# IMPLEMENTATION AND INTERPRETATION OF A LEARNER-CENTRED APPROACH: THE CASE OF SOME MATHEMATICS TEACHERS IN MASERU

Nkoja Claudia Khechane

A dissertation submitted to the Faculty of Education, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Masters of Education by coursework and research report.

# ABSTRACT

*This is a qualitative research project that attempts to describe and explain how selected mathematics teachers in Lesotho interpret and implement a learner-centred approach to teaching and learning mathematics. The study was carried out with nine secondary mathematics teachers who were participants in the Secondary Education Support Project programme and who were working under different contextual conditions. Data were collected through the use of classroom observations and interviews.*

*The findings of this study indicate that while secondary mathematics teachers espouse some form of commitment to learner-centred practice, this practice is not reflected in most classrooms. However, some teachers managed to display some elements of learner-centred practice in their lessons. The study also established that contextual conditions did not emerge as a main factor for or against the implementation of a learner-centred approach.*

*The study argues that an explanation for the gap between teachers' espoused and enacted theories is that teachers in Lesotho are encouraged to change their practices, but, the wider curriculum remains unchanged. This may force teachers to continue using old practices. Therefore, the study suggests that if a change in teachers' practices is to be achieved, there should be a change in syllabus, textbooks, and modes of assessment.*



KEYWORDS : learner-centred, mathematics teaching, espoused and enacted understandings

# DECLARATION

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

NKhechane

Nkoja Claudia Khechane

30th day of September, 1998.

DEDICATION

TO

Kahlolo, Kamoho and 'Maleihlo

# ACKNOWLEDGEMENTS

It would not be possible to list everyone who gave information valuable to this study. However, certain individuals need special mention.

My sincerest thanks to:

My supervisors, Professor Jill Adler and Karin Brodie for their guidance, encouragement, sympathy, support, friendship and patience in guiding me through this study.

The head-teachers, teachers and students of the six schools in which the study was conducted for allowing me to undertake the study in their schools.

The SESP mathematics specialist for his willingness to provide the necessary information that helped shape this study.

# TABLE OF CONTENTS

# CHAPTER ONE

# INTRODUCTION

## 1.1 MOTIVATION FOR THE STUDY

This study is motivated by poor mathematics results in Lesotho secondary schools and claims that these are affected by the way mathematics is presented in schools. The argument made is that mathematics is transmitted by teachers in ways which make it seem to be a meaningless activity. For example, the Central Inspectorate of the Ministry of Education in Lesotho characterised the teaching of mathematics in one secondary school as follows:

> In all classes seen, there was strict adherence to pupils' text-books by the teacher and very little pupil involvement. The mode of teaching as a result tends to be expository which makes lessons dull and pupils become passive recipients of information. A lot of opportunities were missed where students could have been engaged in practical or investigative activities in the lesson (Ministry of Education, 1995:23).

This observation has been confirmed by research findings which indicate that the most dominant teaching strategy in Lesotho secondary schools is that of exposition-example-exercise (Kokome, 1990; Moru, 1994 and Polaki, 1996).

In an attempt to improve the teaching of mathematics in Lesotho secondary schools, the government of Lesotho, in conjuction with the British government, provides INSET courses for mathematics teachers. In these courses, teachers are encouraged to change from teacher-centred to learner-centred approaches. This study focuses on teachers who have been on one such course through the Secondary Education Support Project (SESP). It explores how teachers, who have had some exposure to learner-centred practice interpret and implement a learner-centred approach to teaching and learning mathematics.

## 1.2 AIMS OF THE STUDY

My study aims to describe and explain how selected teachers in Maseru interpret and implement a learner-centred approach to teaching and learning mathematics.

In order to achieve the above aim, the following research questions will be answered:

1. What do teachers understand by the term 'learner-centred'? That is,

(a) What do they say a learner-centred approach is or should be?

(b) How do they implement or enact what they view as learner-centred practice?

2. How can teachers' understandings of learner-centred be explained?

Are classroom conditions the main determining factor for implementing a learner-centred approach?

## 1.3 SIGNIFICANCE OF THE STUDY

This study will illuminate what teachers do manage to do in relation to a learner-centred approach. It is hoped that this might help those responsible for INSET courses to concentrate more on building on what teachers can do in their various contexts, rather than focusing on things which teachers do not do. Most importantly, this may inform the government and those responsible for the running of the workshops, what kinds of things they need to accept or acknowledge in the inevitable gap between theory and practice. This is particularly important in a context where intended changes in pedagogy have not been accompanied by reconsiderations of other aspects of the curriculum, in particular the stated syllabus, prescribed textbooks, and tests and examinations.

The findings of this study can also contribute to mathematics teachers' understandings of current, popularised learner-centred approaches to mathematics teaching and learning.

## 1.4 SUMMARY OF CHAPTERS

Chapter 2 provides a framework that helps to explore teachers' understandings of a learner-centred approach. This framework posits two kinds of theories that teachers hold and which can be used in understanding teachers' meanings of learner-centred practice. These are espoused and enacted theories. Espoused theories are what we are able to say we think and believe and enacted theories are

theories containing the assumptions and beliefs that actually guide our behaviour.

The framework also acknowledges that espoused and enacted theories may not be compatible. The explanations provided for this incompatibility include teachers' beliefs about the nature of knowledge and their contextual conditions.

In addition, the framework recognises the learning of mathematics as a process whereby students themselves construct mathematical knowledge. It further indicates that in learner-centred teaching, the teacher's role needs to be redefined.

In Chapter 3, a description of the methodology of the study is discussed, and the methods used to collect data on teachers' interpretation and implementation of a learner-centred approach are described.

Chapter 4 deals with interpretation and analysis of the data that have been collected through classroom observations and interviews. This chapter provides an in-depth analysis of three cases which are interesting and representative. In addition, a summary of the remaining six cases is also provided.

Chapter 5 deals with conclusions from the findings of the study and implications for policy-makers, INSET providers and teachers.

# CHAPTER TWO

# THEORETICAL FRAMEWORK AND THE REVIEW OF RELATED LITERATURE

## 2.1 INTRODUCTION

This study set out to explore teachers' understandings of a learner-centred approach to teaching and learning mathematics. In order to interpret teachers' understandings, the study is informed by two theoretical perspectives: 1. action theories, as expounded by Argyris and Schon (1974); and 2. constructivist philosophies of teaching and learning mathematics. Action theories were drawn on in this study because teachers' understandings could be revealed in two ways, that is, through what they say and what they actually do. On the other hand, constructivist philosophies of teaching and learning mathematics are drawn on in this study because these philosophies might provide a framework for describing and explaining learner-centred practice. In the next section, I will therefore deal with each of these two in more detail.

## 2.2 ACTION THEORIES

Osterman and Kottkamp (1993) argue that the decisions one makes, the action one takes and the way one acts are all governed by personal action theories. For Robinson and Viviane, cited by Osterman and Kottkamp (1993:28), a theory of action, from an actor's point of view is a theory of

control because it specifies how to achieve particular purposes under given conditions. From the observer's point of view, they argue that a theory of action has explanatory and predictive power, because it tells people why actors behave as they do, and how they are likely to behave in future. Action theories have two elements: espoused and enacted theories. Espoused theories are described by Argyris and Schon (1974) as theories of action which are inferred from how people say they behave or would behave. Hence, in finding out how teachers interpret learner-centred teaching, the researcher was looking for teachers' espoused theories, which may or may not influence their classroom practices or instruction. Argyris and Schon (1974) further indicate that to examine espoused theories, people have to be asked to talk or write about issues.

Therefore it was important in this study to talk to teachers in order to elicit their espoused understandings of learner-centred teaching. Argyris and Schon concluded that these espoused theories have two distinct characteristics:

1. They exist at a conscious level, that is, they reflect conscious ideas, intentions and beliefs.
2. They change with relative ease in response to new ideas and understandings. Therefore, teachers may emerge from INSET courses able to articulate new ideas such as learner-centred practice.

On the other hand, theories of action which are inferred from actual behaviour are called theories-in-use or enacted theories. Osterman and Kottkamp (1993) have observed that

actions are often inconsistent with intentions. They believe that theories-in-use are powerful in influencing how people act. These theories according to Argyris and Schon (1974), contain the assumptions and beliefs that guide people's behaviour. They state that: "theories-in-use are so deeply ingrained in our consciousness that we cannot easily articulate them; they are not easily changed" (p.9). For Osterman and Kottkamp (1993), theories-in-use are built up and solidified over a long period of time and are reinforced by ongoing experience in the culture. That is, they become an integral part of our beings such that they are difficult to identify or isolate.

In the light of the above statement, one would argue that it is important in this study to observe teachers in classrooms because it might not be possible for them to say everything that they understand about a learner-centred approach to teaching and learning mathematics. Some of the meanings people make might be so embedded in their action that it would not be easy for them to realise or be aware of them. Classroom observation would reveal some of these. In order to get at teachers meanings, both teachers' espoused and enacted theories are therefore required in this study.

However, Argyris and Schon (1974) and Argyris (1976) point out that theory-in-use may or may not be compatible with one's espoused theory and if there is incompatibility, an individual may or may not be aware of this. Thus, we may believe that the espoused theories guide our actions, but this may not be case. In particular, while espoused

theories incorporate new ideas, theories-in-use may resist change. This argument about the incompatibility of these two theories has been illustrated by numerous studies. The explanations provided usually relate to classroom conditions such as large classes and lack of resources; teachers' pre-existing beliefs and practices; school policies; and the organisation and practice of formal schooling (Cornbleth, 1990; Cuban, 1995).

Researching the impact of the 'Critical Thinking Project', Cornbleth (1990) found that some of the teachers in the project were able to talk nicely about critical thinking, but could not put these new ideas into practice. Some of the reasons brought forward were classroom conditions such as large classes, teachers' pre-existing beliefs and practices, and school policies. That is, teachers' pre-beliefs and practices, and school policies may have a great influence on teachers' instructional practice.

According to Swafford (1995), what teachers believe about the nature of mathematics and about the nature of mathematics learning and teaching have a great influence on teachers' instructional practices. Thompson (1992) also argues that what teachers believe about the nature of mathematics and mathematics learning has been shown to be as important as their knowledge of mathematics. For both Swafford and Thompson, a teacher who believes that mathematics is a set of procedures, rules or facts will often view the teaching of mathematics as the presentation of procedures and concepts. In addition, a teacher who

believes knowing mathematics is the ability to recite facts and perform computations will often view the learning of mathematics as drill and practice.

Thompson (1984) has pointed out that research has shown a fairly consistent relationship between teachers' beliefs about the nature of mathematics and their instructional practice. Similarly, Cobb, Wood and Yackel (1990) have observed a strong relationship between teachers' beliefs about teaching and their beliefs about how students learn mathematics.

However, a teacher may believe in a learner-centred approach but find that the expectations or demands of the school to cover the syllabus forces him/her to teach in a manner inconsistent with his/her beliefs. As it has been pointed out earlier, school policies may also influence teachers' instructional practices.

Morar's (1997) research also shows the gap between espoused and enacted theories. Researching on 'Professional Development in Teaching Primary School Mathematics - Can We Really Change Teachers' Practices', Morar (1997) found that teachers from a staff development course made attempts to incorporate the new ideas in their teaching but many of them failed to demonstrate many of the necessary skills for that approach. For Morar, the reason for the gap is that:

> for many of our teachers, there are points of uncertainty as to how to proceed and they then take refuge in that which is more familiar as a mechanism

> for coping when tensions occur for which they can see no readily available alternative (p.259).

Similarly, Backhouse (1987) found that some teachers could not use new ideas gained from a staff development course because some staff (especially senior maths colleagues) in their schools were resistant to the introduction of new ideas from the course. What Backhouse (1987) found as the chief obstacle to putting ideas from the course into practice was lack of time for preparation - that is, inclusion of new ideas into already existing schemes. He also found that another matter of concern to some teachers was the design and location of classrooms. Thus, school conditions such as the design and location of the classrooms may force teachers to teach in a manner that might be inconsistent with their beliefs. This results in the gap between the espoused and enacted theories.

### 2.2.1 SUMMARY

In this section, a framework for understanding the gap between the espoused and enacted theories has been provided. Factors such as classroom conditions; teachers' beliefs about the nature of knowledge, how it is learned and how it should be presented and school policies are said to create the gap between the espoused and enacted theories. In the next section, a framework for understanding a learner-centred approach will be developed.

## 2.3 CONSTRUCTIVIST EPISTEMOLOGY

Constructivist epistemology has had an important influence both in mathematics education (Jaworsky (1989), von Glasersfeld (1991), Campbell and Johnson (1995)) and on learner-centred approaches. Much of the constructivist literature has its roots in Piaget's work. Although the advocacy of "learner-centred" (South African and Lesotho Policies), "child-centred" (Ginsburg and Opper, 1978) or "progressive" (Darling, 1990) approaches to teaching and learning in school has had a long history (Darling, 1990), Piaget was the first person to argue that children's ideas be taken seriously as making sense from their perspective. Taking children's ideas seriously in the classroom requires a discussion of :(a) influence of current knowledge on new knowledge; (b) activity and discovery; (c) social interaction, (d) role of teacher and (e) difficulties associated with learner-centred practice. The following sections will focus on these.

### 2.3.1 INFLUENCE OF CURRENT KNOWLEDGE ON NEW KNOWLEDGE

According to Piaget, education should stem from a child-centred perspective. For Piaget, knowledge is constructed by the child him/herself as he/she strives to organise his/her experiences in terms of pre-existing mental structures (Piaget cited in Ginsburg and Opper, 1978).

Piaget further pointed out that a child views the world differently from the adult because the child's view of the world is based on a limited amount of information. For him,

the child's use of language is different from that of the adult. That is, if a child uses a word, it does not automatically convey the same meaning that it does when an adult uses it. Therefore when an adult says something to a child, it should not be taken for granted that the same meaning is conveyed to the child. The child's understanding of what has been said would depend on his/her existing mental structures.

