MATHEMATICS TEACHERS' CONSTRUCTIONS AND ENACTMENTS OF LEARNER-CENTRED PRACTICES

By

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BSc (Mathematics and Chemistry), Concurrent Diploma in Education (CDE), B Ed honours, MSc (coursework)

A thesis submitted in complete fulfilment of the academic requirement for the degree of

DOCTOR OF PHILOSOPHY
in
Mathematics Education in the

School of Education
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Supervisor: Professor S. Bansilal
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STATEMENT OF ORIGINALITY

The work contained in this thesis was carried out by the author at the University of KwaZulu-Natal from September 2014 to November 2019 under the supervision of Professor S. Bansilal. This study represents an original work done by me except where the due reference is made to other writing. The work will not, and has not been, submitted for examination in any other university for any diploma or any degree, except to the University of KwaZulu-Natal.

Signature .....

Date: .....

DECLARATION BY SUPERVISOR

As the candidate's supervisor, I agree to the submission of this thesis entitled:

Mathematics teachers' constructions and enactments of learner-centred practices

Signature: ----------

Professor Sarah Bansilal

14 November 2019

Date

DEDICATION

This thesis is dedicated to my beloved late mother

Mrs Ethah Lomjovo Ndlovu

(1924 – 1996)

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LIST OF ACRONYMS

ZPD	Zone of Proximal Development
OBE	Outcomes-Based Education
APOS	Action, Process, Object and Schema
RME	Realistic Mathematics Education
LCM	Lowest Common Multiple
L	Learner
L_1	Learner one
L_2	Learner two

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ABSTRACT

Mathematics teachers' constructions and enactments of learner-centred practices

An important aspect of effective teaching is the personal understandings that teachers have of theories about teaching and learning. In this qualitative case study, I sought to explore Mathematics teachers' constructions of learner-centred practices and the extent to which their personal enactments of "learner-centred" practices enabled meaningful learning at Grade 6 level in Eswatini. The sample was convenient, involving three grade 6 Mathematics teachers from three urban schools in the Shiselweni region of Eswatini.

Data was collected through lesson observations, semi-structured interviews and field-noted observations. The three teachers were observed teaching a Mathematics topic. All their lessons were video-recorded and were followed by a one-on-one interview with each teacher. The interviews were based on the teachers' observed lessons. The audio-recorded interviews with the teachers were transcribed verbatim and thereafter analysed thematically.

The study is broadly informed by a socio-cultural framework and Meaningful learning theory. Furthermore, the study is located within an interpretative paradigm to gain an insight into the teachers' constructions of learner-centred practices and the extent to which their personal enactments of learner-centred practices enabled meaningful learning.

The study found that the three teachers shared some common understandings that within learner-centred teaching, the teacher takes on the role of a guide. To them, guiding learners basically involved walking around the class and watching the groups working on a problem without making any meaningful intervention, while encouraging them to participate. The study also found that the teachers' enactment of what they considered as "learner-centred practices" prioritised the outward forms and sidestepped the main function of learner-centred practices

which is to enable meaningful learning. The teachers stressed the importance of group work in their personal enactments of "learner-centred" practices. Their belief was that engaging learners in group work would enable meaningful learning in their learner-centred teaching without attending to the matters underlying it.

The study recommends that teacher professional development programmes be introduced by the in-service department to ensure that teachers get the required training on the important ideas that underpin learner-centred practices in order to enable meaningful learning.

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Key words: Learner-centred practices, Learner-centred teaching, Meaningful learning

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CHAPTER 1

INTRODUCTION

1.1 OVERVIEW OF THIS CHAPTER

This chapter aims to present the research process that was undertaken to explore Mathematics teachers' constructions of learner-centred practices and the extent to which their personal enactments of "learner-centred" practices enabled meaningful learning at Grade 6 level in Eswatini. It provides an overview of the study where the background and the problem statement are discussed in detail. The chapter also provides research questions; delimitations; aims; rationale for the study; its significance; and the organization of the thesis.

