well-occupied and disciplined while the educator was busy teaching other groups. Group leaders were usually the brighter learners. Many of these five educators defended this arrangement by saying that the same learner was not necessarily the best in his/her group in all aspects of mathematics. They suggested that when a different aspect of mathematics was being taught, the possibility existed that group leaders could change. Thus, they felt that this method of selection ensured that all learners would try harder and aspire towards being group

leaders. However, none of these educators could assure me that within the year every learner would have had an opportunity to be a group leader at least once.

In two classes the educators did not allocate any responsibility to learners but took care of all aspects of management themselves. Educator Number 4 said that she did not usually nominate group leaders, but that if she ever required a leader she would spontaneously select one exclusively for the specified purpose. Educator Number 7 felt that the learners were too young (Grade 2) to assume the responsibility of leadership.

From the above it may be concluded that the management of groups needs to be shaped further to meet MCPT's goals of developing leadership potential within all learners. As has been shown, in those classes where there are group leaders, educators have generally appointed a single learner to take charge of discipline, equipment and peer teaching for his / her group. This responsibility for a foundation phase learner, merely 7 or 8 years of age, seems enormous. Thus some educators are reluctant to delegate this mammoth task to their learners.

4.3.5 Learner-Learner Interaction without the Educator

MCPT's conceptions in terms of the role of the learner in the mathematics class, are closely aligned to those of Bruner (mentioned in Chapter Two), who sees scaffolding between peers taking place when a learner explains to less competent peers or when a learner explains to a learner of matched ability.

MCPT suggests that, ideally the educator should be seen to be encouraging learners to talk to each other about how they worked out problems, to check with each other so that they can benefit from each others' thinking, and finally ask questions which show creative thinking even without the educator's encouragement. It is for this reason that MCPT encourages educators to provide learners with opportunities to engage with each other as part of its learning strategy.

Group work sessions in six out of ten classes I observed were characterised by learner – learner interaction without the educator. Sometimes learners decided, as a group, how to distribute amongst themselves various aspects of a task assigned to them. Often, while learners were busy on an independent task, they compared answers with each

other and where there were differences they tried to establish what the correct solution ought to be.

Educator Number 2 was doing revision with her learners and consequently she had discouraged collaboration between learners (only at this stage) as she believed that it would hinder her assessment of learners in terms of their revision needs.

Although Educator Number 4 had her learners seated in groups they worked as individuals, particularly during the first two observations. On the third day, learners collaborated with each other within the context of a shopping game. The rating allocated to Ed 'cator Number 4, again highlights the weaknesses inherent in tabulating data acquired in a qualitative research. (This weakness was alluded to earlier under "Availability of Resources".)

The learners of Educator Number 10 only collaborated after her intervention. This Educator had not received MCPT Inset Training per se, but was trying to shape her classroom practices to meet the teaching goals as set out by MCPT.

Of the three classes in which there was no learner-learner interaction, Educator Number 3 insisted that learners should remain silent and work independently. This could be attributed to the fact that there were in excess of 50 learners in the class, this being the largest number of learners, allocated to a single educator, in any of the classes that I had observed. Educator Number 5 expected her learners to work independently, as she felt that in this way she could control the learners in terms of producing their own work and in not copying. In Educator Number 7's class, learners were not interactive because she was supervising two classes (her colleague's classroom was being used as a venue for the final examinations) and claimed that in this instance learner-learner interaction could be disruptive. However, it was apparent that the learners had not in the past been encouraged to interact with their peers.

As indicated earlier, Educators Numbers 2 and 5 specially taught group teaching lessons at my request. Although the learners were able to learn within a partnership, they did not probe each other for details.

From the above it can be surmised that MCPT is beginning to shape classroom practices which encourage learner-learner interaction. Interestingly, the three educators

whose classes displayed difficulty in this area, experienced difficulty in actualizing other aspects of 'Group Teaching and Role of Learners during the Mathematics Lesson".

In conclusion

- It is clear that most educators have resorted to group teaching as an effective teaching strategy. Their implementation thereof indicates that most educators encourage learners to discuss problems, questions and activities by themselves.

- Although MCPT would like to see all learners having opportunities to share management responsibilities, it is apparent that educators are still placing responsibility for management of groups only in the hands of a few learners.

- In terms of keeping learners meaningfully occupied for the duration of the entire lesson, it is apparent that most educators are unable to provide meaningful activities for all learners in their classes. Extension work was often limited to peer teaching where faster learners taught their slower peers.