As indicated, constructivist literature which has its roots in Piaget's work has had an important influence in mathematics education. For example, it is argued that mathematical understanding is acquired when the child is actively attempting to construct and test the meaning of a new experience in the light of his or her prior understanding. In the words of Campbell and Johnson (1995),

> no one can give a child mathematical knowledge; developing mathematical knowledge is not a matter of memorising rules or practising skills; mathematical knowledge comes from an individual's effort to connect new experiences or conclusions to prior knowledge (p.37).

They further indicate that research findings suggest that students learn mathematics when they connect their prior experiences to new experiences.

According to Piaget, quoted by Ginsburg and Opper (1978), the child does not necessarily learn his/her words from the adult, but assimilates them into his own schemata or mental structures which are quite different from the adult. The fact that adults and children have different schemata

implies that each of them will process information presented differently (Sotto, 1995).

This is why educationists argue that, in teaching, the teacher should always try to find out what knowledge or experiences students already have so as to start teaching from where the students are (Sotto, 1995). If a teacher does not do this, it is possible that the students may not be able to follow what is going on in the lesson because there might be no connection between what they already know and the new information. The teacher can best find out what the students know by giving them opportunities to speak and verbalise their thinking.

In this way, Piaget suggests that an educator should try to adopt a child-centred point of view and should not assume that the child's experiences are the same as his/her own. For Piaget, an educator may feel that a given idea is simple and self-evident, but the child may find it difficult. Therefore it is important for an educator to interact with his/her pupils in order to gain insight into their thinking. Thus, through interaction with his/her pupils, an educator would begin to understand them and be able to tailor educational experience to their needs. However, Piaget himself never said that teachers in formal schools should be child or learner-centred. Educationists interpreted his developmental theory as meaning that every educator, including teachers, should be child-centred or learner-centred.

### 2.3.2 ACTIVITY AND DISCOVERY

Darling (1994) points out that child-centred education emphasises that it is in the nature of the child to be active. According to Darling (1994), progressives argue that "children are intellectually curious, keen to find things out and actively engaged in making sense of the world they live in" (p.37). Hence, it is argued, that if a teacher teaches a child something he/she could have discovered for him/herself, the child would be kept from inventing it and consequently from understanding it completely (Edwards and Mercer, 1987). Campbell, cited in Darling (1994), argues that it is not what the teachers do to the child or for the child that educates him, but what they enable him to do for himself, to see and learn and understand for himself. In other words Campbell emphasises the need for teachers to create suitable activities that would encourage students to find things out for themselves.

According to Sotto (1995), the importance of allowing the students to find or "discover" ideas or knowledge for themselves is that they will have a direct experience of that idea or knowledge:

> this knowledge is encoded inside them in a compacted, abstract, living form. That enables them to grasp its meaning. They don't see the items bit by bit, word by word, they see the matter as an integrated living whole and they also see how it interconnects with the thousands of other things they already know (Sotto, 1995; p.59).

The "Plowden Report" (1967) entitled *Children and their Primary Schools* advocates child-centred education in England. It indicates that:

> the teacher will miss the whole point if he/she tells the children the answer or indicates too readily and completely how the answer may be found, but at the same time he/she must not let them flounder too long or helplessly (Edwards and Mercer, 1987; p.37).

Thus, the point being made here is that children are agents of their own learning and they should be given a chance to make their own judgements or discoveries. Campbell and Johnson (1995) indicate that the act of telling would not advance student's understanding because what he/she was told may not make sense to him/her.

In mathematics education, Jaworski (1989; 289) argues against telling as a method of transferring knowledge. She holds that "implicit in telling is the notion that there exists truth or knowledge to be told... telling about mathematics may unduly constrain the pupils' thinking".

A similar view is expressed by von Glasersfeld (1991) who argues that knowledge cannot simply be transferred ready-made from parent to child or from teacher to students, but has to be actively built up by each learner in his or her own mind.

According to Cuevas (1995), educational research offers evidence that students learn mathematics well only when they construct their own mathematical understanding. This

suggests that to really learn mathematics, one has to act on it. This also suggests that learning mathematics is not only a matter of listening to a teacher, but also of having had appropriate experiences.

In short, Keiny cited in Polaki (1996) indicates that:

> once knowledge is conceived as 'something' that is actively constructed by the learner, in a process that involves him or her subjectively, it becomes clear that knowledge cannot simply be transferred from the teacher to the learner. Verbal presentations do not automatically yield understanding, and a problem presented by the teacher may be interpreted in different ways by his or her learners. In other words, the instrumental model of the teacher as the transferor of knowledge is misguided. The alternative model is the developmental teacher whose role is to develop his or her students as learners, learners who are able to construct their own conceptual structures (p.4).

A similar view has been expressed by Sotto (1995) who indicated that real learning is not what happens when students are fed information. For him telling a student what to do may not help in the long run. He contends that, "it is possible for a student to follow a set of instructions exactly and obtain the required result and learn nothing" (p.50). In these cases, according to Sotto, a student will have learned to follow instructions, but will not necessarily see how these relate to other knowledge. This has very important implications for teachers. It suggests that the primary function of a teacher is not to convey information but to give students chances to experience or 'discover' things for themselves.

However, Love and Mason (1992) have indicated that telling can be useful, especially if learners are in a state to be able to make connections and to assimilate what is being said. Therefore what Campbell and Johnson have indicated does not necessarily mean that there should be no telling. Rather, it should be done at the right time, for example, when there is something problematic or when there are uncertainties. Hence a teacher should not give up his/her responsibility for what is learnt, he/she should be continually looking for such opportunities.

### 2.3.3 SOCIAL INTERACTION

Although many people have considered Piaget to have overlooked the important role of social interaction in cognitive development, Rogoff (1990) argues that in some of his writing, Piaget focused directly on the role played by social context in cognitive development.

Similarly, Ginsburg and Opper (1978) point out that in Piaget's view, social interaction certainly influences or promotes cognitive development. For Ginsburg and Opper (1978),

> when one child talks to another, he comes to realise that his way of viewing things is not the only perspective. The child sees that other people do not necessarily share his opinions (p.230).

Therefore, they conclude that social interaction will lead to arguments and discussions. It is during such discussions and arguments that the student's views will be questioned. On the one hand the student will try to defend and justify

his/her opinions. This process forces the student to clarify his/her thoughts for he/she wants to convince others that his/her views are valid. In the process of doing this, the student will have an opportunity to reflect on his/her constructions.

The implications of this view is that social interaction should be encouraged in a learner-centred classroom. Teaching strategies such as small group discussions, pair work and whole-class discussions therefore characterise a learner-centred classroom. This point is supported by Ginsburg and Opper who argue that students should converse, share experiences and argue, as these are major tools in the acquisition of knowledge.

A similar view has also been raised by Tobin and Fraser (1988) quoted by Polaki (1996). They point out that:

> meaningful learning occurs as a result of personal actions on data which are derived from active engagement in activities in which students discuss ideas and problems with their peers, manipulate equipment, work independently, listen to the teacher in whole-class settings, and respond to teacher questions. Because knowledge is personalised, active teaching is required to monitor student understanding, and to facilitate learning through the use of cues, prompts, and clarifications (p.17).

Similarly, Cobb et al. (1992) point out that discussions can give rise to learning opportunities because during discussions students are encouraged to contribute and to clarify their point of views by elaborating on them. And in

the process, they have opportunities to reflect on their constructions and to receive new ideas from colleagues. Therefore, if meaningful learning is to occur in the classroom, it is important for students to be given the opportunity to engage in group activities since, as has been mentioned above, these kinds of activities make important contributions to clarifying one's thinking. Love and Mason (1992) also argue for discussion in the classroom. For them, connecting new experiences to prior experiences can be stimulated by discussion.

The importance of social interaction in the learning process has also been confirmed by Cobb et al. (1990:19) cited by Morar (1996) who found that social interactions, including both teacher-student and student-student, are important in enabling students to verbalize their thinking, explain or justify their solutions, and ask for clarifications.

Wood and Yackel (1990) have also pointed out that research findings indicate that small group problem solving and class discussion result in opportunities for learning that do not occur in traditional classrooms. For them, those learning opportunities arise from collaborative work, as well as from the resolution of conflicting points of view. They further argue that:

> genuine mathematical problems arise in the course of social interactions in small group problem solving, as well as from an individual student's attempt to complete instructional activities (p.244).

Thus a learner-centred approach argues against treating students as passive recipients of knowledge. Instead, it advocates that learning activities should be designed in such a way that the students are able to construct their own mathematical meanings or knowledge. Strategies such as group discussions, including both whole class and small groups, problem-solving, and investigations would therefore be ideal for promoting a learner-centred approach to mathematics teaching and learning. These strategies encourage students to be independent, to participate and reflect on their work. These are some of the observable indicators that will be used in this study to find out how the selected teachers interpret learner-centred teaching in their practice.

### 2.3.4 ROLE OF THE TEACHER

While it is the student who ultimately constructs mathematical knowledge, this does not mean that the student can do this on his/her own. A learner-centred approach does not mean that there is nothing the teacher can do to assist student's learning processes. On the contrary, a learner-centred approach places an enormous responsibility on the teacher. For example, when students are busy working together in pairs or in small groups on a task designed by the teacher, the teacher should circulate among the groups, asking questions that will "challenge them to engage in deeper mathematical thinking, asking for evidence to support students' solutions, and redirecting and refocusing groups which are off task" (Lappan and Briars, 1995: 143).

Darling (1994) points out that in learner-centred practice, teachers still teach, but their teaching has to shift from giving out information to selecting and developing worthwhile mathematical tasks; posing problems and asking questions that build on students' thinking. Worthwhile mathematical tasks according to Love and Mason (1992) are those which encourage students to make connections and at the same time involve contradictions or conflicts. These are tasks that will encourage students to engage in discussions because where there are contradictions or conflicts, students would find themselves arguing in order to resolve their differences. In the process of doing this, they will have the opportunity to explain things to each other and to locate differences and agreements in their explanation. This may therefore result in meaningful learning.

According to Henningsen and Stein (1997), mathematical tasks are central to students' learning because tasks convey messages about what mathematics is and what doing mathematics entails. It is on this note that Lappan and Briars (1995) have argued that choosing worthwhile mathematical tasks around which to organise instruction is the key to fostering quality mathematical teaching.

On the other hand, asking the child questions that stimulate, encourage and guide him/her towards making his/her own sense of things is regarded as an important aspect of learner-centred teaching (Lappan and Briars, 1995). The student in learner-centred teaching is expected

to explain how he or she solved the problem and why he or she did it in a particular way. This may prompt the child to reflect upon and modify his or her thinking. And if there are any misunderstandings or misconceptions, the child will have an opportunity to correct them.

Campbell and Johnson (1995) also argue that the role of the teacher is to ask appropriate questions that will provoke the students to reflect on their actions and also to defend their approaches and reasoning. For them, questioning is necessary especially in learner-centred teaching because it "may lead to the child's assimilation, accommodation or integration of new understanding" (p.30). They further suggest that the teacher should avoid questions that require single-word responses or if these type of questions are asked, they should be followed with requests for students to explain their solutions.

According to Lappan and Briars (1995), the role of the teacher is also to enhance and promote students' mathematical discourse in the classroom. Elaborating this point, Mercer (1995) indicates that the role of the teacher especially during discussions is to translate what the students have said into "academic discourse". He points out that:

> without a teacher a group discussion tends to gravitate towards a common denominator in terms of an 'everyday' discourse that everyone can understand and use effectively. Whereas a teacher can, without necessarily dominating the discussion, help to translate some of what is said into terms of the 'academic discourse', so that the group members can see how the ideas they already hold can be made to work within that discourse. (p.82)

Thus, the teacher should help the students to connect or link their everyday knowledge to school knowledge or academic discourse.

Through classroom interactions, a teacher could therefore help his/her students to acquire proper mathematical discourse. In this way, students will learn what mathematical activities, explanations and justifications are acceptable.

This section has discussed conceptual and empirical research that highlights some teacher practices that may reflect a learner-centred classroom. However, these may or may not be realised in classrooms. In the next section, I will discuss some of the problems which research suggests might make it difficult to implement learner-centred practices.

### 2.3.5 DIFFICULTIES ASSOCIATED WITH LEARNER-CENTRED TEACHING

Even though many teachers in many countries have been encouraged to adopt a learner-centred approach to teaching mathematics, research findings have indicated that this approach is not alive in many mathematics classrooms. For example, research done in Britain indicates that although students are often seated around desks in groups, they still work predominantly on their own (Edwards and Mercer, 1987).

A similar point has been raised by Brodie (1998) who points out that a commonly observed phenomenon in South Africa is of pupils sitting in groups, but working individually. With

this type of practice, Brodie argues that the interactional benefits of group work would not be achieved. That is, those opportunities for students to converse, share experiences and argue are not achieved.

Cuban (1995) found that in an effort to introduce "student-centred" instruction in US classrooms, two forms of teacher-centredness emerged. These are the "pure form" and the "hybrid form". According to Cuban (1995: 203), the pure form is characterised by whole class instruction, teachers talking most of the time while students listen, activities limited in range and perfomed by the whole class (e.g. those in the textbook). For him, the hybrid form is a mixture of practices drawn from the two traditions of teaching (teacher-centred and student-centred). Cuban's research further indicated that most teachers especially at high school level were still using the pure form of teacher-centred teaching.

Some of the reasons why learner-centred practice is not alive in many classrooms and why only a hybrid version between teacher- and learner-centred approaches is observed are: in learner-centred classrooms, students are expected to construct their own meanings. This approach recognises that each student will construct meanings which may be different from those which are constructed by others. But what remains problematic is that schools do not recognise or reward individual construction of meaning. School practices recognise only those particular constructions which are acceptable in the community. This, according to Zevenbergen

(1996), is witnessed in formal examinations where students are not rewarded for their own construction of meaning but for the construction of knowledge that is seen as legitimate by examining bodies.