1.2 BACKGROUND OF THE STUDY

My interest in learner-centred practices stems from my experience as a Mathematics educator at High School level in Eswatini, and as a lecturer at a teacher training institution. On the one hand, the college curriculum requires that all education courses must incorporate learner-centred teaching methods, on the other, the Eswatini Ministry of Education and Training policy document of 2011 advocates for learner-centred teaching methods where Primary school teachers teach any subject offered by the Primary school curriculum in Eswatini. However, the policy document neither gives a definition, operational or otherwise, of learner-centred practices, nor state how teachers should facilitate learner-centred teaching in order to enable meaningful learning.

Similarly, with regards to the teaching of Mathematics, the Ministry of Educucation and Training (2013) Primary school Mathematics syllabus only provides a definition of learner-centred teaching. Yet again, the document does not explain how Mathematics teachers should enable meaningful learning as they conduct their lessons using learner-centred practices.

Whilst attending workshops, seminars and conferences in Eswatini, I have also informally noted and observed that Primary school Mathematics teachers misconstrue the meaning of learner-centred teaching. To me, that implied that in practice the approach could be inappropriately implemented by primary school Mathematics teachers in Eswatini.

Regarding the construct of meaningful learning, I observed that High School Mathematics teachers' explanation of meaningful learning were partly consistent with mine. This transpired whilst I was a Mathematics teacher at High School. My understanding about meaningful learning was centred on a successful lesson. To me, a successful lesson was one where learners were able to answer questions during the evaluation of a lesson or when they could complete an exercise at the end of the lesson. Through some informal discussions with High school colleagues, I observed that they referred to meaningful learning as a Mathematics lesson that either went well or that was successful. To them, a successful lesson was about finishing the lesson within its allocated time, and learners being able to respond to their questions during the lesson.

Several years later, the Teaching Service Commission of Eswatini, which is responsible for hiring and promoting teachers, promoted me to the post of a lecturer in a teacher training institution in the country. This college offers a diploma programme in Primary school education and produces the largest number of diploma graduates every academic year in Eswatini. One of the requirements for the completion of the diploma programme at the college is that students should do teaching practice for 12 weeks. They do this with the supervision by the college lecturers. Thus, I also supervised and assessed a group of about 10 students every academic year whilst they were engaged in teaching practice. Basically, college lecturers are supposed to observe and assess a student teacher teaching any subject, because there is no subject specialisation at Primary school level. Moreover, Mathematics happens to be one of the subjects that I usually observe and assess when student teachers are teaching.

To my surprise, I observed that when student teachers evaluate their Mathematics lessons, they would claim that there was meaningful learning because their lessons were learner-centred. Some student teachers would also say that there was meaningful learning during their lessons because the learners answered the questions posed to them. An important observation here is that both my colleagues at High school and my student teachers at college view meaningful learning slightly differently. Whilst High school teachers associate

meaningful learning with a successful lesson, student teachers link it with learner-centred lessons and learners being able to answer questions during the lessons. Seemingly to the student teachers, a learner-centred lesson informs meaningful learning. The student teachers believe that when a Mathematics lesson is learner-centred then meaningful learning is attained.

It is not surprising to note that the student teachers make a connection between learner-centred teaching and meaningful learning. The reason for this is that, at the college, students are taught various teaching approaches, one of which is the learner-centred teaching approach which is supposed to be emphasized by the lecturers. In retrospect, there is a strong correlation between learner-centred practices and meaningful learning. Basically, learner-centred practices are the context within which meaningful learning occurs. Seemingly, both constructs are not clearly articulated by both practising teachers and student teachers.

In education literature, 'meaningful' is viewed in terms of learning experiences which earners believe have a specific meaning to them (Kostiainen, Ukskoski, Ruohotie-Lyhty, Kauppinen, Kainulainen & M€akinen, 2018) . Learners must give meaning to the learning experiences for meaningful learning to occur. However, in cognitive development, meaningful learning is viewed in terms of the learner relating new ideas with what s/he already knows (Agra, Formiga, Oliveira, Costa, Fernande & Nóbrega, 2019; Novak & Gowin, 1984; Novak, 2002). In order for meaningful learning to occur, the learner must be assisted by the teacher to associate new information to his/her prior knowledge which is relevant for the new information to be understood and learned. Of note is that with meaningful learning it is synonymous to effective learning as articulated in the context of education.