From the educators' perspective group work was done because the educators agreed that learners could benefit better from this type of seating arrangement than if they all sat facing the chalkboard. Educators quoted more economical use of space, easier sharing of equipment and peer teaching as advantages of group work.

4.4 Educators' Mathematical Knowledge and Confidence

As indicated in Chapter Two, MCPT's view that the educator's subject knowledge is a fundamental requisite for the effective delivery of the mathematics curriculum, is well located within the research and theory provided by Alletson (1962), Fennema and Franke (1992), Hasweh (1986) and Olivier (1989).

However, during my classroom observations, I found that educator's conceptual understanding was not easily assessable over the relatively short period of time, that is 3 class visits.

Table D below, reflects my findings.

	Educator's Content Knowledge and Confidence		
	3	2	1
1	✓		
2	✓		
3	✓		
4		✓	
5		✓	
6	✓		
7		✓	
8	✓		
9	✓		
10	✓		

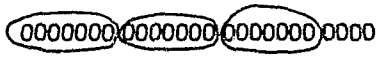
Table D

What is clear from Table D is that, most educators were able to cope with the lessons that they presented. It is only when learners attempt to deal with problems in a more sophisticated manner than that which is generally accepted as "normal" limits for that particular grade level, that the educator's subject knowledge and confidence are brought to light. For example,

Educator Number 7 had given her learners the following sum to do : *Share 25 sweets amongst 7 children.*

This is the way some learners worked it out:

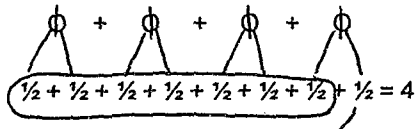
25 ÷ 7 = □



7 + 7 + 7 = 21

25 ÷ 7 = 3 remainder 4

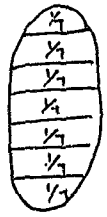
The remaining 4 was divided as follows



4 ÷ 7 = ½ remainder ½

By this stage the learners had calculated that 25 ÷ 7 = 3 + ½ = 3½ (with a ½ left over).

At this point, a group of learners did not know what to do with the remaining ½ so the group leader asked the educator what she should do. The educator suggested that the ½ could further be divided into 7 equal pieces, which a learner did diagrammatically on the chalkboard as follows:



making 7 portions of 1/7

The *educator then* suggested that if the 1/7 be added to the

$$\underline{3 + ½} + 1/7 =$$

(At this stage it was clear that the educator *did not know* that 1/7 of ½ =1/14)

The educator then helped her learners to calculate that 25 shared by 7 is

$$\underline{3 + ½ +} \underline{1/7} = ?$$

At this point the educator was baffled and could not do the calculation!

Usually one would expect the learner's level of mathematical competence in Grade 4 to be such that a calculation of "25 ÷ 3 = 7 remainder 4" would be acceptable. However, because MCPT's methodology allows learners to push their levels of competence beyond their "normal" limits, the learners in this example wanted to share the remaining 4 as well. This type of thinking amongst learners (which could become more common as learners experiment with and explore numbers further) challenges their potential, as well as that of their educators, to levels well beyond generally-expected norms. Thus, if the educator's level of mathematical competence is regarded as being sufficient if it is just beyond that of the level of the learners she is teaching, then she will often find herself in muddy waters when faced by such a challenging situation.

This finding reveals that while Outcomes Based Education focuses on the need to practice progressive teaching methodology, cognisance needs to also be given to the low levels of mathematical skill of many practicing educators.

4.5 Planning and Preparation of Lessons

While preparation in mastery of content knowledge and teaching methodology is generally established during pre-service training, preparation of lessons must continue to take place on an ongoing basis. This is borne out by the words of the director who says that planning and preparation play an:

> "absolutely major role, key role. If the teacher has not made a very good plan, then the teacher is acting ad hoc and will never be able to hold a proper constructivist dialogue with the children. She will never be able to understand where the child is having difficulty, in terms of constructing concepts, etc" (From interview with director of MCPT).

MCPT advocates that thorough planning and preparation of lessons presents educators with opportunities to look more broadly at the scope of teaching a concept. In this way the educator can plan to extend her lesson both horizontally and vertically in accordance with the needs of her learners. As explained by the director of MCPT:

> "It is absolutely crucial that the teacher knows the different stages too.....all these things must be in the plan so that teacher always has a contingency measures ready so that she does not bash the children for their incompetence or inadequacies but to use every stage to move them further. Planning is crucial." (From interview with director of MCPT).