The same concern has also been raised by Ellerton and Clements (1992) who pointed out that "... even if students are given a chance to construct their own meanings, the final constructions that would be considered would be those in the curriculum". With this knowledge, teachers may not find it useful to spend a considerable amount of time encouraging their students to construct knowledge which is not going to be rewarded. That is, teachers will be tempted to concentrate on those constructions that will be required at the end of the year. And by so doing, they may be tempted to tell their students what kind of knowledge is required in the curriculum.

The above discussion suggests that if curriculum, especially modes of assessment, do not change, it would be difficult for most teachers to adopt a learner-centred approach, especially when teachers' success is judged on examination results. The mode of assessment therefore has a great influence on the teaching strategies used by teachers.

Another difficulty associated with a learner-centred approach is that it discourages direct telling. However, Green (1993) points out that making sense of mathematics will involve teachers at times telling their students things about mathematics (e.g. telling students certain rules or

knowledge regarding mathematics)(refer to Love and Mason, p.17). This puts teachers in a dilemma as to when and what they should tell their students.

The above discussion highlights some difficulties with teacher intervention. There are further problems: given the opportunity to construct their own mathematical knowledge, students might explore in directions which the teacher knows are outside the syllabus. In this case should students be stopped, or should they be a given chance to come up with whatever they may discover? When specifically, should students be stopped? Is there a time when the teacher should step in to clarify what has been learned? Is summing up allowed? And in a class of say 40 to 50 students, how will the teacher recognise when learning is or is not taking place?

Another criticism levelled against a learner-centred approach is that it has a lot to say about how students learn, and does not sufficiently stress the need for teaching, while in fact the teacher plays a more important role than before. Peters, cited in Darling (1994), argues that learning involves the teacher. He points out that "the procedures of a discipline can only be mastered by an exploration of its established content under the guidance of one who has already been initiated" (p.80). In the classroom it is the teacher who has already been initiated and should therefore guide the newcomers.

With all these questions, weaknesses and tensions associated with learner-centred teaching, it is not surprising that research findings indicate that this approach is not alive in many classrooms or has been practised on a small scale.

## 2.4 SUMMARY OF THE THEORETICAL FRAMEWORK AND THE LITERATURE

In this chapter, I have developed a framework that will help in describing and explaining how teachers interpret and implement a learner-centred approach. The framework posits two kinds of theories that teachers hold and which can be used in understanding teachers' meanings of learner-centred practice. These are espoused and enacted theories. The framework recognises that these theories may not be compatible. The explanations provided for the incompatibility of these two theories includes teachers' beliefs about the nature of knowledge, how it is learned and how it should presented, and contextual conditions.

The framework also recognises that a learner-centred approach comes out of constructivism, where constructivism sees the learning of mathematics as a process whereby students themselves construct mathematical knowledge. This suggests a learner-centred approach, where worthwhile tasks and social interaction are key for learning mathematics. In learner-centred teaching, the teacher's role shifts to designing worthwhile tasks, eliciting pupils' meanings and listening to them, questioning, providing opportunities for social interaction and mediating meanings. The literature

review has, however, indicated that this approach is not alive in many classrooms. This might be due to problems within the approach, contextual conditions and curriculum.

It is this framework that has been brought to bear on the research design discussed in the next chapter, and the analysis of data in chapter 4.

# CHAPTER THREE

# RESEARCH METHODOLOGY

## 3.1 DESIGN OF THE STUDY

This is a qualitative research project that attempts to describe and explain how selected mathematics teachers in Maseru interpret and implement a learner-centred approach to teaching and learning mathematics.

A qualitative approach was adopted in this study because I wanted to gain insight into how mathematics teachers understand a learner-centred approach. According to Bogdan and Biklen (1982), qualitative researchers are concerned with a "participant perspective". McMillan and Schumacher (1993: 373) agree with this, and argue that qualitative research is concerned with understanding the social phenomenon from the participants' perspective. Understanding for McMillan and Schumacher is acquired by analysing the contexts of the participants and by narrating meanings for these situations and events. Participants' meanings include their feelings, beliefs, thoughts and actions.

For Bogdan and Biklen (1982), there are five characteristics of qualitative research. These are:

- It has the natural setting as the direct source of data.

- It is descriptive, with emphasis on words rather than numbers.
- It is concerned with processes rather than products or outcomes.
- Data is analysed inductively.
- Meaning made by different participants is of essential concern.

All these characteristics are applicable in this study. Firstly, my research is classroom-based and attempts to explore teachers' meanings within the constraints of the classroom setting. Bogdan and Biklen (1982; 27) have pointed out that actions are better understood in the context of the history and institutions of which they are part.

Secondly, my research is descriptive in that it tries to present a detailed description and explanation of the teachers' understandings of a learner-centred approach.

Thirdly, my research is concerned with what is happening in the classrooms and its relations to teachers' beliefs, rather than products (e.g. testing students).

Fourthly, the analysis is grounded in the data. The researcher's perspectives and the evidence are constantly challenging and influencing each other. I as a researcher had a conception of what might constitute learner-centred practice, but through giving an account from the

participants' perspective, I have modified and elaborated my initial conception.

Finally, the teachers meanings were central to this research.

## 3.2 SAMPLE AND SAMPLING TECHNIQUES

The sample was selected from Maseru, the major urban centre in Lesotho. This study used purposeful sampling.

> In purposive sampling, researchers hand-pick the cases to be included in the sample on the basis of their judgement of their typicality. In this way they build up a sample that is satisfactory to their needs (Cohen and Manion, 1994; 89).

Similarly, McMillan and Schumacher (1993) point out that in purposeful sampling, the researcher is "selecting information-rich cases for study in-depth when he wants to understand something about those cases without needing or desiring to generalise to all such cases" (p.378).

In this study, I needed teachers who had been exposed to ideas on learner-centred practice through INSET and who were working under different contextual conditions. On the basis of these criteria, 9 teachers who were participants in the Secondary Education Support Project (SESP) programme and who were working under different contextual conditions were purposefully selected. The reason for selecting teachers from the SESP programme is that through its workshops, the

SESP programme explicitly encourages teachers to adopt a learner-centred approach to teaching and learning mathematics. Different contextual conditions were important in this study because one of the research questions is whether contextual conditions are inhibitors or barriers for implementation of a learner-centred approach. Therefore teachers participating in SESP and teaching in church and government owned schools were chosen (see Table 1). The reason for selecting schools owned by different authorities is that church schools are believed to be better resourced than government schools.

TABLE 1: Summary of the teachers, levels and the type of school (government or church)

| TEACHERS | LEVELS/GRADE | GOVERN/CHURCH SCH. |
|---|---|---|
| T1 | 8 | church |
| T2 | 9 | government |
| T3 | 11 | church |
| T4 | 11 | church |
| T5 | 11 | church |
| T6 | 8 | church |
| T7 | 9 | government |
| T8 | 9 | government |
| T9 | 12 | government |

## 3.3 TECHNIQUES FOR DATA COLLECTION

Since this study aims to describe and explain teachers' understandings of a learner-centred approach, data has bee.. collected through classroom observations and interviews. These methods were used in this study because they access

teachers espoused and enacted theories of a learner-centred approach. The classroom observation and interview schedules (see Appendices A and B) were developed from the research questions and conceptual frame. The observation schedule was adapted from an existing one (see below).

### 3.3.1. Classroom Observations and Observation Schedule:

McMillan and Schumacher (1993) point out that:

> the advantages of using observational methods are that the researcher does not need to worry about the limitations of self report bias, social desirability and information is not limited to what can be recorded accurately by the subjects (p.257).

In observational methods, the researcher is recording what he/she sees and hears of what the observed people are doing. This method is important in this study because it will enable the researcher to answer the question how do teachers implement or enact what they view as a learner-centred practice? Teachers' actions or practices are very crucial in this study because it is through their actions and practices that I will be able to explore their enacted theories. The classroom observation schedule used to collect data was adapted from that used in the Wits FDE-Baseline study (see Adler, Lelliot, Slomnisky et al, 1996). The observation schedule was piloted on a video recording of a mathematics classroom where a learner-centred approach was used. On the basis of this piloting and after discussion with the researcher's supervisors, I was able to adjust and

refine some of the items before a final classroom observation schedule was developed.

The first part of the observation schedule was for recording the basic resources available in each school and classroom. This includes the duration of the lesson observed, the grade and the number of students in the class. This part provides data on contextual conditions and enables analysis of whether they are inhibitors or barriers to implementation of a learner-centred approach.

The second part of the observation schedule is an unstructured section which allows for a narrative of the lesson as it progresses. The narrative was written by me, during the lesson.

The third part of the observation schedule contains structured items relating to elements of learner-centred practice as discussed in chapter 2. There are eight items, which are: lesson introduction, group or pair work, pupil-pupil interaction (without teacher), verbal pupil participation with teacher, whole class teacher-pupil interaction, tasks, misconceptions and teacher questioning. Each item has four categories. The numbers in the categories are not a quantitative measure of an aspect of practice, but rather describe different ways of doing things in the classroom. For example:

2. Group or Pair Work

| | | | |
|---|---|---|---|
| No group or pair work (1) | Very few pupils interact, others just listen (2) | Group of learners with limited interaction/interact when teacher motivates (3) | Learners are explicitly organised in such a way that facilitate group/pair work. Group of learners discuss by themselves (4) |

The structured section also contains space for the observer to write comments against each observation item.

### 3.3.2 Semi-Structured Interview and Interview Schedule:

The interview followed a semi-structured format, in which, according to McMillan and Schumacher (1993), questions are phrased to allow for individual responses. The researcher probes issues raised by the teachers which are relevant to the study. According to Cohen and Manion (1994: 272), the importance of an interview is that it provides access to what is "inside a person's head", it makes it possible to describe what a person knows, what a person likes or dislikes and what a person thinks. Therefore to answer the question what do teachers say a learner-centred approach is or should be?, this method was important. In other words, this method was used in this study in order to access teachers' espoused theories. The interviews played an important role in this study because conclusions drawn on classroom observations only would not give teachers' full understandings of a learner-centred approach.

The interview schedule was constructed by the researcher. Questions were discussed with the researcher's supervisors and the information gathered from such discussions was used to construct and re-construct some of the questions.

## 3.4 PROCEDURES

The researcher paid each school in the sample a familiarisation visit, in order to meet the head-teachers and teachers involved in the study and seek permission to observe and interview teachers.

I decided to do the classroom observations before interviewing the teachers. This was because I thought that the behaviour of teachers might be influenced or affected by the questions that would be asked in the interviews. I did not want the teachers to know the purpose of my study until I had interviewed them. I thought that teachers would be aware of what I would be looking for in their practices, and as a result might have done what they do not normally do, or what they did not intend to do. This would give a distorted impression of what goes on during their usual lessons.

Each teacher was observed for one double (80 minutes) or one single (40 minutes) lesson. A full narrative of each lesson was made during the lesson. The narrative was used to complete the observation schedule after the lesson.

Before interviewing each teacher, the assurances that the information collected in the interview will be treated

confidentially was made and with teachers' permission, the conversation was tape-recorded. The tapes were later transcribed. I went through the transcripts several times while listening to the tapes in order to check if there were discrepancies between the recording and the transcript. On the basis of the checking, corrections were made. Each interview lasted for 15 minutes.

## 3.5 VALIDITY AND RELIABILITY

Both reliability and validity originate in quantitative research methods to ensure that the research is objective (McMillan and Schumacher, 1993; Maxwell, 1992). However, objectivity is not necessarily a criterion for qualitative research. In the next sections, validity and reliability in this qualitative study will be defined and discussed.

### 3.5.1 Validity

Validity in qualitative research is viewed as a

> relationship between an account and something outside of that account, whether this something is construed as objective reality, the constructions of actors, or a variety of other possible interpretations (Maxwell, 1992; 283 ).

Validity is always relative to the purposes and circumstances of the research and dependent on some community of enquirers on whose perspective the account is based (ibid; 284). Hence validity cannot be guaranteed from the beginning in qualitative research.

According to Maxwell (1992), there are five categories of validity. These are descriptive validity, interpretive validity, theoretical validity, generalising validity and evaluative validity. In this study the following are applicable: descriptive validity, interpretive validity, theoretical validity and generalising validity.
In this study, descriptive validity has been achieved. When interviewing teachers, I tried to record the teachers' words as accurately as possible. A tape recorder was used to record what the teachers said and after transcribing the tapes, I went through each transcript while listening to the tape to ensure that I have written precisely the teacher's words.

Maxwell (1992; 287) points out that descriptive validity is by no means independent of theory - all observation and description are based on theory. In this study, my way of seeing things in the classroom was in fact guided by theory. That is, chapter 2 gave me a foundation of what learner-centred classroom or practice should be like.

According to Maxwell (1992; 288), qualitative researchers are not only concerned with providing a valid description of the physical events and behaviours in the settings they study, they are also concerned with what these events and behaviours mean to the people engaged with them. That is, they (researchers) are concerned with explaining and describing what physical events and behaviours mean to the actors. In this study, my interpretation of how teachers implement a learner-centred approach has been shaped by a

theoretical framework, as well as my experience as a teacher. This gives me interpretive validity.

Theoretical validity in Maxwell's typology concerns the concepts used to explain the data and the relationships between them. In this study, theoretical validity is attended to in chapter 4 where terms used to explain data are those developed in chapter 2 and accepted within the research community.

Generalisability in qualitative research refers to the extent to which one can extend the account of a particular situation or populations to other persons, times or settings than those directly studied (Maxwell, 1992; 293). Though my study concentrated on selected teachers, the theoretical framework and the literature provided in chapter 2 and its informing of the data analysis in the next chapter make it possible for others to interpret this research into their own contexts or situations.

### 3.5.2 Reliability

Reliability refers to consistency in the procedure or research strategies and meaning making of the data (McMillan and Schumacher, 1993; Fraenkel, 1990). In qualitative research, reliability is enhanced by use of different methods of data collection. In this study, two sources of data collection were used, namely, classroom observation and interview. That is, these instruments enabled the researcher to give full descriptions of the data.

Another way of enhancing reliability is to give data to another researcher to check. This was not possible in this study, however, as indicated earlier, the transcripts were reviewed again and again.