Vale, Weaven, Davies, and Hooley (2010) argue that the most challenging aspect of learner-centred teaching is to say that meaningful learning did take place. On the one hand, Black (2007) makes the assertion that the learner-centred approach is not clearly understood and properly implemented by classroom teachers. This would mean that the notion of learner-centred teaching and meaningful learning pose some conceptual misunderstanding among Mathematics teachers.

Whilst it is documented in education literature about the implementation of learner-centred approaches (Black, 2007; Vavrus, Thomas & Bartlett, 2011), this study is particularly interested in Mathematics teachers' constructions of learner-centred practices of three Grade 6 Primary school Mathematics teachers in the Shiselweni region of Eswatini and how the teachers enable meaningful learning in their personal enactment of "learner-centred" practices. Both schools were located within the urban area of Nhlangano town in the Shiselweni region.

I envisage that the study would give an insight into the teachers' understandings of learner-centred teaching and meaningful learning, and how they would enable meaningful learning in their learner-centred practices.

1.3 STATEMENT OF THE PROBLEM

This study was based on the assumption that learner-centred practices is the context within which meaningful learning occurs. Thus, the two constructs, learner-centred teaching and meaningful learning are interconnected. In other words, in every Mathematics lesson, meaningful learning is promoted if the teacher conducts his/her lesson within the learner-centred teaching framework. During learner-centred teaching, the focus is on the learner who brings a wealth of information to the class which is referred to as prior knowledge. S/he uses this knowledge in an attempt to understand new knowledge. Whilst the teacher facilitates the learning process in learner-centred teaching, the learner actively participates in order to achieve understanding. According to (Vavrus et al., 2011), learner-centred teaching is grounded on a constructivist theory of learning which backs the inclusion of learners' experiences in the teaching and learning process. Vavrus et al. argues that during learner-centred teaching, the teacher should involve learners whilst learners contribute their experiences from their own environment.

The Eswatini government advocates for the implementation of learner-centred approach in all subject disciplines in Primary school (Ministry of Education and Training sector policy, 2011). The government believes that learner-centred teaching is the vehicle to better citizens of the country. Therefore my assumption is that during learner-centred practices, meaningful learning should

occur because the former serves as a context within which the latter happens. According to Ausubel, Novak, and Hanesian (1978), meaningful learning involves learners relating their prior experiences with pre-existing knowledge during the learning process. They argue that prior knowledge or prior skill is key entry behaviour to new knowledge. Thus, my belief is that meaningful learning is firmly linked to learner-centred teaching. To me, the experiences that learners bring to class during learner-centred teaching serve as a foundation to learning new knowledge, hence the interconnection between the two constructs, learner-centred teaching and meaningful learning.

My interest in the study, therefore, emanated from the aforementioned experiences about learner-centred practices and meaningful learning as articulated by my colleagues at High school and my student teachers at college. I have noted that Primary school Mathematics teachers misconstrue the meaning of learner-centred teaching and my colleagues at High school and my student teachers at college view meaningful learning slightly different.

I also developed an interest in the study as a result of the Eswatini policy documents' lack of articulation of how Primary school Mathematics teachers should teach Mathematics within a learner-centred paradigm in order to enable meaningful learning.

Worth pointing out here is that little attention has been given to meaningful learning in learner-centred practices in the education literature (Ausubel et al., 1978; Kostiainen et al., 2018). Therefore, meaningful learning has been incorporated in the study because of the interconnection it has with learner-centred approaches.

Learner-centred teaching is an approach that is advocated for by the Eswatini Ministry of Education and Training at Primary school level. Hence the study sought to explore Mathematics teachers' constructions of learner-centred practices and the extent to which their personal enactments of "learner-centred" practices enabled meaningful learning during their lessons.