MCPT echoes Ball's (1990) pertinacity that educators plan and prepare their lessons and resources meticulously beforehand since it is only in planning and preparing thoroughly that the educator is freed to engage in discussions with groups in the class.

In addition to planning and preparation of lessons MCPT also encourages educators to "keep better records of their children's progress" (From interview with director of MCPT).

During my classroom visits I asked educators whether I could look at their records. My findings are reflected in the table below.

Educator	Weekly / Daily Lesson Plans	Other Records			
		Term Plans	Mathematics Syllabus	Mark Book / Mark Schedules	Test Book
1	✓	✓	✓	✓	✓
2			✓		
3	✓	✓	✓	✓	
4					
5					
6			✓		
7		✓		✓	
8			✓	✓	
9	✓	✓	✓	✓	
10	✓			✓	

Table E

Most educators were unwilling to comment on the records they kept or on the extent of their planing and preparation of lessons. It was only after a great deal of persuasion that educators were willing to divulge the information contained in the table above.

The information contained in the table reveals that Educators Numbers 1, 3 and 9 prepared their lessons on a regular basis. They also had available their syllabi, term plans and mark books. They consulted their syllabi in planning of lessons and recorded their learner's assessment scores in their mark books. It is worth noting that Educator Numbers 1 and 3 both taught at the same school and that the records they kept were standard requirements of that particular school.

Educator Numbers 7 and 8 had mark books in which to record their learners' progress. While Educator Number 7 admitted that she did not plan her lessons in advance, Educator Number 8 said that she regularly consulted a set of lessons that she had

planned three years ago but that she had forgotten it at home on this particular day. Educator Number 7 sourced her content from her term plan while Educator Number 8 referred to her syllabus.

Educator Numbers 6 and 10 had a syllabus and a mark book respectively. Neither of these educators planned their lessons in advance.

Educator Numbers 4 and 5 kept no records of lesson planning or learner progress whatsoever and believed that they were able to teach effectively without them.

Generally, I found a high degree of correlation between the educators' level of classroom practice, her planning and preparation of lessons and the records that she kept. Those educators who maintained proper records and planned their lessons adequately were able to present lessons far superior to those who had not planned their lessons in advance.

Exceptions to this general finding were Educator Numbers 3 and 6. Educator Number 6 had many years of experience and taught at a school which set out clearly what the requirements were in terms of planning and record-keeping. Though her skill as an educator had not improved significantly, thorough records supported her lessons.

Educator Number 6 was a talented teacher whose practice could only improve with thorough planning and preparation of lessons.

4.6 Outcomes Based Education Methodology

The primary distinction between traditional classroom practice and Outcomes Based Education (OBE) is located in aspects of teaching methodology. Within the context of the mathematics classroom, a shift to OBE methodology would push change in:

- Teaching Mathematics in a Way that Relates to Learners' Everyday Needs
- Problem Solving
- Calculations: Standard and Non-Standard Calculation Procedures

MCPT's desires are that learners "must see mathematics as something that will help them to perform in a meaningful way" and that 'more and more the child is expected to use the mathematics that they have learnt, to select the mathematics that they need to solve a problem' (From interview with director of MCPT).

These goals are well located within the critical outcomes in Curriculum 2005, two of which state that learners should be able to:

> 'Demonstrate an understanding of the world as a set of related systems by recognising that problem-solving contexts do not exist in isolation" and "Identify and solve problems and make decisions using critical and creative thinking" (Department of Education, 1977c).

The extents to which educators have internalised these goals are reflected in Table F, below.

Educator	1 Teaching Mathematics in a way that relates to Learners' Everyday Experiences			2 Problem Solving			3 Calculations: Standard and Non-Standard Calculation Procedures		
	3	2	1	3	2	1	3	2	1
1	✓			✓			✓		
2			✓			✓			✓
3			✓	✓			✓		
4	✓				✓		✓		
5			✓		✓				✓
6	✓			✓			✓		
7	✓			✓			✓		
8	✓				✓		✓		
9	✓			✓			✓		
10	✓			✓			✓		

Table F

4.6.1 Teaching Mathematics in a Way that Relates to Learners' Everyday Experiences

As reflected in Table F, during my classroom observations, I found that seven of the ten educators observed were able to successfully show learners how the topics being dealt with corresponded to their experiences outside school. Some evidence of this follows.

Educator Number 9 taught capacity in relation to milk and cool drinks that learners bought. One learner remarked that a 250 ml measure of cool drink was called a 'Baby Jake' in the township, and the educator later posed questions to learners regarding how many "Baby Jakes" would be in a 1.25 ml bottle of cool drink.