## 3.6 LIMITATIONS

The study was affected by factors such as the inadequate time available for the research. Initially, I wanted to observe fourteen teachers for least two consecutive double periods each. However, due to the fact that the research was conducted towards the end of the year when external examinations were about to be written, there were only nine teachers available for both interviews and classroom observations. Those nine teachers were visited once and some were observed for a single lesson while others were observed for a double lesson. This is a serious limitation for this study because conclusions are made on the basis of single observations. This does not give a holistic picture of each teacher and might not show teachers at their best because they might not have prepared for this kind of activity on that day.

Limitations to this study are also related to the methods used. Interviewing poses some special problems in that the researcher is "usually in the presence of the person interviewed only briefly, and must necessarily draw inferences from what happened during that brief period to the rest of the informant's life" (Maxwell, 1992; 294). A

limitation associated with observation is that as an observer, I could not see everything and therefore I had to make a selection of what to concentrate on.

However, I will argue in the next chapter that though there are limitations regarding this study, there is still a lot to learn from it.

## 3.7 SUMMARY

In this chapter, a description of the methodology and methods used in collecting data for this study has been given. Issues relating to validity and reliability in this study have also been discussed. The argument raised is that although this study concentrates on selected teachers the theoretical framework and the literature provided in chapter 2 and its informing of the data analysis in chapter 4 makes it possible for others to interpret this research into their own contexts or situations.

# CHAPTER FOUR

# DATA ANALYSIS, INTERPRETATION AND DISCUSSION

## 4.1 INTRODUCTION

This chapter deals with interpretation and analysis of data that have been collected through classroom observations and interviews. In this chapter, I will first provide an in-depth analysis of three cases which highlight important contrasts between the teachers. The first case is a teacher who was teaching in a poorly-resourced school and yet was able to display some elements of learner-centred practice in his teaching. The second is a teacher who was teaching in a relatively well-resourced school and yet his practices did not show any learner-centred aspects. The third case is a teacher who was teaching in a school that was more resourced than the school of the first teacher, but not as well-resourced as the school of the second teacher. This teacher's practices were in the middle of the first two teachers regarding learner-centred practice.

This combination of cases will assist in exploring contextual conditions as explanation on the one hand and insight into a learner-centred approach itself on the other. A summary of the remaining six cases will also be provided. The reason for providing such a summary is to show similarities and differences relative to the first three

cases and the extent to which the three cases are representative of the whole sample.

Throughout the chapter, I will explore teachers' espoused and enacted theories of learner-centred teaching in an attempt to both describe and explain what their understanding of a learner-centred approach is. I will answer the central questions of the study, that is:

1. What do teachers understand by the term 'learner-centred'? That is,

(a) What do they say a learner-centred approach is or should be?

(b) How do they implement or enact what they view as learner-centred practice?

2. How can teachers' understandings of learner-centred be explained?

3. Are classroom conditions the main determining factor for implementing a learner-centred approach?

Before entering detailed analysis, I need to remark here, and this will be revisited in detail and with evidence, that all 9 teachers espoused some form of commitment to learner-centred practice.

## 4.2 CONTEXTS, VIEWS AND DATA ANALYSIS OF TEACHERS T3, T4 AND T2

In this section, a description of the classroom and school of each teacher will be presented, together with the analysis of the interviews and classroom observations for each of the three cases.

### 4.2.1 TEACHER T3

**4.2.1.1 Description of the school:** Teacher T3 was teaching in a church owned school which was not well-resourced[1]. There was no library in the school, no telephone, nor electricity. I was told that the school is in the process of installing telephone and electricity. Due to the fact that there was no electricity in the school, facilities such as a photocopying machine and a new model type-writer were not available. What was available was an old manual type-writer. Teachers relied mainly on the use of a stencil for making copies. Running water and pit latrines were available. Apart from being poorly resourced, the school seemed to be well organised.

During class hours, there were no students loitering around, all of them were in their respective classes. Students were neatly dressed in their school uniform and the surroundings were clean.

**4.2.1.2 Classroom:** The lesson observed was in Form D (Grade 11) and it took 80 minutes. There were 61 students present and 4 absent. There was not enough space in the room for students to work comfortably. Each student had a chair but some were sharing desks. The majority of students did not

[1] This is a contradiction with regard to sampling because it was expected that church schools would be better resourced.

have textbooks and calculators and as a result had to share with those who had.

Students were initially arranged in rows of pairs and later in groups. There was a chalk board which was large enough for working, but there were no maths learning aids available in the class.

4.2.1.3 Lesson: Solving quadratic equations using quadratic formula

**Note: Students utterances are indicated in [ ]**

The lesson began with the teacher writing the following equations on the board:

(i) $x^2 + x - 12 = 0$

(ii) $6x^2 - 13x + 6 = 0$

He asked the students to solve these equations on the board. Since this was a review of work done earlier, students seemed to have no problems with these questions. Student 1 did the following on the board:

$x^2 + x - 12 = 0$ *[by factorisation this is]*

$(x - 3)(x + 4) = 0$ *[therefore]*

$x - 3 = 0$ OR $x + 4 = 0$

$x = 3$ OR $x = -4$

Thereafter, the teacher asked the class whether there were questions or not, and there seemed to be no questions. Another student was asked to do the next equation. She did the following:

$6x^2 - 13x + 12 = 0$

$(3x - 2)(2x - 3) = 0$ *[by factorisation]*

The teacher said "*any questions?*" and there were none. He then wrote the equation $x^2-6x-8 = 0$ on the board and asked students to solve it in pairs in their exercise books. Students were supposed to tell the teacher when they were through with the problem. While students were busy solving the equation, the teacher was sitting at his table waiting for students' responses. He kept on asking them whether they were through or not. However, students seemed to experience problems with this question. None of them came up with a solution. They tried to find factors but failed. After some time, some of the students told the teacher that "this problem does not have factors sir". The teacher thereafter started introducing the quadratic formula. He told students that if a quadratic equation does not have factors, a quadratic formula should be used. He then stated the formula on the board:

$$x = \frac{-b \pm \sqrt{(b^2 - 4ac)}}{2a}$$

*where a is the coefficient of* $x^2$
*b is the coefficient of x*
*c is a constant*

An example of how a formula works was given, that is:

$x^2-6x-8 = 0$ ; *where* $a=1$ , $b=-6$, $c=-8$

$$x = \frac{-b \pm \sqrt{(b^2-4ac)}}{2a}$$

$$= \frac{6 \pm \sqrt{(36 + 32)}}{2}$$

$$= \frac{6 \pm \sqrt{68}}{2}$$

$$= \frac{6 \pm 8.24}{2}$$

*Therefore* $x = \frac{6 + 8.24}{2}$ *OR* $x = \frac{6 - 8.24}{2}$

$x = 7.12$ *Or* $x = -1.12$

Another example $2x^2 + 5x - 1 = 0$ was given and one student was asked to work it on the board. The student with the help of the teacher managed to solve the question. He did the following: $2x^2 + 5x - 1 = 0$; $a = 2$, $b = 5$, $c = -1$

$$x = \frac{-b \pm \sqrt{(b^2 - 4ac)}}{2a}$$

$$= \frac{-5 \pm \sqrt{(25 - 4x2x1)}}{2}$$

(at this stage, the teacher reminded the student that c=-1 not 1, and the student corrected his mistake by substituting -1)

Thus,

$$= \frac{-5 \pm \sqrt{(25 - 4x2x-1)}}{2}$$

$$= \frac{-5 \pm \sqrt{(25 + 8)}}{2}$$

$$= \frac{-5 \pm \sqrt{33}}{2}$$

*[Therefore]* $x = \frac{-5 + 5.74}{2}$ *OR* $x = \frac{-5 - 5.74}{2}$

Thereafter, a task from the textbook was given and students worked on it in groups. While working on the task, students were freely arguing and discussing with each other, except for three or four students who decided to do the task individually. The teacher did not have any objections to those who decided to work individually. Furthermore, students in groups were freely consulting with other groups, and the teacher circulated among the groups, checking or helping students with what seemed problematic. While circulating among the groups, the teacher realised that some students were having a problem with the minus sign in front of the letter b. So he stopped the discussion and explained how a negative number is substituted into the formula. He told students that whenever substituting into the formula, they should first write the formula as it is and then put whatever they are substituting in brackets to avoid confusion. He did the following:

*If say* $a = 2$, $b = -3$ *and* $c = -4$

$$x = \frac{-b \pm \sqrt{(b^2 - 4ac)}}{2a}$$

$$= \frac{-(-3) \pm \sqrt{(-3)^2 - (4 \times 2 \times -4)}}{2 \times (2)}$$

$$= \frac{3 \pm \sqrt{9 + 32}}{4}$$

$$= \frac{3 \pm \sqrt{41}}{4}$$

He then asked his students, "*is this clear*", and they answered yes in chorus. The teacher told them to continue

with their work and he also continued to check and mark students' work.

At the end of the lesson, students were asked to finish the rest of the problems at home and those who were almost through with the task were asked to continue with the next exercise.

#### 4.2.1.4 Classroom observation

In this section, the scores this teacher (T3) obtained will be discussed. It should be remembered from chapter 3 that the numbers stand for different aspects of each category and are not a quantitative measure of anything. See appendix A for a breakdown of the categories.

Table 2

| Teacher | 1. lesson intro. | 2. Group /pair work | 3. Pupil-pupil inter. | 4. Verbal pupil part. With teacher | 5. Whole class discussion | 6. Tasks | 7. Mis-conceptions[2] | 8. Teacher questioning |
|---|---|---|---|---|---|---|---|---|
| T3 | 3 | 4 | 4 | 4 | 3 | 3 | 4 | 1 |

For items 2, and 3, the teacher scored 4 which indicates that learners were organised in groups and they were freely discussing and arguing with one other. For item 4, he also scored 4 because students in his class volunteered to work out problems on the board and during group discussions, they were questioning each other. For item 5, he scored 3. This indicates that the teacher did create the opportunity for pupil-pupil interaction.

[2] In this study, misconceptions denote students' errors or difficulties.

Student interaction increased through group and pair work. The teacher gave students standard tasks from a textbook and therefore scored 3 for item 6. For item 7, he scored 4 because he was able to notice students' errors or difficulties and provided an explanation which facilitated conceptual clarity. However, in whole-class discussion or teaching, the teacher did not ask students questions, instead, he asked them to work out problems and used phrases such as "any questions?" and "is it clear?". Hence, for item 8, he scored 1. However, T3 did ask students questions in their groups.

This teacher's enacted interpretation of a learner-centred approach in practice is that students should work in groups or individually on exercises from a textbook. In addition, they should do so on the board and in their exercise books. This was evident in what he did in the lesson. This teacher often requested students to solve problems on the board and also to work on tasks in groups.

Furthermore, his enacted interpretation of a learner-centred approach in practice is that students should interact, discuss or converse with each other about the given work or task. This was reflected in his lesson where most teaching occurred in pair and group work. In such groups, students were freely talking and discussing about the problems. In this way, the teacher was providing opportunity for social

interaction. According to Campbell and Johnson (1995), this practice in a mathematics classroom gives the students an opportunity to reflect on their constructions and also make these constructions available to other students in a group. For Ginsburg and Opper (1978), social interaction should be encouraged because it will lead to arguments and discussions and these are the major tools in the acquisition of knowledge.

Through listening and questioning students in their groups, T3 was able to draw on students' meanings and pick up their errors and difficulties. Therefore, social interaction had also helped the teacher to check what kind of learning has taken place and gave him an opportunity to correct students' errors or misconceptions (Sotto, 1995).

The use of a variety of strategies (individual, pair work and group work) in this class would be regarded as an "observable measure" of a learner-centred practice by Cuban (1995). Teacher T3's understanding of learner-centred practice appears to be that students should be given the chance to find out certain things for themselves. In the lesson, the teacher created the need for the quadratic formula. Though the teacher eventually told his students that they would need the quadratic formula to solve the equation $x^2-6x-8 = 0$, he avoided telling them at the start of the lesson. Instead, he gave his students an opportunity to realise or see for themselves that it was not possible to solve the equation by factorisation. Love and Mason (1992) indicate that telling is useful, especially if learners are

in a state to be able to make connections and to assimilate what is being said. At this stage, it was easy for the students to see why the formula was necessary for that particular question.

One could also conclude that T3 understands a learner-centred approach as a method whereby the teacher should not sit back and watch his students while they are working on a task. During the lesson, the teacher moved from one group to another, listening, questioning and checking students' work. This, according to Lappan and Briars (1995), is the role of the teacher in learner-centred teaching.

What is interesting with T3 is that while he created a need (in the learners) for the formula, this was then presented as is, with no explanation as to its sense or meaning. Thus, his control is still strong because he was holding some information back from students as in teacher-centred practice. Therefore his practices reveal what Cuban (1995) calls "hybrid" teaching. That is, a mixture of both traditions (teacher- and learner-centred) were present in his teaching.

#### 4.2.1.5 Interview

When asked what learner-centred means to him, T3 indicated that:

> *learner-centred means involving students in learning, they should be actively involved in their learning.*

On the question of whether he practises this approach in his classes, he pointed out that:

> *yes I do. I give students work everyday. You know, with maths, it is very easy to involve students. I sometimes give them oral questions or use group work like I did today or ask them to work problems on the board and explain to each other.*

Commenting on the strengths and weaknesses of a learner-centred approach, T3 indicated that:

> *learner-centred helps students, at least every student to find things for him or herself and as such they won't easily forget because they would have done things themselves. Again it helps shy students. They find it easier to communicate with their peers than with the teacher.*

However, he pointed out that:

> *the biggest problem of learner-centred method is that it is time-consuming. There are a lot of topics to cover before the end of this year, so if you concentrate on this method, you won't be able to cover all those topics. Again you find that some students don't participate in group work, they just go there to observe others or you find that others dominate the discussion.*

Teacher T3 also highlighted that:

> *large number of students, lack of resources such as textbooks, calculators and equipment such as photocopying machine make the implementation of this method difficult.*

This teacher's espoused understanding of a learner-centred approach is that students should be actively involved in the learning process. By "active involvement", the teacher meant that students should do some work. That is, they

should solve problems. This was evident in what he said in the interview when he pointed out that *"I give students work everyday. You know, with maths, it is very easy to involve students"*. Thus, involving to him means giving work or getting students to do some work.