It is worth pointing out that research on learner-centred education and its challenges are well documented in the education literature (Black, 2007; Chisholma & Leyendeckerb, 2008; Vavrus, Thomas & Bartlett, 2011).

However, no researcher has undertaken research specifically on constructions and enactments of learner-centred practices in a single study. The study's unique contribution therefore is that it provides Mathematics teachers' constructions of learner-centred practices and the extent to which their personal enactments of "learner-centred" practices enable meaningful learning at Grade 6 level in Eswatini.

1.4 RESEARCH QUESTIONS

One of the core elements of a research study is to formulate some reasonable research questions that will guide it, hence this study sought to answer the following research questions.

(a) What are Primary school Mathematics teachers' understandings of learner-centred teaching?
(b) How do the teachers' understandings of learner-centred teaching influence their instructional practices?
(c) To what extent do the teachers enable meaningful learning in their personal enactments of "learner-centred" practices?

In order to answer the above questions, it was necessary for the researcher to conduct lesson observations and teacher interviews based upon the observed lessons. These were the main data collection instruments in the study. The process of lesson observations and teacher interviews is discussed in detail in the next chapter, Chapter 2 of this study.

1.5 DELIMITATIONS OF THE STUDY

The purpose of the study is to explore Mathematics teachers' constructions of learner-centred practices and the extent to which their personal enactments of learner-centred practices enabled meaningful learning. Only three teachers were observed teaching a Mathematics topic of their choice. This was followed by the teachers' engagement into one-on-one, semi-structured interviews with the researcher. Basically the interviews were about the teachers' teaching practices with regards to learner-centred teaching and their conceptions of meaningful learning. Thus, the study was delimited to a convenience sampling procedure of

three Grade 6 Mathematics teachers who participated in the data collection stages in the Shiselweni region of Eswatini.

The study was limited to three urban schools in the Shiselweni region of Eswatini, which has only four urban schools within the Nhlangano town.

1.6 AIMS AND OBJECTIVES OF THE STUDY

The aim of the study was to explore Mathematics teachers' constructions of learner-centred practices and the extent to which their personal enactments of learner-centred practices enabled meaningful learning at Grade 6 level in Eswatini. In order to illustrate the focus of the study, the following objectives were explored:

- To determine the teachers' understandings of learner-centred teaching within the new Eswatini curriculum.
- To explain how the teachers' understandings of learner-centred teaching influenced their instructional practices.
- To explain how the teachers enabled meaningful learning in their personal enactments of "learner-centred practices".

1.7 RATIONALE FOR THE STUDY

There are three aspects to the rationale of this study. The first aspect is to bring new knowledge to the Mathematics community about enabling meaningful learning in learner-centred practices. Such knowledge would have implications for Mathematics educators in the Eswatini context and beyond about the teaching of Mathematics. The second one is to deepen my understanding about Mathematics teachers' interpretations of learner-centred practices and meaningful learning. Hence their interpretation of the construct of learner-centred practices would shape the way they enable meaningful learning during their personal enactments of learner-centred teaching. Lastly, the emphasis of the Eswatini education sector policy document of 2011 for the use of learner-centred pedagogies in all Primary schools of the country has important pedagogical implications for Mathematics classroom teachers, hence the study seeks to explore teachers' understanding of learner-centred teaching.

1.8 SIGNIFICANCE OF THE STUDY

From my experience as a High school Mathematics teacher and a Mathematics lecturer at a teacher training institution, I have observed that teachers evaluate their lessons in a number of ways. Some would focus on the learners' achievement of instructional or learning objectives and others would base their evaluation on their lessons being learner-centred. Thus, they would argue that there was meaningful learning in either cases. To me, there was inconsistency among the teachers about their use of the construct of meaningful learning. Hence, I believe that the study would be significant to High school, Primary school teachers, and student teachers in that they would gain an insight into meaningful learning in learner-centred practices from its findings.