For homework, Educator Number 1 asked learners to find and list things in their environment that were made out of the various shapes introduced.

Educator Number 4 had learners buying and selling real items with play money.

Of the three educators who made no effort to teach mathematics in a way that related to learners' everyday experiences, Educators Numbers 3 and 5 were teaching multiplication with the use of counters. No effort was made by either educator to link the multiplication process to everyday happenings. Educator Number 2 was drilling procedure for calculating on a number-line. This exercise was being taught in a mechanical way, with clearly outlined steps, from which learners were not allowed to deviate.

From the above, it is apparent that amongst the more recently trained educators, with the exception of Educators Numbers 1 and 5, there is a clearer understanding of the rationale for, and the process of teaching mathematics in a way that relates to learners' everyday lives,

4.6.2 Problem Solving

In terms of classroom practice, it is clear from the table, that most educators are competent in their teaching of problem solving and calculations.

In problem solving 6 out of 10 educators emphasized independent problem solving and reasoning by asking questions, which pushed learners' thinking. Educators set non-routine problems, for example, learners had to formulate their own definitions of the four basic geometric shapes or when learners were confronted with several containers of different volumes, they were asked to formulate as many equations as they could in terms of the volumes of the different sized containers that they had.

Three educators emphasized independent problem solving, mainly with routine problems, and did not push learners' understanding. For example, one group of learners, after having been shown how to shade 4 quarters of 1 cake was asked how they would shade 7 quarters of 2 cakes.

The sixth educator told her learners exactly how they should solve their problems. She did not encourage learners to find alternative strategies to finding the solution but rather insisted that they should follow her method step by step.

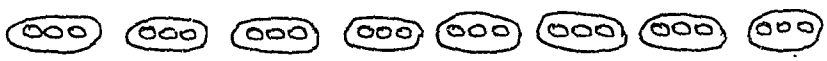
4.6.3 Calculations

In line with MCPT's philosophy, eight of the ten educators encouraged their learners to use their own methods for calculating. All alternatives were accepted if they were a means of arriving at the correct solution. When learners volunteered a solution to a problem, these educators asked their learners how they had worked out the problems. In other words, they wanted to know the steps that the learner had used for calculation. All methods of calculation were allowed, provided that learners arrived at the correct solution.

An example of this was in the class of Educator Number 3, where 24 divided by 3 was done using the following methods:

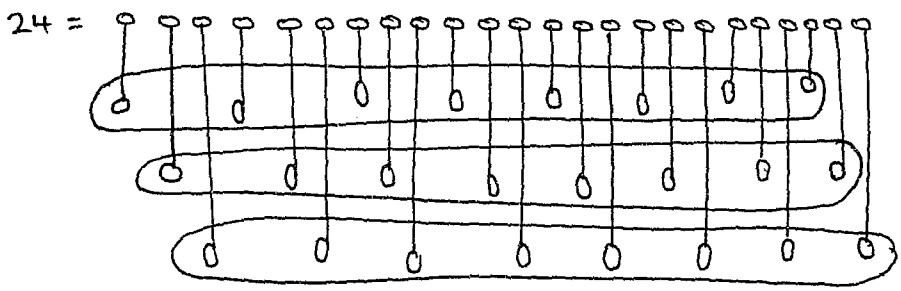
a. Grouping

$24 \div 3 = 8$



(24 = 8 groups of 3)

b. Grouping



$24 \div 3 = 8$

C. Repeated Subtraction

$24 \div 8 = \square$

$24 - 3 = 21$
$21 - 3 = 18$
$18 - 3 = 15$
$15 - 3 = 12$
$12 - 3 = 9$
$9 - 3 = 6$
$6 - 3 = 3$
$3 - 3 = 0$

learners count the number of times the subtracted 3, ie. 8 times
$\therefore 24 \div 3 = 8$

Learners were free to use whichever method they preferred.

On the other hand, two educators insisted that learners follow their methods, step by step, to arrive at the solution. Educator Number 2 checked her learners memorisation of procedural steps for calculating on a number line, by asking questions such as:

> "Where do we begin? What do we do? What colour chalk do we use for a minus? In which direction do we move for a minus? Do we jump above or below the line for minus?"

When the learner who was working the sum out on the chalkboard moved in the *wrong* direction the educator shouted "No! let me help" and proceeded to complete the calculation, on the chalkboard, for the learner.