Therefore, this teacher espoused some commitment to learner-centred practice in that he talks of involving students in their learning, encouraging students to express their thinking to each other, and use strategies such as group work. However, he neglected an important element of learner-centred practice which is worthwhile tasks. As indicated earlier, this teacher's practices reveal elements of both traditions. From this discussion, it can be seen that there is an overlap between his espoused and enacted theories.

Teachers' practices are shaped by many factors. As indicated earlier, some of the factors that may prevent teachers from putting new ideas into practice are classroom conditions such as large classes, teachers' pre-existing beliefs and practices, and school policies. This teacher's justification includes lack of resources and time constraints. However, lack of resources in this case was not a total inhibitor for putting a learner-centred approach into practice. This teacher was able to display some elements of learner-centred practice despite the fact that his school was poorly resourced, his class was large and the teaching conditions were generally not conducive.

Additional constraints on this teacher in including other elements of learner-centred practice in his teaching are lack of time, and his beliefs about the nature of mathematics and mathematics teaching. Mathematics teachers, especially in Lesotho are encouraged to change from teacher-centred to learner-centred approaches, but the format of national examinations and the prescribed syllabus remain unchanged. National examinations in Lesotho are structured in such a way that they cover the prescribed syllabus. The prescribed syllabus is reflected in textbooks. Thus, students can best cope with the examination questions if they have covered the syllabus which means completing the textbooks. The fact that the syllabus is long and students should finish it before writing their national examinations suggests that learner-centred strategies would not be frequently used as they (learner-centred strategies) need a considerable amount of time. In his words, T3 indicated that:

> *the biggest problem of learner-centred method is that it is time-consuming. There are a lot of topics to cover before the end of this year, so if you concentrate on this method, you won't be able to cover all those topics.*

This teacher, as I have already indicated earlier was teaching in grade 11, and grade 11 is one year before school leaving examinations. Therefore a need to cover prescribed syllabus and to prepare students for their examinations might have exerted pressure on the teaching approach used by this teacher.

In addition, the teacher's beliefs about mathematics itself and how it should be learned might have prevented him from including other elements of learner-centred practice in his teaching. Although this teacher created the need for the formula, he seemed to believe that solving mathematics problems is moving from formulae or concepts, to following formal procedures and finding answers. In the previous lesson, students were solving quadratic equations using factorisation and in the lesson that I observed, students were solving quadratic equations using the quadratic formula. This shows that from the concept of factorisation, students were able to follow formal procedures to get the answers. That is why they realised that equation $x^2-6x-8=0$ does not follow the same pattern. Even after introducing the quadratic formula, students were following the formal procedures to get the answers.

The next section deals with T4 who was working in a school which was relatively well resourced and yet did not show any signs or elements of learner-centred teaching.

### 4.2.2 TEACHER T4

**4.2.2.1 Description of the school:** Teacher T4 was also teaching in a church owned school but this school was relatively well-resourced compared to that of T3. There were toilets for both teachers and students, running water, telephone and electricity in the school. There was also a school library which was relatively well stocked. Facilities such as a photocopying and a stencil machine were available for teachers' use. A new model type-writer and a

computer were also available. The school surroundings were clean, there were no papers around. Students were neatly dressed in their school uniform. There were no students loitering around during class hours. The principal of the school seemed to be very strict. During the lessons, he was busy checking whether teachers were in their respective classes. In each classroom, there was a register to be signed by teachers, indicating the subject they had been teaching and the time that particular subject was taught.

**4.2.2.2 Classroom:** The lesson that was observed was as with T3 (it was in Form D and it took 80 minutes). There were 21 students in the class and all of them were present. There was enough space in the room for students to work comfortably. Each student had a desk and a chair. They all had textbooks, instruments, graph books and calculators. The organisation of the classroom was formal, with students sitting in rows of pairs facing the chalkboard and the teacher's table. There were two large chalkboards in the class. One was the ordinary plain chalkboard and the other was a squared chalkboard that was used for drawing graphs.

**4.2.2.3 Lesson:** Inequalities

Teacher T4 introduced the lesson by asking students to mention three steps to follow when drawing inequality graphs and shading regions. One student raised up his hand and said: *step1: the boundary line should be drawn;*

*step2: one point from one side of the line should be tested;*

*step3: the unwanted region should be shaded.*

While the student was mentioning these steps, the teacher was writing them on the board. Thereafter, the teacher elaborated step 2 by saying that "*one point from any of the two sides should be substituted in the inequality*". He further made the students aware that they should know the three steps for examination purposes. He told them that in examinations, they should always read and understand what a question requires. He pointed out that the syllabus requires them to shade an "unwanted region" so that the region representing the set of points is left clearly visible. However, last year's question was different, in that it required students to shade the wanted region instead of the "unwanted region". Hence most students lost marks because they shaded the unwanted region like they are used to.

Thereafter, he wrote $x + y > 2$ on the board and asked students where the line should be drawn. One student said: *the line is at* $x + y = 2$ *and should be a broken line*. The student was asked why the line should be broken. He said: *because there is no equal sign in the inequality*. The teacher drew the graph with the broken line at $x + y = 2$ on the board and asked students where he should shade the region. One student said: *below the line* $x + y = 2$. The teacher said "*correct*" and wrote the point $(3,3)$ on the board and said: "*if for instance, we take this point which is above the line and we substitute it in the inequality, then we have the following:*

*3 + 3 > 2 and this point is therefore in the region that we are looking for, hence we should shade below the line, the unwanted region".*

The region was then shaded. Thereafter, the teacher asked students whether they had questions or not, and very few of them said "*no*".

The following inequalities were written on the board:

(a) $x + y < 4$,

(b) $x - y > 5$,

(c) $x + 2y > 6$,

(d) $-3y + x < 6$

and students were asked to work them out. Students were also told that when they were through with each question, they should first show it to the teacher before proceeding to the next question. While students were working on this task, the teacher was sitting at his table waiting to mark students' work. Students who were through with (a) raised their hands and the teacher started moving around marking students' work. There were two girls who were secretly explaining or discussing the work together. The teacher saw them and shouted at them. He told them that they should do the work individually and learn to be independent. This contributed to a tense atmosphere in the classroom. Students were quiet and working individually. However, there was a boy who seemed to be confused. The teacher asked one of the boys who seemed to understand what the task was all about to explain to the confused boy.

Students who were through with the tasks written on the board were referred to another task in the textbook. At the end of the lesson, those students who were not able to do the task in the textbook were asked to do it for homework while those who managed to finish were asked to do the next exercise in the textbook.

#### 4.2.2.4 Classroom observation

In this section, the scores obtained by teacher T4 will be discussed.

Table 3

| Teacher | 1. lesson intro. | 2. Group /pair work | 3. Pupil-pupil inter. | 4. Verbal pupil part. With teacher | 5. Whole class discussion | 6. Tasks | 7. Mis-conceptions | 8. Teacher questicning |
|---|---|---|---|---|---|---|---|---|
| T4 | 3 | 2 | 2 | 3 | 2 | 3 | 1 | 3 |

T4 scored 2 for item 2 which indicates that in his class, there was no group work and very few pupils interacted. Those who interacted, were doing it secretly because they did not want to be seen by their teacher. Therefore, for item 3, he scored 2. For item 4, he scored 3 because he did ask students to explain their answers. Generally, the teacher spoke much more than the students in this class. Student talk was confined to responding to questions from the teacher. Hence, for item 5, this teacher scored 2 which shows that he was predominantly controlling the class. He gave students standard tasks on the board and from the textbook. So for item 6, he scored 3. Since the teacher was predominantly controlling the class, most students in

the class did not have chance to speak and so the teacher could not notice whether they held errors. So for item 7, he scored 1. For item 8, T4 scored 3 because in addition to recall questions, he asked for some explanation.

If this teacher attaches any value to learner-centred practice, then his enacted interpretation of learner-centred practice appears to be restricted to students working individually on exercises written on the board and from the textbook, and sometimes explaining answers. He does not stress pupil interaction or collaboration. This was reflected in his lesson when he shouted at two girls who were discussing the work that they should do the work individually and learn to be independent. If we compare T3 and T4, we can see that both used textbook exercises. However, they did so in different ways. Unlike in T3's class, where students had opportunities to speak to one another, most students in T4's class did not say a word. That is, T4 did not provide opportunity for social interaction in his class. He spent most of the time talking and explaining to students what kind of knowledge is required in national examinations. Thus, T4 was doing some telling without listening or giving students a chance to question or express their thinking. Though he did ask students some questions, these questions were not drawing students' understandings. This practice, according to Cuban (1995) is a "pure form" of teacher-centred practice.

Clearly, if this teacher values learner-centred practice, then his enacted interpretation has left the teacher's role

untouched. That is, the teacher should do almost everything and students should listen and do the work.

**4.2.2.5 Interview:**

From the interview, it appears that T4 does aspire to learner-centred practice. Describing what learner-centred means to him, T4 stated that:

> *it means that learners are the centre of the learning process, they should be given chance to participate fully in the learning process, they should solve problems by themselves and do more work than the teacher.*

Commenting on how he practises this approach in his class, T4 indicated that:

> *there are different ways of doing this, I sometimes use probing questions in order to come to a certain conclusion. I also use a worksheet which at the end of it they come up with some conclusion. Again I let them work in groups and discuss. My students know that as long as they talk about maths, they can make as much noise as they like.*

T4 had pointed out that the implementation of this approach in his class is hampered by fact that:

> *it is time consuming, and there is a lot to cover before the end of year examinations.*

And for him, this is the biggest disadvantage of this approach. He further pointed out that:

> *in group work, work is normally done by one person while others are not doing anything.*

According to T4, classroom conditions especially

*in the higher classes where there are few students in the class make the implementation of this approach easy.*

Commenting on the strengths of learner-centred approach, T4 stated that:

*students are getting experience of how to solve problems and how to work and benefit from each other, they learn from one another and hence understand more.*

This teacher's espoused understanding of learner-centred practice is that students should be given the chance to "participate fully" in the learning process, "solve problems by themselves" and "do more work" than the teacher. Inferring from this teacher's practice, his understanding of "by themselves" could be that students should solve problems on their own, meaning individually, without others' help. Therefore, teachers T3 and T4 interpret the phrase by themselves" differently. To teacher T3 it means students themselves, with the help of one another but not the teacher, and to teacher T4 it means individually without others' or the teacher's help.

However, T4's espoused understanding of learner-centred practice is that students should work individually on worksheets or in groups. His understanding is that students in their groups should discuss. He pointed out that his "*students know that as long as they talk about maths, they can make as much noise as they like*".

However, looking at what this teacher did in his class and matching it with what he said in the interview, one finds a big gap between his enacted and espoused theories. As mentioned earlier, T4 shouted at two girls who were discussing the work together, and in the interview, he indicated that he lets students work in groups and make as much noise as they like. Argyris and Schon (1978) point out that people's behaviour is often incompatible with the theories of action they espoused. Like T3, T4's justification for not practising what he espoused is that a learner-centred approach *'is time consuming'*, and there are *lot of topics to be covered before end of year examinations*.

Examinations seemed to have also exerted pressure on how T4 teaches. In his lesson, this teacher spent some time telling students what type of knowledge is required in examinations and what students should know for exams. Thus, this teacher ended up teaching according to the type of items appearing in the exams. Throughout the lesson, he was paying more attention to knowledge required in examinations. This teacher's behaviour might be a result of what Zevenbergen (1995) indicated earlier when pointing out that students in formal examinations are not rewarded for their own constructions of meaning but for the construction of knowledge that is seen as legitimate by examining bodies.

Unlike T3 who has been teaching for three years only, T4 has been teaching for more than 10 years. One explanation for the gap between his (T4) espoused and enacted understanding of a learner-centred approach might have been due to his

pre-existing practices. Since T4 has been using the same approach for a long time, this approach may have become part of him, hence it might be difficult for him to change old habits or practices. For a change to occur, a considerable amount of time and effort would be needed. As Argyris and Schon (1974) have pointed out, enacted theories are built over a long period of time and are strengthened by ongoing experience. Therefore, they do not change easily.

As I have indicated earlier, the gap might also be a result of teachers' pre-existing beliefs. As Swafford (1995) indicated, beliefs are resistant to change. Like T3, T4's practice reflects a belief that doing mathematics is following a set of procedures or rules and finding 'the right' answers. In his class, T4 stressed a need to know the three steps for drawing and shading inequality graphs. For him, students were supposed to follow those steps and find 'the right' answers. His classroom practices clearly reflect that learning rules is an important part of mathematics and this belief might have contributed to the gap between his espoused and enacted understanding of a learner-centred approach.

Unlike T3, T4 was teaching in a relatively well resourced school. His class was small and all students had the necessary or basic materials. However, his practices were far from being learner-centred. Teacher T3, though he was teaching or working in bad conditions, did manage to embrace some learner-centred ideals in his teaching. Therefore

presence of resources does not lead to or facilitate learner-centred practice.

The next section deals with T2 who was teaching in a school that was better resourced than the school where T3 was teaching, but not as well resourced as T4's school. T2 is also in the middle of the two regarding implementation of learner-centred practice.

### 4.2.3 TEACHER T2

**4.2.3.1 Description of the school:** Teacher T2 was teaching in a government owned school that was relatively well resourced[3]. In the school, there was a library that was not well stocked, a telephone, electricity, toilets and running water. Facilities such as a photocopying machine, a stencil machine and a type-writer were also available. Both photocopying and stencil machines were available for teachers' use. The school however, seemed not to be organised. There were no teachers in some of the classrooms and students were making a noise and loitering around.

Some of the school windows were broken and surroundings were untidy. The grass was tall and there were papers all over the grounds.