Being a teacher educator in Eswatini, I believe that it is important to explore Mathematics teachers' understanding of learner-centred teaching and hence their interpretation of meaningful learning in learner-centred practices in order to inform my practice. Also, whilst this is a small-scale study involving a small number of teachers, its findings could be informative mainly to Mathematics teachers in Eswatini, other researchers in other countries. These teachers need to be aware of the interpretations of learner-centred practices from the results of my study so that they are better placed to implement the learner-centred approach. Furthermore, the results of the study would broaden the teachers' understandings of meaningful learning in learner-centred practices.

The findings of the study will be informative to Primary school curriculum designers whose main function is to prepare instructional materials. The findings would help them to know what to include in their materials in order to facilitate appropriate implementation of learner-centred approaches. The findings of the study would also help curriculum designers to include activities in their materials that would enable meaningful learning.

The research findings will also be informative to the Eswatini Ministry of Education and Training as policy makers. The Ministry needs to be aware of educational research findings in the country so that, where possible, they could be incorporated in the school curriculum.

1.9 ORGANISATION OF THE THESIS

The current thesis consists of seven chapters. This chapter provided an overview of the current chapter, background to the study, statement of the problem, research questions, and limitations of the study, aims and objectives of the study, rationale and significance of the study. In Chapter 2, I present a review of the literature about the constructs of learner-centred teaching and meaningful learning. Chapter 3 presents a theoretical consideration of the study. Chapter 4 provides the research design and methodology followed in this study. Chapter 5 presents the data gather for this empirical study, Chapter 6 is the discussions of the findings where I focus on a cross-sectional analysis of the three teachers' constructions and enactments of learner-centred practices. Chapter 7 presents the conclusion and recommendation of the study.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The purpose of this chapter is to review literature that explores and describes learner-centred practices and meaningful learning in a classroom setting. In essence a literature review is necessary in research as it provides the researcher with valuable information on issues related to his/her study. Vithal and Jansen (1997, p.14) argue that a literature review provides what has been written on that topic, or has not been written in such a way that it is conceptually or methodologically inadequate so that the study being undertaken would address the 'gap', silence, or weakness in the knowledge base. In particular, the study seeks to explore the following questions:

(a) What are Primary school Mathematics teachers' understandings of learner-centred teaching?
(b) How do the teachers' understandings of learner-centred teaching influence their instructional practices?
(c) To what extent do the teachers enable meaningful learning in their personal enactments of "learner-centred" practices?

The chapter thus presents the theoretical foundations to the study, unpacks the learner-centred practices and presents sections that explore and describe meaningful learning from a selected literature.

2.2 MATHEMATICS TEACHERS' UNDERSTANDING OF LEARNER-CENTRED TEACHING

Learner-centred teaching is based on a constructivist notion of learning, which promotes the inclusion of learners' prior ideas in teaching and learning (Vavrus et al., 2011). This means that learners bring a wealth of experiences into the classroom. These experiences include both their everyday experiences and what they have previously learnt in Mathematics. Learners can as well bring their experiences from other subject disciplines. They would use these experiences to

interpret and make meaning of current new knowledge whilst the teacher makes some effort to involve them during a lesson.

According to the constructivist perspective, learners actively construct their own understanding by making links with what they know already and interpret current knowledge or they may form disconnected new bits of knowledge (Olivier, 1989). By communicating with one another, learners can share their experiences to reach conceptual understanding within learner-centred teaching practices. They relate the unknown knowledge to their experiences.

One of the strategies that is useful in facilitating learner-centred teaching is group work as observed by (Brodie, Lelliot, & Davis, 2002b; Moloi, Morobe, & Urwick, 2008; Mtika & Gates, 2010). When using the group work strategy, the teacher seats learners into small groups so that they discuss a given task or problem with an aim of finding its solution. S/he may as well ask them to work on the given task or problem in pairs which is referred to as pair work (McDonough, 2004). Pair work has an additional advantage to whole class discussions. McDonough (2004) pointed out that pair work encourages one in interaction and in-depth engagement with the problem. This is because to two learners who have no other learner(s) to rely upon, they feel more confident and autonomous in their discussions. In essence, pair work is two learners working on a task together or rather it is the minimum number of learners when they have been divided into small groups.