Educator Number 5, who was teaching counting in threes, only accepted an answer as correct if learners counted "One, two, three (click fingers), four, five, six (click fingers), seven, eight, nine (click fingers)...." in an apparently meaningless way which pointed more in the direction of developing rhythm or timing rather than developing the mathematical skill of skip counting. Although it can be argued that this could be a step towards the learning of counting in threes, it is important to note that when one learner

who was able to, counted in threes, she was reprimanded and asked to follow the procedure outlined by the educator.

In conclusion, it can be said that the classroom practices of educators generally reveal movement towards teaching methodology congruent with Outcomes Based Education and hence Curriculum 2005.

CHAPTER FIVE

Conclusions and Recommendations

This study emerged in response to the question of the effectiveness of an NGO sponsored mathematics INSET on the classroom practices of primary school educators. Donors of NGO-sponsored INSET saw the improvement of two key aspects, namely, educators' subject knowledge and teaching methodology, as being high in priority. This study therefore aimed to probe evidence of developments, if any, in the classroom practices of educators who had been receiving mathematics INSET from MCPT in the two key areas indicated above.

In examining educators' subject knowledge and teaching methodology, in conjunction with the goals set out by MCPT and the requirements of Curriculum 2005, I hope to bring to attention the effectiveness of NGO sponsored mathematics INSET. . Like any case study, it is not possible to claim effects beyond the actual sample of teachers within the case study. However, again as with any case study, the effects in relation to these teachers is likely to have been experienced more widely by other similar teachers involved with MCPT. Furthermore, as alluded to in Chapter Three ,the insights here will have pertinence for similar projects elsewhere. The evidence provided in this study can therefore be generalised, in a manner understood with qualitative research.

In this chapter I will expound on each of the areas which are key to the long term objectives as set out by MCPT and offer recommendations where applicable.

5.1 Teaching Methods

Perhaps the most significant change brought about by MCPT was in the area of "Teaching Methods". From my findings it can be concluded that MCPT has effectively managed to shift the emphasis from an educator-centered classroom to a more learner-centered classroom. This change is clearly aligned with the requirements of Outcomes Based Education. However, at a deeper level the result of this observation has major implications for the implementation of Curriculum 2005. Educators, particularly those

w' ose PRESET training was inadequate, are of the opinion that everything that they did in the past was wrong. Important practices such as direct teaching, drilling or repetition are seen as pejorative means of meaning making within a learning context and therefore are given no consideration whatsoever. This research therefore strongly suggests to future curriculum developers and educator-trainers, to ensure that the message cascaded is one of using a balanced approach, with both traditional and progressive teaching methodologies.

5.2 Availability and Use of Resources

What the findings of this research means in resources strapped provincial and national contexts, is that educators need to be made aware of the value of making creative and optimal use of all learning materials supplied to them. Educators will also need to be shown how they can supplement these learning materials by making use of freely available "waste" materials from the environment, as well as how to make low cost materials on their own. Likewise it is equally important for educators to exercise good control over materials they have and to teach these values of responsibility to their learners.

5.3 Group Teaching and The Role of Learners during the Mathematics Lesson

MCPT has managed to impress upon its educators the value of group work. However, the management of groups is an area requiring additional attention. If educators were to subdivide the management of groups into three or four categories, and appoint that many group leaders per group, the opportunity for each child to experience a leadership position at least once within a school term would be possible. Educators should look creatively for strengths within each learner and although some learners might never manage peer teaching, for example, they could easily learn to manage the control of equipment in their groups.

Findings from this research also have implications for Curriculum 2005, which stresses the value of group work. While group work has important functions, it is also vital for learners to be given opportunities to accomplish tasks as individuals.

5.4 Educators' Mathematical Knowledge and Confidence

The educator's strength in both content knowledge and teaching methodology are essential in order to help the learner in his or her own construction of knowledge. While outcomes based education emphasises teaching methodology, it must be conceded that in the absence of a strong foundation in content knowledge, sophisticated teaching methodology cannot in itself promote effective learning. It would, therefore, be advantageous if MCPT and other INSET projects, would in future focus on developing educators' content knowledge to the same extent that they currently focus on developing teaching methodology.

The problem encountered highlights the value judgement oversight of past policies which accepted that, in order to teach foundation phase learners, prospective educators did not necessarily have to be mathematically competent. Candidates could enroll for a diploma in foundation phase teaching without having done mathematics in high school.

With the courses offered at institutions for higher education not having done much to improve the level of mathematical competence of foundation phase educators, this leaves a void for NGOs , such as MCPT, to fill, especially in light of the challenges being presented by the up and coming "MCPT learner".