[3] This is a contradiction with regard to sampling as it was expected that government schools would be poorly resourced.

**4.2.3.2 Classroom:** Teacher T2 was in a Form B (grade 9) class which is three years before school leaving examinations are written. The lesson took 80 minutes. There were 34 students present and 5 absent. There was enough space in the room for students to work comfortably. There was a chalkboard that was large enough for working. All students had chairs and desks. However, there were those who did not have textbooks and had to share with those who had. Some of the classroom windows were broken and classroom walls were written on. There were also some papers on the floor and the classroom was generally untidy. Students were seated in groups.

**4.2.3.3 Lesson:** Percentage Profit and Loss

The teacher first of all asked students to pick up some papers on the floor. She then introduced the lesson by reminding students that in the previous lesson they had been dealing with percentage increase and decrease. She then said:

*"suppose that in 1996, we had 60 students in* $A_4$[4] *class, and this year we have 40 students in the same class. Is this a decrease or an increase?"*

Student in chorus said: *decrease.*

[4] $A_4$ is the fourth stream of Form A class.

The teacher asked a volunteer to work out the percentage decrease on the board, and one boy volunteered. Without saying anything, he wrote the following on the board:

$$\frac{20}{60} \times 100\% = 33\%$$

Thereafter, the teacher said: " *are there any questions?*" As there were none, she gave students another example.

*T:* *suppose that I'm a business lady and buy a watch for M10.50 and sell it for M15.50. Do I have a gain or a loss?*

*S:* *(in chorus) gain.*

*T:* *the amount that I pay is called the buying price and the price I charge is the selling price.*
*(the teacher wrote M15.50 - M10.50 = M5.00 on the board)*

*T:* *Is M5 a profit or a loss?*

*S:* *(in chorus) profit.*

*T:* *this is the profit and in this case we call it the actual profit. And to calculate percentage profit, we have to calculate the actual profit first, divide it by the buying price and then multiply by 100%*

The teacher did the following on the board:

$$\% \text{ profit} = \frac{\text{actual profit}}{\text{buying price}} \times 100\%$$

$$= \frac{M5.00}{M10.50} \times 100\%$$

$$= \frac{500}{1050} \times 100\%$$

$$= 47\ \frac{13}{21}\%$$

*T:* *Any questions on this?*

*S:* (in chorus) *No questions.*

The teacher gave another example.

T: *Suppose that the buying price for a jacket is M48 and its selling price is M30. Is this a gain or a loss?*

*S:* (in chorus) *a loss.*

*T:* *anybody to work out what a % loss is?*

Nobody volunteered to work this out

*T:* *percentage loss is worked out in the same way as percentage profit. What you have to do is to calculate the actual loss. And follow the same procedure. Ânybody to work out this?*

*S1:* (raised up his hand and did the following on the board)

$$\%\ loss = \frac{actual\ loss}{buying\ price} \times 100\%$$

$$= \frac{M18}{M48} \times 100\%$$

$$= 37.5\%$$

*T:* *Correct. Are there any questions?*

There seemed to be no questions.

Then a task from the textbook was given. Students did it in groups. In their groups, students were freely sharing ideas by explaining and discussing together. However, there were two or three students who decided to do the task individually and the teacher did not have any objections to that. While students were working on the task, the teacher was busy circulating and marking students' work. At the end of the lesson, students were asked to do the next set of questions at home.

#### 4.2.3.4 Classroom observation

T2 obtained the following scores:

Table 4

| Teacher | 1. lesson intro. | 2. Group /pair work | 3. Pupil-pupil inter. | 4. Verbal pupil part. With teacher | 5. Whole class discussion | 6. Tasks | 7. Mis-conceptions | 8. Teacher questioning |
|---|---|---|---|---|---|---|---|---|
| T4 | 3 | 4 | 4 | 2 | 3 | 3 | 1 | 2 |

Teacher T2 scored 4 for both items 2 and 3. This indicates that learners in her class were organised into groups and in their groups they were freely discussing and arguing with each other. Even though there were two or three students who did the task individually, the majority of students were doing it in groups. For item 4, this teacher scored 2. This shows that students were most of the time responding to the teacher's questions in one word or in chorus. Though students did not ask questions in the lesson, one of them did volunteer to work out a problem on the board. For item 5, this teacher scored 3. This indicates that she did

create an opportunity for pupil-pupil interaction, by organising students into groups. The task given was from the textbook. Hence for item 6, T2 scored 3. For item 7, this teacher scored 1. This indicates that the teacher did not notice students' difficulties. However, this judgement might not be accurate as the teacher might have noticed and corrected students' difficulties while helping them in their groups. For item 8, T2 scored 2. This indicated that she was asking simple recall questions.

Like T3, T2's enacted interpretation of learner-centred practice is that students should work either in groups or individually on exercises from a textbook. In addition, they should do so on the board and in their exercise books. This was evident in what she did in the lesson. In her class, students were doing the work in groups and individually. Some students also worked out the problems on the board. Thus, this teacher accommodated different teaching strategies in class.

Social interaction is an important and necessary aspect of learner-centred teaching for this teacher. The fact that her classroom was arranged in a manner that permits students to work together, in groups, shows some signs of learner-centred teaching. The classroom organisation in her class was similar to that of T3's class, and her interpretation of learner-centred practice is similar in some ways to that of T3. That is, they provided opportunity for social interaction in their classes and accommodated different teaching strategies.

However, the difference is that T3 was more active than T2. In his class, T3 was moving from one group to another. He also argued with students about the solutions they had. On the other hand T2 moved from one group to another but concentrated mainly on marking or correcting students' work. She was not publicly arguing with students. They were also different in that T3 set up a need for the formula while T2 told students what to do rather than letting them experience things themselves. Another difference between T2 and T3 is that since T3 was engaging with students' ideas he was able to pick up some students' misconceptions while T2 did not display such behaviour.

Another element of T2's enacted interpretation of learner-centred practice was that it is a method requiring the use of real life examples to illustrate the mathematics that she is teaching. That is, the teacher is translating the everyday language into "academic discourse" (Mercer, 1995).

Inferring from her practices, T2, like T3 and T4, also thinks that there is still a strong role for the teacher in learner-centred teaching. What the teacher did in the lesson is to teach, instead of helping her students to learn. For instance, the teacher could have allowed students to calculate percentage profit themselves because they already knew how to calculate percentage increase and decrease. What was required was the connection between what they already know and the new information, and students could have done this themselves.

In some ways, T2 and T4 followed or used the same teaching approach. That is, they both gave a few examples on the board at the start of the lesson and set similar exercises for students to work on.

Teacher T2 did ask questions, but these required one word responses. She never asked questions publicly that encouraged students to think deeply about their answers or methods. Her way of questioning was similar to that of T4 in that it did not elicit students' understanding. This therefore, does not resonate with what Campbell and Johnson (1995) suggest. They point out that the teacher should avoid questions that require single-word responses, or if these type of questions are asked, they should be followed with requests for students to explain their solutions. This was not there in T2's class.

**4.2.3.5 Interview:**

When asked what learner-centred meant to her, T2 indicated that:

> *it means giving students chance to discover things by themselves, giving them more work rather than telling them that, this is that, let them do the work on their own and this will give them chance to explore and think creatively about the problem.*

T2 further pointed out that she practices this in her class. On the question of how she practices this in her class, she said:

*I sometimes design some activities, give students some instructions and by following these instructions, students are able to come up with conclusions themselves. In short, I design something like a worksheet. But what I use most of the time is group work.*

Commenting on the strengths of learner-centred teaching, T2 indicated that:

*once the students have discovered things for themselves, it is not easy for them to forget because they would have done it themselves.*

However, she pointed out that:

*this approach is time consuming and if you concentrate too much on it, you end up not finishing the syllabus. Again you find that very few students participate in group work.*

According to T2, what is hampering the implementation of a learner-centred approach is also the lack of materials:

*when you want to give students worksheets, getting them run or photo-copied is a problem, you will be told that there is no paper.*

This teacher's espoused understanding of learner-centred practice is similar to that of T3 in that they both believe that students should be given chance to do the work on their own. In the interview, T2 said *"let them (students) do the work on their own and this will give them chance to explore and think creatively about the problem"*. By this, she meant that students on their own and in groups should be given a chance to converse and reflect on the problem. This shows some overlap between her espoused and enacted theories.

Teacher T2 indicated that she practices this approach by grouping students. However, she also indicated that a learner-centred approach is time-consuming and if one concentrates too much on it, he/she would not be able to finish the syllabus.

Like T3 and T4, covering the syllabus seems to be a major concern for T2 even though she was teaching in grade 9. As indicated with teachers T3 and T4, students in Lesotho can best cope with examination questions if they have covered the syllabus. That is why these teachers are concerned with covering or finishing the syllabus.

Like T3 and T4, T2 also believes that doing mathematics is following a set of formulae and finding the 'correct' answers. In her class, T2 stated formulae for calculating percentage profit and loss and students were suppose to use these formulae to find the 'correct' answers.

As indicated above, T2 was teaching in a relatively well-resourced school which however, was not as well-resourced as T4's school. Compared with T3's school, T2's school was better-resourced, but her practices were less learner-centred than those of T3.

### 4.2.4 SUMMARY

In summary, the three cases can be placed on a continuum. In terms of learner-centred practice, T3 was the best, followed by T2 and the worst being T4. In T4's class, closed tasks from the textbook were used, there was little

or no social interaction and there was a little teacher mediation. In T2's class, closed tasks from the textbook were also used, but there was pupil-pupil interaction and there was some involvement of students. In T3's class, closed tasks from the textbook were used, pupil-pupil interaction was encouraged, there was more involvement of students in that students were encouraged to express or verbalise their thinking. Teacher T3 also made some attempt to see what students were doing and realised that they held some errors. He intervened by pointing out shared errors and providing an explanation.

All three teachers, including the most engaging teacher (T3), used closed tasks from a textbook and followed a similar approach. That is, they showed a few examples on the board and set similar exercises for students to do. However, T3 diverted by creating a need for the formula before giving the formula and an example of how it works. As indicated earlier, one explanation for this type of practice shown by these teachers is the type of mathematics textbooks used in Lesotho Secondary schools. Prescribed mathematics textbooks in Lesotho are closely linked to syllabi. For example, a prescribed textbook for Form D (grade 11) covers the whole Form D syllabus. These textbooks are such that when you use them, you don't even have to refer to the syllabus because they are the syllabi themselves. So to cover the syllabus, you just have to finish the whole book. This results in teachers adhering to the textbooks.

In addition, these textbooks are structured in such a way that for every topic, there are two or three examples showing the procedures for working out problems in that topic, followed by similar set of exercises. This is why all the three teachers followed the same teaching approach. That is, examples and exercises.

All three teachers indicated that learner-centred strategies are time-consuming and if one concentrates on them, he/she would not be able to finish the syllabus. As pointed out earlier, the need to cover the syllabus clearly exerted a significant amount of influence on teaching approaches used by these teachers.

Furthermore, these teachers seemed to believe that doing mathematics or solving mathematical problems involves moving from formulae or concepts, to follow formal procedures and finding answers. All of them stressed the use of formulae or steps so that pupils should be able to find the answer. As has been pointed out earlier, Swafford (1995) argues that what teachers believe about the nature of mathematics and about the nature of mathematics learning and teaching have a great influence on teachers' instructional practices.

Finally, these three cases suggest that optimal conditions are not a main determinant for the implementation of elements of learner-centred practice. T3 whose teaching was more learner-centred was working in materially difficult conditions. On the other hand T4 whose teaching was not learner-centred was working under 'good conditions'.

The next section will provide an overview of the remaining six teachers.

## 4.3 OVERVIEW OF OTHER TEACHERS

### 4.3.1 Description of the schools

In this section, a summary of the descriptions and basic materials available in schools where the six remaining teachers (T1, 5, 6, 7, 8 and 9) were teaching will be provided. This information is indicated in Table 5 below.

| TABLE 5 | T.1 | T.5 | T.6 | T.7 | T.8 | T.9 |
|---|---|---|---|---|---|---|
| Electricity | yes | yes | yes | yes | yes | yes |
| Phone | yes | yes | yes | yes | yes | yes |
| Toilets with running water or pit latrines | pit lat | pit lat | toilet | toilet | toilet | toilet |
| Running water | yes | yes | yes | yes | yes | yes |
| Photocopying machine | no | no | yes | yes | yes | yes |
| Stencil machine | yes | yes | yes | yes | yes | yes |
| Type-writer | yes | yes | yes | yes | yes | yes |
| Library | no | no | yes | yes | yes | yes |
| Computer | no | no | yes | no | no | no |
| Are school windows broken? | no | no | no | yes | no | yes |
| Are school surroundings clean? | yes | yes | yes | yes | yes | no |
| Is the school church or government owned? | church | church | church | govern | govern | govern |

Both T1 and T5 were teaching in the same church owned school. From the above table, it is clear that their school was not well resourced. As indicated with T3, this is a contradiction to what was expected. Teacher T6 was teaching in the same school as T4 and, as indicated above, their school was relatively well resourced and the best when

compared with other schools. Teachers T7, T8 and T9 were teaching in different, government owned schools. As can be seen from the table, these schools were relatively well resourced and this is counter to what was expected in the sample. However, T9's school was not well organised. The situation in the school was similar to that of T2's school (i.e. there were no teachers in some classes and students were making a noise and loitering around). The schools of both T7 and T8 were well organised. The situation in these schools was similar to T3's school.