According to Webb, Franke, De, Chan, Freund, Shein and Melkonian (2009), group work enables effective learning among learners in a classroom climate. This means that group work would generate learning opportunities among learners because of the various experiences they bring to class. As a strategy of facilitating learner-centred teaching, group work also enables learners to participate and engage meaningfully with the given task or problem (Brodie et al., 2002b). Learners may feel more confident when working on an activity in small groups. On the same note of group work, Mtika and Gates (2010) mentions that group work enables learners to discuss and share ideas thereby enhancing conceptual understanding. During group work discussions, learners

come with different experiences that they exchange and use to reach a common understanding.

In their small groups, learners need to interact with one another in order to achieve understanding (Brodie et al., 2002b; McDonough, 2004). Communication plays an important role during learner interactions in group work. Learners need to engage in the communication of meaning in their small groups (McDonough, 2004). They speak and exchange experiences among themselves in order to arrive at a common understanding. This type of interaction is learner-learner interaction amongst the group members. During group work discussions, even those learners who are shy may gain confidence when communicating with his/her peers compared to communicating with the teacher.

However, learners' communication during group work may be hindered by language barriers especially if the medium of instruction in the class is not their mother tongue. Learners may not communicate effectively with one another as expected by the teacher because of their cultural backgrounds which prohibits children from questioning adults especially in Eswatini. As a result, they may transfer this experience into a classroom situation which could affect their communication with one another. Others may be too shy to communicate with either the teacher or their peers. Also, during group work activities, there has to be effective teacher-learner interactions (Brodie et al., 2002b). The teacher needs to interact with group members so that s/he can offer some guidance and assistance to learners as the lesson progresses. This can be done in a form of an intervention by the teacher during group work activities or when learners are presenting their work to the whole class.

However, not all learners in their groups may actively participate. Badger et al. (2012) have noted that during small group discussions, some learners may become reliant on others to work on a task or problem. According to Badger et al., learners would watch and observe one learner or a few learners who are attempting to work on a given task. In short, they may not all participate or work effectively in their engagement with a given task or problem. This may be caused by a lack of training of the learners or by the teacher to work in small

groups (Theobald, Eddy, Grunspan, Wiggins, & Crowe, 2017). This would affect the teacher's use of group work immensely as a strategy of facilitating learner-centred teaching.

Theobald et al. (2017) also point out that during group work one learner may dominate the discussions such that the group's functioning is negatively affected. Theobald et al. referred to the type of learner who dominates group discussions as a dominator. According to them, the other learners in the group may lack self-confidence to challenge their peers' solutions and ideas because of the group's dominance by one learner. This would lead to underperformance of these learners in Mathematics. Another drawback of group work is the situation where, if not properly monitored by the teacher, learners would tend to work individually in their groups. In this type of situation, learners may be sitting together, but not collaborating with one another or sharing ideas among themselves. This individualistic group work takes on the form, but not the structure of authentic group work.

A serious challenge that may face Mathematics teachers as they use group work as a strategy to facilitate learner-centred teaching is the fact that they may not be able to offer guidance and assistance to every pair or groups in the classroom especially with a large number of learners (McDonough, 2004). Also, during group work, the teacher may start teaching learners as a whole class even though s/he has asked them to work in small groups. This often happens as s/he reverts to his/her belief system that is directed by teacher-centred teaching. Research has shown that despite countries advocating for the implementation of learner-centred teaching, classroom teachers end up adopting the traditional teacher-centred teaching approaches (Brodie et al., 2002b; Chisholma & Leyendeckerb, 2008; Jansen, 1999b; Mtika & Gates, 2010). This happens in part when teachers have to use group work as a strategy to enhance learner-centred teaching.