5.5 Planning and Preparation of Lessons

The high degree of correlation found between the educators' level of classroom practice, her planning and preparation of lessons and the records that she keeps flags an area of great concern for district officials. For the large numbers of educators who have emerged from a resistance-mode past, any "additional" tasks outside the actual delivery of lessons are seen as additional work that warrants additional pay. District officials are therefore finding their tasks cut out for them in having to ensure that planning and

preparation of lessons takes place, and also that they are of an acceptable standard. Perhaps the announcement by the present Minister of Education, Kader Asmal, that the "public out there felt that teachers were" not "really worth the money spent on them" (Khumalo 27/9/1999) would have the desired effect of forcing educators to toe the line, and in this way ensure a higher level of teaching and learning for all.

In terms of my own experiences the passage of time has been both, a problem and an opportunity. The time lapse between me conducting the research and the writing of this report, resulted in much of the data being dated and consequently irrelevant to this study. It is for this reason that I needed to review the key aspects under investigation, in order to make this study more topical.

Because of the closeness of MCPT's practice to OBE, the scope for implementation of Curriculum 2005 can easily draw on this study. In other words, the demands of Curriculum 2005 and its intentions are illuminated by the study of MCPT. Findings from this research illuminate classroom practice in all three learning programmes of the foundation phase. This study further suggests the importance of researching implementation of Curriculum 2005.

On the other hand, my experience with this project indeed shaped and sharpened by my own practice as a foundation phase district official.

According to Jonathan Jansen :

> "for OBE to succeed even in moderate terms required that a number of interdependent innovations strike the new educational system simultaneously. It requires trained and retrained teachers" (Jansen, 1997:7).

This training and retraining of teachers is resource intensive - financially and otherwise, and cannot be fulfilled by the Department of Education alone. NGOs, like MCPT, with creativity and foresight can indeed pave the way for higher levels of implementation at the school level.

6

Appendices

6.1 Appendix 1: Interview One

(Interview with MCPT to establish a list of classroom practices that the MCPT hopes to develop in educators).

A. What do you see as a problem with current mathematics classroom practices?

1. What are your goals (or the Centre's goals) in terms of educators' mathematics classroom practice?
2. Why do you see these goals as being important?
3. What would you say best describes the mathematics classroom practices that you encourage?
4. Please describe each of these practices very briefly to me so that I understand what they are.
5. Is there anything else that you would like to tell me in relation to the project's goals and methods?

B. What can I expect in relation to an educator's ability to cope with a large class?

1. What would you say is a reasonably large size of class that an educator would be able to teach in support of your goals?
2. In relation to your goals how would an educator cater for different ability levels?
3. How would an educator give individual attention to those learners who are most in need of it?
4. Is there anything else that you would like to tell me in relation to class size and the related practice?

C. In terms of classroom environment and its resources, what types of modifications would I expect to see that would encourage mathematics learning?

1. Is it possible to teach mathematics without teaching aids using the methods you have just described? (If so, how?)
2. Assuming that an educator has a shortage of suitable materials for a particular lesson then will she still be able to conduct her lesson successfully? How?
3. Is there anything else that you would like to tell me in relation to resources and classroom environment?

D. What role would I expect to see in the educator's behavior in the classroom?

1. In your method of teaching mathematics how could I expect to see educators respond to learners questions and answers?
2. Assuming that a learner arrives at a correct answer, could I expect that response to be analysed at all?
3. Assuming that a learner arrives at an incorrect answer to a problem, what could I expect as the normal follow-up procedure?
4. What role does the planning and recording of lessons have for this method?
5. What is MCPT's policy and practice in relation to educators using more than one language in class? Why?
6. What forms of assessment does the project encourage for mathematics?
7. How could I expect to see these in the classroom?
8. What do you expect of educator's descriptions and reflections?
9. Is there anything else that you would like to tell me in relation to the educator's role in the mathematics class?

E. What roles can one expect to see the learners playing in their mathematics lessons?

1. Would I be able to see learners sharing ideas? If so, how?
2. Would I see peer-teaching playing a role? What would it look like?
3. I am sure that you desire that learners should enjoy their mathematics lessons. What would be evidence of this?

4. One of the issues in child-centered learning is what is often viewed as rote practice - learners chanting, repeating the words of the teach etc. Does that have any place in the MCPTs classroom? If so , how can I expect to see it . Does drilling have any place?
5. What form does it take?
6. What could I expect to see learners talking about in the mathematics class?
7. Is there anything else that you would like to tell me in relation to the learner's role and mathematical knowledge?