4.3.2 Classrooms

Table 6 below gives a summary of classroom arrangements and a list of materials available in the six classrooms for Teacher1, 5, 6, 7, 8 and 9.

| TABLE 6 | T1 | T5 | T6 | T7 | T8 | T9 |
|---|---|---|---|---|---|---|
| A chair for each student | Yes | yes | yes | yes | yes | yes |
| A desk for each student | no | yes | yes | no | no | yes |
| Is there enough space in the room for students to work comfortably? | no | no | yes | no | no | yes |
| Is there a chalkboard which is large enough for working? | yes | yes | yes | yes | yes | yes |
| Does each student have a textbook? | no | no | yes | no | no | no |
| How are students arranged? | rows | rows | rows | rows | groups | rows |

From Table 6, students in all classes observed had chairs. In addition, each student in the classrooms of T5, T6 and T9 had a desk. However, in the classrooms of T1, T7 and T8, there were some students who did not have desks. In all classes, except in T6's class, there were some students who

did not have textbooks and other materials such as calculators and sets of mathematical instruments. All classrooms had chalkboards which were large enough for working. In all classrooms except for T6 and T9, there was not enough space for students to work comfortably. The situation in these classrooms was similar to that of T3's classroom. Like in T4's class, students in all classes, were arranged in rows of pairs facing the chalkboard and teacher's table. Only T8's class was arranged in the same way as T3's and T4's classes, that is, in groups.

### 4.3.3 Content and observation schedule

In this section, a summary of the lessons and classroom observations for the six remaining teachers will be provided.

TABLE 7: Overview of Lessons

| TEACHER | FORM(GRADE) | NO. OF PUPILS | LENGTH OF LESSON | TOPIC |
|---|---|---|---|---|
| T1 | A (8) | 75 | 80 mins | Rounding Off – decimal numbers |
| T5 | D (11) | 45 | 40 mins | Quadratic Equations |
| T6 | A (8) | 40 | 80 mins | Area and Perimeter |
| T7 | B (9) | 56 | 40 mins | % Increase and Decrease |
| T8 | B (9) | 46 | 80 mins | Area |
| T9 | E (12) | 30 | 80 mins | Trigonometry- Sine Rule |

Teacher T1's lesson began with the teacher asking students to round off numbers such as 8.2, 345 to the nearest ten, hundred etc. Students were able to give answers as this was

a review of the work done earlier. Thereafter, the teacher wrote 27,017 on the board and asked students what the answer was when expressing this number to 2 decimal places. Students appeared to have problems with this question because there was no response. The teacher started explaining what should be done. Thereafter, the teacher gave students another example. One student was then asked to work out the third example. Thereafter, a task from a textbook was given, and students did it individually.

Teacher T5 introduced the lesson by writing $x^2 - 4x - 12 = 0$ and started explaining what to do when completing the square. Thereafter, a second example was given: $x^2 - 2x = 3$. He then asked students whether they understood, and they reluctantly said yes. A task from a textbook was given and students had to do it individually.

Teacher T6 introduced the lesson by writing the topic for the day on the board and asking the students whether it was their first time to hear the two words - area and perimeter. Some said no, and others said yes. The teacher drew a triangle whose sides were 4cm, 3cm and 4cm. He asked one student what the perimeter was and the student said 11cm. The teacher said that was good and told the class that perimeter is the distance all around the outside of the figure and one could find it by adding all the sides → 4cm + 3cm + 4cm = 12cm. Students were asked whether they had questions or not and in chorus, they said no. Then a task from a textbook was given and students did it individually.

Teacher T7 introduced the lesson by giving students examples on percentage increase and decrease.

1996 - there were 40 pupils in a class

1997 - there are 28 pupils in the same class. Is this an increase or a decrease? Students in chorus said, decrease. The teacher told them that as a percentage, this is:

*40 - 28 = 12*

*12/40 x 100% = 30%*

The teacher further said that: *the difference should be divided by the original number which in this case is 40.* A task from a textbook was then given and students also did it individually.

Teacher T8 introduced the lesson by asking students *"how many square metres are there in a square kilometre?"* Students tried to find the answer but failed. The teacher gave them the following hint: $1km^2$ = 1km x 1km. With the hint given, students were able to find the answer. The teacher then told the students that: 1 hectare = 10 $000m^2$, and asked students how many hectares there would be in 20 $000m^2$. Some students said 2, and others said 4. The teacher told them that the correct answer was 2 and showed them how to solve the problem. Another example was given and a volunteer was asked to work it out. Thereafter, a task from a textbook was given and students did it in groups.

In her introduction, T9 reminded students that sine, cosine and tangent formulae (SohCahToa) could only be applied in a

right-angled triangle. She further told them if a given triangle is not a right-angled triangle, they will have to use other rules. An example of such a triangle was given and the teacher told students that to calculate a missing side, they have to use the Sine rule. The teacher stated the rule on the board and showed students how to use it to find the missing side. Thereafter, a second example was given. A task from a textbook was given and students worked it individually.

Like T2's, T3's and T4's lessons, all six lessons followed a similar pattern. All teachers started their lessons by giving examples and explaining or telling students what to do. As I have already indicated, T3 was the only one who diverted from this. This kind of practice confirms the observations made by Kokome (1990) and Moru (1994) that the teaching of mathematics in Lesotho is mainly 'example-exercise'. Like T2, T3 and T4, all these teachers adhered to the textbooks. This behaviour substantiates what I pointed out earlier that the link between the prescribed syllabus and the textbooks influences the way that teachers teach.

### 4.3.4 Classroom observations

In this section, the scores obtained by the all teachers will be discussed.

TABLE 8: Overview of Lessons

| Teachers | 1. lesson intro. | 2. Group /pair work | 3. Pupil-pupil inter. | 4. Verbal pupil part. With teacher | 5. Whole class discussion | 6. Tasks | 7. Mis-conceptions | 8. Teacher questioning |
|---|---|---|---|---|---|---|---|---|
| T1 | 3 | 2 | 2 | 3 | 2 | 3 | 1 | 3 |
| T5 | 3 | 2 | 2 | 2 | 2 | 3 | 1 | 2 |
| T6 | 3 | 2 | 2 | 2 | 2 | 3 | 1 | 2 |
| T7 | 3 | 2 | 2 | 2 | 2 | 3 | 1 | 2 |
| T8 | 3 | 4 | 4 | 4 | 3 | 3 | 1 | 1 |
| T9 | 3 | 2 | 2 | 2 | 2 | 3 | 1 | 2 |

In 5 of the 6 lessons, there was no group or pair work, individual and whole class instruction was used. The arrangement in these five classes was similar to that in T4's class. Teachers T1, T5, T6, T7 and T9 were predominantly controlling their classes. That is, students were not given a chance to express their understandings. However, the situation in T8's class was similar to that in T2's and T3's classes. Students in T8's class did the work in groups and individually. As indicated earlier, T3 differed from these two in that he was more 'active'.

Like T2 and T4, all these six teachers did not give themselves a chance to listen and follow through students' ideas, hence could not notice whether students held errors or not. Of all the nine teachers, only T3 did this.

These teachers' enacted interpretation of learner-centred practice therefore display aspects that were seen in T2, T3 and T4. For all these teachers, students should be 'active'- but activity here means on exercises from a textbook. In addition, they should do so on the board and in exercise books either in groups or individually. The teachers differ from each other in allowing students to

talk, noticing students' errors and creating a need for the formula. Only T3 displayed the last two.

**4.3.5 Interviews:**

As I have pointed out earlier, these teachers, like T2, T3 and T4 have espoused some form of commitment to learner-centred practice. When asked what learner-centred means to them, both T1 and T7 indicated that it means that students should discover things on their own. In words of T1, " *it is a method whereby pupils themselves can discover certain concepts or ideas on their own*". Responding to the same question, T5 and T8 pointed out that "*learner-centred means that students should find/discover things for themselves*". Teacher T6 indicated that "*it means more learning for the students*". And T9 pointed out that "*it means that students should be more involved in the learning situation*". All the six teachers indicated that they practice this in their teaching.

On the question of how they practice this approach in their classes, both T1 and T5 indicated that ".... *I sometimes use pair work*". They further pointed out that they involve their students by allowing them to solve problems on the board. Like T2, T3 and T4, teachers T6, T7, T8 and T9 indicated that "*I..... use group work*".

Commenting on the strengths and weaknesses of learner-centred approach, T1, T5 and T9 also indicated that the advantage of this approach is that "*students do not easily*

*forget what they have discovered*". Like T4, teachers T7 and T8 pointed out that "*students understand/learn more*". And T6 indicated that "*this approach has created students' interest in maths*". However, like T2, T3 and T4, all six teachers indicated that learner-centred teaching is time-consuming. These six teachers also pointed out that classroom conditions such as large classes and lack of materials make this approach difficult to implement.

From the interviews, a dominant understanding of learner-centred practice is that students by themselves should work individually on a task. When they are doing this, they are regarded as active and this is somehow better - more interesting, lasting learning. This is similar to T4's espoused interpretation of learner-centred practice.

Like T2, T3 and T4, all six teachers seemed to have similar beliefs about the nature of mathematics, how it is learned and how it should be presented. As I have already indicated with the first three cases, these teachers seem to view the teaching of mathematics as the presentation of procedures and concepts. Example, T7 stated the formula for calculating % increase,

$$\% \text{ increase} = \frac{\text{actual increase}}{\text{original price}} \times 100\%$$

And T9 wrote the Sine rule on the board and showed students how it is used. Hence tasks in all these classes remained unchanged.

As I have already indicated above, T3, T2 and T8 were the only teachers who embraced some elements of learner-centred practice in their teaching. Looking at the conditions under which they were working, T3 was the only teacher who was working in materially difficult conditions and yet the best in terms of learner-centred practice.

However, as indicated earlier, Argyris and Schon (1974) have pointed out that espoused theories reflect intentions and beliefs, and change with relative ease in response to new ideas or understanding, while enacted theories are deeply ingrained in our consciousness and cannot be easily changed. That is, it might be easy to say what you think or understand, but to put your understanding into practice is another story. Enacted theories are said to build up over a long period of time and are strengthened by ongoing experience. Therefore it is understandable why teachers had problems in putting learner-centred teaching into practice. Being a new teaching approach which is currently encouraged in many countries, it is easy for many teachers to understand and talk nicely about it. However, when it comes to classroom practice, it might not be easy for them to change their practices. In this study, teachers, especially those who have been in the profession for a long time (e.g. T4 has more than 10 years teaching experience and T8 has more than 18 years) remained mostly teacher-centred. As indicated, one reason for this might be that these teachers have been using the 'old' teacher-centred method for a long time and this approach eventually formed part of their being and it is very difficult for them to change. To change

these methods, a considerable amount of time, regular practice and maybe theory courses are needed. A massive change in curriculum is also required. In that way, teachers may, with time, change their practices.

The fact that learner-centred or child-centred ideology originated in a one-to-one situation between a researcher and subject may also be a problem. In classroom situations, where pupil-teacher ratios are much higher, it may not be possible to be fully learner-centred. In addition, teachers in learner-centred classrooms are faced with ongoing dilemmas such as when to tell and how they should do it. Therefore there are many reasons why learner-centred practice is not always in many classrooms and why only a hybrid between teacher- and learner-centred approaches is observed.

# CHAPTER FIVE

## CONCLUSIONS AND RECOMMENDATIONSNS

This study has investigated how selected teachers in Maseru interpret and implement a learner-centred approach to teaching and learning mathematics. For all the teachers in the study, the most clear interpretation of a learner-centred approach in practice is that students are 'active' on their own and at times in groups. Active is interpreted as pupils solving as many problems as possible and these are done in their exercise books.

Textbooks were used as the major resource for teaching mathematics. Thus, in all classes seen there was a strong adherence to students' textbooks. This point has also been made by the Central Inspectorate of the Ministry of Education in Lesotho (1995). One explanation for this is that textbooks cover almost everything that is in the syllabus and therefore following them closely means covering the syllabus. The need to cover the syllabus seemed to be an important factor for all teachers in this study. This is because students can best cope with the national examinations if they have covered the syllabus. Therefore, if real change in teachers' practices is to be achieved, there is a need to review the syllabi, re-structure our examinations and to examine the type of textbooks used in our schools. As long as the wider curriculum remains unchanged, real change in teachers' practices will never be achieved.

The influence of textbooks on teachers' practices was also observed in what the teachers did in their classes. All of them followed the same teaching approach. They showed a few examples on the board at the start of the lesson and students were asked to do similar exercises from the textbook. This is the structure used in the prescribed textbooks. At the beginning of each topic, there are two to three examples given and these are followed by similar sets of exercises. Therefore, this structure provided in the textbooks is seen as a means to complete the whole textbook which in turn would mean completing the syllabus.

In addition, teachers in the interviews showed the importance of involving students in the learning process. However, classroom observations indicate that involvement in most cases was limited to working problems on the board and in students' exercise books. Furthermore, students did the work individually. Explanations offered for this include teachers beliefs about the nature of mathematics and about the nature of mathematics learning and teaching; contextual conditions; and the structure of formal school.

Though most teachers interpreted "on their own" as individual, there were some lessons in which there was groupwork. Teachers in these lessons allowed their students to work either individually or in groups. Students in their groups were discussing and arguing with each other. However, teachers in these classes indicated that learner-centred practice is time consuming and if one uses it very often, he/she will not finish the syllabus.

In this study, classroom conditions did not emerge as a main factor for or against an implementation of a learner-centred approach. It has been seen that the teacher who was working under 'bad' conditions was able to display some elements of learner-centred practice in his teaching.

## RECOMMENDATIONS

The recommendations made will focus on three groups of people: policy-makers, INSET providers and teachers.

**Policy-makers:** If real change in teacher's practices is to be attained, policies made should look at the wider spectrum of curriculum. For instance, we cannot talk about a teacher and teaching without mentioning students, the content being taught (prescribed content- books and syllabus) and how the prescribed content is assessed. We cannot change one of these without considering other components. This study recommends that there should be a change in the curriculum and its components.

**INSET provider:** Mathematics in-service courses are important to teachers who are already in the teaching profession because these courses inform teachers of new developments in mathematics. This study suggests that when such courses are provided, INSET providers should pay regular school visits so as to assist teachers with actual everyday classroom experiences. The visits to the classrooms would give the providers useful insights into real classroom experiences and what is possible or not possible to achieve. This ca..

make for courses more focused on classroom realities and may allow for more and better change among teachers. It further suggests that theoretical foundations together with procedures be provided in these courses.