Brodie et al. (2002b) have argued that teachers take up the ideas of learner-centred practices in different ways. In particular, Brodie et al. found that a majority of teachers take up the outward strategies or *forms* of facilitating learner-centred teaching without attending to the *substance* of their learner-centred practices. Achieving the underlying substance of learner-centred

teaching would require teachers to employ strategies like group work, ask probing questions, offer meaningful tasks and encourage engagement with learners' ideas. However, Brodie et al. (2002b) found that the majority of teachers took up the outward forms of learner-centred teaching such as arranging learners in groups, but neglecting the other more substantial criteria for authentic learner-centred practices. In order to facilitate learner-centredness, it is the learner's participation in the learning opportunities that is the central focus, hence the planning and implementation of the lesson must be done with the learners' needs in mind. The teacher must know what the learners know already and activities must be designed with this knowledge in mind. Learners must be given opportunities to ask questions and the teacher must be able to adjust the direction of the lesson if necessary to ensure that learning was taking place.

According to Brodie et al., teachers may be aware of the need to engage learners, for instance, in group work during learner-centred teaching, but they do not translate that into practice. Also, teachers may be aware that during learner-centred teaching, learners should actively participate but teachers do not enforce that. They have difficulty in making meaningful interventions when learners are working on activities within groups or when groups are reporting their findings to the entire class; for example, in instances where teachers could not engage with learners' ideas and try to use these ideas to improve the learning. The hard part for the teachers is to ensure that the main substantive aims of learner-centred teaching are enforced e.g. that there is active participation among learners during group work activities.

Nevertheless, as the teacher uses group work during learner-centred teaching, it is expected that learners take control of their own learning whilst s/he "guides" and "facilitates" the learning process (Sikoyo, 2010). In other words, during learner-centred teaching, the teacher helps learners access and process knowledge by guiding them and facilitating group discussions (Di Napoli, 2004). The learners interact with one another striving to acquire knowledge. Harden and Crosby (2000) point out that when the teacher guides learners, s/he helps and keeps them focused on the intended learning outcome as he/she is a competent Mathematics education practitioner. As a facilitator of learners'

learning, the teacher listens to learners' conversations carefully, observes and asks them probing questions to get clarifications and details of their thinking as they engage in some task situation (Harden & Crosby, 2000; Webb et al., 2009). Webb et al. (2009) emphasize that the teacher needs to listen to the learners so that s/he can make a hypothesis about the group's difficulties before deciding on the questions to ask or when giving suggestions. This in itself requires the teacher's professional capacity on how to use group work in order to facilitate learner-centred teaching. It is worth pointing out that when the teacher facilitates the learning process during learner-centred teaching, s/he is in fact helping learners construct new knowledge (Bansilal, 2010). However, as a facilitator of the learning process, the teacher is not to inform or tell them what they should do, but encourage discussions in order to ensure participation among learners.

Worth mentioning here is that the role of being a facilitator can pose challenges to classroom teachers during learner-centred teaching. The classroom teacher may not be skilful enough when asking learners probing questions, listening to their discussions and re-phrasing their explanations (Webb et al., 2009).

Vavrus et al. (2011) mention that while learner-centred pedagogy is being advocated for by policy documents across the world, some practicing teachers may not understand its underlying philosophy. What this implies is that the approach may pose implementation challenges to some classroom teachers. Black (2007) argues that learner-centred pedagogy is not yet understood by classroom teachers. As a result, they may not undertake and appropriately implement it when conducting their day-to-day lessons. On the other hand, Chisholma and Leyendeckerb (2008) mentioned that learner-centred education in sub-Saharan Africa has not yielded wide-spread change in classroom practices, yet it is one of the most prevalent education philosophies promoted by the various education authorities. What the authors meant was that the actual implementation of learner-centred education was different in form and purpose from the intended learner-centred education as envisioned by the authorities. According to Chisholma and Leyendeckerb (2008), in the sub-Saharan countries like Tanzania, Malawi, Uganda, Botswana, Ghana, Nigeria and Namibia, the prevailing teaching strategies are the traditional teacher-centred

pedagogies despite their governments favouring learner-centred teaching and pushing for its implementation.