6.2 Appendix 2: Interview Two

(To establish educators' perceptions of acquired skills and the extent to which these developments have been internalised.)

1. How long have you been involved with MCPT?

   _____

2. What in your view, are the benefits to you of being with MCPT?

   _____

   _____

   _____

   _____

3. Can you tell me a little more about the way in which you feel that your involvement with MCPT has affected the way in which you teach mathematics?

   _____

   _____

   _____

   _____

4. We know that for many of the learners English is not a first language. Given this, what, in your experience, is the most effective way to transmit mathematical knowledge to them?

_____

_____

_____

_____

5. I have noticed that you have your learners arranged in groups

5.1. Please explain to me how you group your learners?

_____

_____

_____

5.2. Why do you do it this way?

5.3. When do you group your learners?

5.4. Does the composition of groups change at all during the course of the year?

5.5. Could you tell me about it?

6. During the lesson I noticed that some learners took responsibility for the management of activities. Could you explain to me how the responsibility of learners actually comes into being and how this is organised?

7. How do you assess learners?

7.1. What is the purpose of these assessments?

8. Can you tell me about reflecting upon your teaching.

8.1. How often do you do it?

8.2. Do you do it on your own or with all the other foundation phase mathematics educators?

8.3. Do you do it only in front of the facilitators?

8.4. What role does it play?

9. What happens in your classroom to learners who have special needs, for example, those learners who have difficulties and those who achieve very high mathematics?

9.1. How do you plan for learners with special needs?

10. Does peer teaching have a place in your classroom?

10.1. What form would it take? Give me an example.

10.2. How often does it take place?

10.3.Is it planned as part of your teaching for the day?

11. What MCPT materials do you have?

11.1. How do you use them?

11.2. What difficulties do you have in obtaining materials?

11.3. How much of the materials that you use have been made by you?

12. How do you feel about teaching foundation phase mathematics?

12.1. Can you elaborate?

13. Do you feel that you are able to teach mathematics in the way you would like to?

14. In teaching mathematics are there any restrictions / frustrations that you still experience and would like to overcome?

14.1. What are they?

14.2. What do you think you can do to overcome these difficulties?

15. How do you think the learners feel about mathematics?

16. How do learners in your class acquire confidence in working with mathematics?

17. What criteria do you use to decide that a child's mathematical knowledge is sufficient for him/her to progress onto the next concept, step, grade, etc.?

18. Could you tell me something about the records you keep.

_____

_____

_____

19. Would you mind showing them to me?

_____

_____

_____

General Information

Age: _____

Qualifications: _____

Highest grade at school: _____

Diploma: _____

Degree: _____

Number of years of teaching experience _____

No. of years of teaching foundation phase mathematics _____

When did you start your MCPT training _____

How long have you taught at this school? _____

Have you specialized in mathematics teaching while at college _____

6.3 Appendix 3: Observation Schedule

Name of School : _____

Name of Educator : _____

Name of Facilitator : _____

Grade: _____

No. of learners in class: _____

A. TEACHING METHODS

1.Using a Variety of Teaching Methods

3	2	1
Educator uses a variety of methods that involve learners.	Educator uses 1 or 2 methods that involve learners.	Educator uses no methods that involve learners.

Description _____

2.Drilling/ Teaching by Repetition

3	2	1
Repetitive learning is used only for committing information to memory so that it can be recalled quickly. Material that has been learnt by means of repetitive practices is fully understood and learners are able to use this knowledge in many different ways.	Repetitive learning is used for committing information to memory so that it can be recalled quickly. Learners do not understand how these answers were arrived at, but are able to transfer knowledge to novel situations.	Learners learn all mathematical concepts by repetition and are unable to transfer knowledge to novel situations.

Description (Example) _____

B. AVAILABILITY AND USE OF RESOURCES

1.Use of Resources by Learners

3	2	1
Learners share and use materials.	Only the educator uses the materials in front while the children are observing.	No materials are available for the learners or the educator to use.

Description _____

2.Manipulation of Resources by Learners

3	2	1
Learners share and all manipulate materials in groups or pairs.	Some learners manipulate others watch.	None of the learners manipulate materials.

Description _____

3.Availability of Contextually Produced Resources

3	2	1
Sufficient resources are available, most of which have been produced by the educator and learners.	Sufficient resources available. Most have been commercially produced.	Insufficient resources available.