**Teachers:** The study recommends that teachers should reflect on their practices- they should make their enacted theories (theories that inform their classroom practices) explicit so that they could reflect on those theories for change in their practices.

Most importantly, what this study has shown is that change is not an easy process, involving a range of factors that influence teacher's classroom practices. An acknowledgement of this reality, may allow for more textured policies, INSET courses, and teacher reflections and interpretations, which in turn may lead to teachers who are better able to bridge the gap between espoused and enacted theories, between policy and practice.

# REFERENCES


Adler, J., Lelliott, T., Slonimsky, L., et al (1997) A Baseline Study: Teaching and Learning Practices of Primary and Secondary Mathematics, Science and English Language Teachers Enrolled in the Wits Further Diploma in Education. Report. Johannesburg: University of the Witwatersrand.

Argyris, C. and Schon, D.A. (1974) *Theory in Practice: Increasing Professional Effectiveness. Jossey-Bass.*

Argyris,C. (1976) *Increasing Leadership Effectiveness.* U.S.A.

Blackhouse, J.K. (1987) Changing Teaching Methods Trough INSET. *British Journal of In-service Education,* 14,1,25-33.

Bogdan, R.C. and Biklen, S.K. (1982) *Qualitative Research for Education: An Introduction to Theory and Methods.* Boston: Allyn Bacon.

Brodie, K. (1998) Teacher- or learner-centred: How do Mathematics Teachers in south Africa teach? In Ogude, N.A. and Bohlmann, C. (eds) *Proceedings of the Sixth Annual Meeting of SAARMSE,* Pretoria: Unisa.

Campbell, P.E. And Johnson, M.L. (1995) How Primary Students Think and Learn. In Carl, I.M. (ed) *Seventy-five Years of Progress: Prospects for School Mathematics.* National Council of Teachers of Mathematics, INC. 21-42

Cobb,P., Wood, T. And Yackel, E. (1990) Classroom as Learning Environments for Teachers and Researchers.

*Journal for Research in Mathematics Education*, 4, 125-46.

Cobb,P., Wood, T. And Yackel, E. (1992) Interaction and Learning in Mathematics Classroom Situations. *Educational Studies in Mathematics*, 23,1,99-122.

Cohen, L. And Manion, L. (1994) *Research Methods in Education*. London: Routledge.

Copeland, R.W. (1979) *How Children Learn Mathematics: Teaching Implications of Piaget's Research*. London: Routledge and Kegan.

Cornbleth, C. (1990) *Curriculum in Context*. The Falmer Press.

Cuban, L. (1993) *How Teachers Taught: Constancy and Change in American Classrooms 1880-1990*. New York: Teachers College Press.

Cuevas, G.J. (1995) Empowering all Students to Learn Mathematics. In Carl, I.M. (ed) *Seventy-five Years of Progress: Prospects for School Mathematics*. National Council of Teachers of Mathematics, INC. 62-77

Darling, J. (1990) Progressivism and individual Needs. In Entwistle, N.E. (ed) *Handbook of Educational Ideas and Practices*. London: Routledge.

Darling, J. (1994) *Child-centred Education and its Critics*. London: Methuen.

Edwards, D.E. and Mercer, N. (1987) *Common Knowledge: The Development of Understanding in the Classroom*. London: Methuen.

Ellerton, N. and Clements, M.A. (1992) Some Pluses and Minuses of Radical Constructivism in Mathematics Education. A Paper Presented at the 15th Annual

Meeting of the Mathematics Education Research Group of Australasia. University of Western Sydney.

Fraenkel, J.R. and Wallen, N.E. (1990) *How to Design and Evaluate Research in Education*. McGraw-Hill.

Ginsburg, H. And Opper, S. (1979) *Piaget's Theory of Intellectual Development*. Englewood Cliffs: Prentice Hall.

Green, J. (1993) Constructivist Strategies for the Mathematics Teacher. In Malone, J.A. and Taylor, P.C.S. (eds) *Constructivist Interpretations of Teaching and Learning Mathematics*. Australia: Curtin University of Technology. 157-168.

Henningsen, M. and Stein, K.M. (1997). Mathematical Tasks and Student Cognition: Classroom-Based Factors that support and Inhibit High-Level Mathematical Thinking and Reasoning. *Journal for Research in Mathematics Education*, 28,5,524-49.

Jaworsky, B. (1989) Is versus Seeing as: Constructivism and Mathematics Classroom. In Pimm, D. (ed) *Mathematics, Teachers and Children*. London: Hodder and Stoughton. 287-289.

Kokome, N. (1990) The Teaching of Mathematics in Lesotho Secondary Schools: A package of ideas. Unpublished Diploma Dissertation. University of Bristol.

Lappan, G. and Briars, D.(1995) How Should Mathematics be Taught? In Carl, I.M. (ed) *Seventy-five Years of Progress: Prospects for School Mathematics*. National Council of Teachers of Mathematics, INC. 131-156

Love, E. And Mason, J (1992) *Teaching Mathematics: Action and Awareness*. The Open University Press.

Maxwell, J.A. (1992) Understanding and Validity in Qualitative Research. *Harvard Educational Review*, 62,3,279-300.

McMillan, J.H. and Schumacher, S. (1993) *Research in Education: A Conceptual Introduction*. Harper Collins College.

Mercer, N. (1995) *The Guided Construction of Knowledge: Multilingual Matters*. Clevedon.

Ministry of Education (1995) Central Inspectorate General Observations. Lesotho: Maseru.

Morar, T. (1996) Professional Development in Teaching Primary School Mathematics-Can we really change teachers' practices. In Sanders, M. (ed) Proceedings of the fifth *Annual Meeting of the Southern Africa Association for Research in Mathematics and Science Education*, 256-262.University of the Witwatersrand.

Moru, E.K. (1994) Developing the Quality of Pupil learning in Secondary Mathematics in Lesotho. Unpublished M.Ed Dissertation. University of Bristol.

Njisane, R.A. (1992)Constructivism. In Shuter and Shooter (eds) *Mathematics Education for In-service and Pre-service Teachers*. South Africa: Pietermaritzburg. 26-37.

Osterman, K.F. and Kottkamp, R.B. (1993) *Reflective Practice for Educators:Improving School Through Professional Development*. Corwin Press.

Polaki, M. (1996) Strategies Used to Teach Mathematics in Nine Schools in the Maseru City of Lesotho: Some Roots of The Gap Between Theory and Practice. A paper Presented at the Sixth Boleswa Symposium on

Educational Research and Human Resource Development. University of Botswana.

Rogoff, B. (1990) *Apprenticeship in Thinking: Cognitive Development in Social Context*. Oxford University Press.

Sotto, E. (1995) *When Teaching Becomes Leaning*. London: Cassell.

Swafford, J.O. (1995) Teacher Preparation. In Carl, I.M. (ed) *Seventy-five Years of Progress: Prospects for School Mathematics*. National Council of Teachers of Mathematics, INC. 157-174

Von Glasersfeld, E. (1991) *Radical Constructivism in Mathematics Education*. Dordrecht: Kluwer.

Zevenbergen, R. (1995) Constructivism as a Liberal Bourgeois Discourse. *Educational Studies in Mathematics: An International Journal*, 31,2,95-110.

Thompson, A.G. (1992) Teachers' Beliefs and conceptions: A synthesis of the research. In Grouws, D. (ed) *Handbook of Research on Mathematics Teaching and learning*. New York: Macmillan. 127-144

Thompson, A.G. (1984) The Relationship of Teachers' Conceptions of Mathematics Teaching to Instructional Practice. *Educational Studies in Mathematics*, 15, 105-27.

Wood, T. and Yackel, E. (1990) The Development of Collaborative Dialogue Within Small Group Interactions. In Steffe, L. and Wood, T. (eds) *Transforming Children's Mathematics Education: International Perspective*. Lawrance Erlbaum Associates. 244-252.

# APPENDICES

## APPENDIX A

## PROCEDURE FOR CLASSROOM OBSERVATION

On a blank piece of paper, I will try to write everything that will be taking place in the class. Special note on methodologies used, pupil participation, teacher questions and any interesting quotes will be kept. Having taken the description of the lesson, then the observation schedule will be filled or completed for analysis purposes. Each class will be observed for at least one double-period.

### CLASSROOM OBSERVATION SCHEDULE
**(Adapted from the Wits FDE base-line study 1996)**

Type of school: Length of lesson:
form:
Number of students:

| **Checklist classroom materials** | **Y** | **N** |
|---|---|---|
| 1. Is there a desk and chair for each student? | | |
| 2. Is there sufficient room for students to work? | | |
| 3. Is there a board? Is it large enough for working? | | |
| 4. Does each student have a textbook? | | |
| 5. Are there any maths learning aid available in the class? | | |
| 6. Are there any physical constraints to the lesson? (e.g. too hot, loud noise from outside, etc) | | |
| 7. Are there any disruptions to the lesson? | | |
| 8. How are the pupils arranged? (individual rows, groups, pair, etc.?) | | |

Tick in the box where appropriate. Write down any useful comments relating to each of these items.

1. Lesson introduction

| | | | |
|---|---|---|---|
| No introduction ie no links with past lesson and no direction for new lesson | Links with past lesson but no direction for present lesson | Links with past lesson and structured intro. with direction | Lesson is clearly contextualised and arouses learners' interest. Attention is focused. |

Comment.....
.....
.....
.....
.....
.....
.....

2. Group or Pair Work

| | | | |
|---|---|---|---|
| No group or pair work | Very few pupils interact, others just listen | Group of learners with limited interaction/interact when teacher motivates | Learners are explicitly organised in such a way that facilitate group/pair work.Groups of learners discuss by themselves |

Comment.....
.....
.....
.....
.....
.....
.....

3. Pupil-pupil Interaction (without teacher)

| | | | |
|---|---|---|---|
| Pupils do not question or probe for details | Very few pupils question each other secretly and quietly because this is not allowed | Pupils only question or help others when prompted to do so by teacher | Pupils freely enter into discussions with each other |

Comment.....
.....
.....
.....
.....
.....

4. Verbal pupil participation with teacher

| | | | |
|---|---|---|---|
| No verbal pupil participation | Pupils participate only in response to teacher questions.One word answers or chorus answers | Pupils participate in response to teacher and give simple rule based answers to why questions | Pupils respond to teacher questions and give answers which shows understanding. They volunteer to ask and work out problems |

Comment.....
.....
.....
.....
.....
.....
.....

5. Whole class teacher-pupil interaction

| | | | |
|---|---|---|---|
| Totally controlled by the teacher | Predominantly controlled by the teacher | Teacher creates opportunity for pupil questions and pupil-pupil interaction | Control of interaction shifts between pupils and teacher |

Comment (on the kind of interaction taking place, if any, roles of teacher and pupils)
.....
.....
.....
.....
.....
.....
.....

6. Tasks

| | | | |
|---|---|---|---|
| No tasks | Poor or inappropriate (beneath/beyond pupils' level) task | Standard task(s) on the board or from the textbook | Investigative task(s) that extend students' thinking |

Comment (are tasks for individuals or groups)
.....
.....
.....
.....
.....
.....

7. Misconceptions

| | | | |
|---|---|---|---|
| Does not notice misconceptions | Notices and gives the right answer | Notices and engages in some kind of explanation | Notices and uses explanation which facilitate conceptual clarity |

Comment.....
.....
.....
.....
.....
.....
.....
.....

8. Teacher Questioning

| | | | |
|---|---|---|---|
| Does not ask questions at all | Asks questions that only require recall, repetition or simple factual questions | In addition asks questions which require some explanation or justification | In addition asks questions that challenge and extend intellectual demand. Involving critical thinking |

Comment.....
.....
.....
.....
.....
.....
.....
.....

## APPENDIX B

## INTERVIEW SCHEDULE

## ETHICS

The interview data will be collected using a tape recorder. The data will be treated as confidential. After using the tape for data analysis purposes, the tape will be erased. Neither the school nor teachers will be named.

### TEACHER BIOGRAPHY

School: .....

Type of school: government or church?: .....

Highest mathematics qualification: .....

Maths teaching experience: .....

How long have you been in the SESP?: .....

**Key question 1**

What have you learnt from the SESP programme?

**Probing questions**

1.1 How does it help in teaching of mathematics?

1.2 Has it influenced the way you teach? (approaches/methodology)

1.3 In what way?

1.4 What do you mean?

1.5 How do you do it in your class?

1.6 Can you give an example?

**Key question 2**

What does learner-centred mean to you?

**Probing questions**

2.1 Why is that learner-centred?

2.2 What is the difference between learner-centred and the strategies of teaching you were using before?

2.3 In your opinion, what are its strengths and weaknesses?

**Key question 3**

Do you use learner-centred approaches in your class?

**If yes to Q.3 then,**

**Key question 3a**

In what way have you been able to use a learner-centred approach?

**Probing questions**

3.1 Can you give an example?

3.2 What about group or pair work?

3.3 Does group or pair work help you in your teaching?

3.4 How does it help you?

3.5 What are your experiences of using learner-centred approach?

3.6 What conditions make this approach successful in your class?

**If no to Q.3 then,**

**Key question 3b**

Why don't you use it?

**Probing questions**

3.1 Do you mean that there is nothing good about this approach? What is it?

3.2 Are there any conditions that affect this approach in your classroom?

3.3 What are they? And in what way do they affect it?

**Key question 4**

In the lesson, you used the task ..... Has SESP helped you to design this task?

**Probing questions**

4.1 Can you tell me how?

4.2 What do you mean?

4.3 Can you give an example?

4.4 If SESP has not helped you in preparation of this lesson, how did you select it?

4.5 Has anything changed in the way you teach this topic since you have joined the SESP programme?

**Key question 5**

I noticed that in this class pupils had difficulties or interesting ideas about .....

**Probing questions**

5.1 Does this happen very often when you teach this topic?

5.2 How do you normally deal with this?

**General questions**

1. What have you learnt from SESP that you have been able to use?
2. What have you learnt from SESP that you wanted to practice with your class but have not been able to practice?
3. Why were you not able to practice these?