Description

C. GROUP TEACHING AND THE ROLE OF LEARNERS DURING THE MATHEMATICS LESSON

1. Learners Work in Groups

3	2	1
Groups of learners discuss problems, questions and activities by themselves.	Group of learners with limited interaction, interact when educator motivates.	Learners sit in groups but work as individuals.

Description

2. Peer Teaching and Learning

3	2	1
Educator encourages learners to talk to each other about how they worked out problems, to compare answers and check with each other so that learners can benefit from each other's thinking. Educator organises activities where learners work with each other, listen and share ideas together so they are able to create meaning together.	Educator occasionally organises activities where learners work together but activities are not structured in a way that learners benefit from each other's thinking.	Educator does not encourage learners to discuss their work. She does not organise activities where learners collaborate to solve problems.

Description

3. Activities of Learners while Educator is Busy with a Group

3	2	1
All learners are meaningfully occupied with differentiated, challenging mathematical tasks for entire period while educator is busy.	Learners are provided with differentiated, challenging tasks to keep them occupied. Work is insufficient for faster workers.	Learners are provided with simple tasks at the lowest level so that the entire class copes.

Description _____

4. Management of Groups

3	2	1
All learners take turns at management roles within their own groups.	Few learners share responsibility for the management of their own groups or of the whole class. Group leaders and roles are fixed.	Learners do not share responsibility for the group. Educator takes care of all aspects of management by herself.

Description _____

5. Learner- Learner Interaction without the educator

3	2	1
Learners freely enter into discussions with each other.	Learners only question or help each other when prompted to do so by the educator.	Learners do not question each other or probe for details.

Description (Frequency) _____

D. EDUCATOR'S MATHEMATICAL KNOWLEDGE AND CONFIDENCE

1. Subject Knowledge and Confidence

3	2	1
Good knowledge, confident and shows greater understanding of the subject. (relates to other ideas/concepts/topics).	Sufficient knowledge and relatively confident.	Basic knowledge with inaccuracies.

Description _____

2. Conceptual Understanding

3	2	1
Educator teaches learners how to think in more abstract ways. Educator focuses on the process of solving problems by designing activities which encourage learners to hypothesize, use their prior knowledge, predict , investigate, estimate, discover and recognise patterns.	Educator occasionally focuses on developing conceptual understanding for mathematics by explaining and showing connections, e.g. 3x4=3+3+3+3 or number patterns.	Educator focuses on teaching learners number facts. Educator trains learners to get a particular answer rather than teaching them to gain conceptual understanding.

Description

E. OUTCOMES BASED EDUCATION METHODOLOGY

1.Teaching Mathematics in a way that Relates to Learners' Everyday Experiences.

3	2	1
Learners are frequently encouraged to and are able to see the relationship between the mathematics that is being taught and its relationship to the real world.	Learners are occasionally encouraged to and are able to see the relationship between the mathematics that is being taught and its application to the real world.	Mathematics taught in an abstract way. Learners are never encouraged to see the relationship between what is being taught and its application to the real world.

Description

2. Problem solving

3	2	1
Educator emphasises independent problem solving and reasoning by asking questions which push learners' thinking. Educator sets non - routine problems so learners need to think about how the work them out but learners by aski explain their reaso	Educator occasionally emphasises independent problem solving but this is mainly with routine problems. Educator tends not to push learners' thinking.	Educator tells or shows learners how to solve problems. Educator does not ask learners to explain. Educator sets routine problems which have a specific method that is followed in order to solve the problem.

Description

3. Calculations: Standard and Non-Standard Calculation Procedures

3	2	1
Educator encourages learners to become independent thinkers. Educator encourages learners to use their own methods for calculating and to experiment with different ways of finding the answer.	Educator encourages learners to use their own method for calculating but educator still favours one method.	Educator teaches mathematics as if all learners calculate in the same way. Educator repeats and drills in one particular method for calculating.

Description

F. LANGUAGE OF TEACHING AND LEARNING

1. Teaching of mathematics is closely related to use of language

	2	1
Educator incorporates the use of everyday language in the mathematics lesson so that learners become aware of mathematics everywhere in their daily lives and its links with formal language	Language of mathematics mostly taught in an abstract and formal way with educator occasionally attempting to use informal language and to draw parallels between mathematics and learners' daily lives.	Only formal mathematical language used in an abstract way / learners are unable to see mathematics everywhere in their lives.

Description

2. Use of language to improve learner understanding

3	2	1
Educator uses English, switches to home language when necessary.	Communicates only in English, even when learners do not seem to understand, discourages use of home language.	Uses home language only.

Description

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