In Malawi, learner-centred education had been introduced both at Primary and Secondary school levels (Mtika & Gates, 2010). This was done in line with international imperatives to improve the quality of education in that country. Mtika and Gates found that trainee or qualified teachers in Malawi were unable to implement learner-centred education. Furthermore, Mtika and Gates (2010) point out that trainee or qualified teachers' efforts to implement learner-centred practices were resisted or completely 'washed away' by the school system or national curricular orientation. South Africa was no exception with regards to curriculum reform. In post-apartheid South Africa, an initiative towards a positive policy position was taken to institute an education system called Outcomes-Based Education (OBE). Just like learner-centred teaching among the sub-Saharan countries, OBE posed some problems to the classroom teachers at the implementation stage among South African teachers.

In 1997, the South African government, through the Ministry of Education, launched an education policy which was termed Curriculum 2005 (C2005). This was to commit the South African education system to an OBE system of education by 2005. C2005 meant that all schools in South Africa had to have OBE fully implemented by 2005. According to Jansen (1999b), OBE was an education paradigm which strengthened C2005. What Jansen meant was that OBE was a vehicle that intended to *transport* the South African education policy of the post-apartheid education system leading to 2005. Although OBE emphasized learning areas rather than discreet and separate subject disciplines (Lewin, Samuel, & Sayed, 2003), it is an epistemological shift from teacher-centred approaches to learner-centred practices. In short, OBE was meant to identify different learners' achievement competences and the teachers' roles in the classroom discourse. Jansen (1999b) outlined some reasons why the implementation of OBE in South African schools was likely to fail.

He pointed out that one of the roles of the teacher in OBE should be to facilitate the learning process which resonates with the role of the teacher in learner-centred practices as mentioned by Di Napoli (2004). Jansen argued that South

African teachers misconstrued the meaning of a facilitator in a classroom discourse. Furthermore, Jansen (1999b) mentioned that the re-organization of the classrooms also posed a challenge to teachers in the implementation of OBE.

According to the OBE construct, re-organization of classrooms entails learners working in small groups, with the teacher facilitating and mediating the learning proceedings unlike in the teacher-centred learning processes. However, despite the teachers organizing their learners into small groups, they adopted a whole-class teaching approach instead of allowing learners to engage with one another in their groups as mentioned earlier in this section. According to Jansen, teachers returned to teacher-centred teaching whilst learners were organized into small groups. According to Jansen (1999b) that was a reflection of ill-preparedness of the teachers in the teaching of the new OBE curriculum. On the issue of the teacher taking the role of a facilitator in OBE, the teachers emphasized giving learners some activities without making any necessary interventions like guiding and assisting the learners as they worked on the tasks.

The issue of trained and untrained teachers came to the fore in OBE approaches. In order to implement C2005, it meant that the South African teachers needed to move away from a teacher-centred teaching philosophy to a learner-centred teaching philosophy which is a requirement of OBE. In the traditional and content-based way of teaching, the teacher dominates the lesson proceedings whilst OBE emphasizes learners taking control of their own learning as the teacher assumes the role of guiding and assisting learners. According to Jansen, teachers needed more proper training by the South African Ministry of Education officials in order to be better positioned to implementing OBE which emphasized learner-centred teaching.

Furthermore, in South Africa, the OBE system of education required a completely different mind-set or personal philosophy of how learners learn best. The successful implementation of the learner-centred philosophy underpinning C2005 needed teachers to recognize that learners cannot be taught solely by teacher talk. Learners required different experiences and opportunities to participate meaningfully in these activities so that they can actually build up their knowledge by active learning experiences. This way of thinking about

learning is completely different from the traditional receptive-accrual philosophies of learning where learners receive and accrue the knowledge they are introduced to. Hence the implementation of OBE meant that classroom teachers needed rigorous, intensive in-service training with classroom support so that the teachers could improve their teaching and thereby meet the demands and requirements of this learner-centred approach advocated by C2005.

Finally, inadequate resources in some of the South African schools and classrooms affected the implementation of OBE (Jansen, 1999b). During the implementing stage of OBE, teaching resources were not available in some South African schools especially in township schools. Basically, OBE relied on resources like computers and libraries which were simply not available in the schools. The availability of such resources would enable learners to further investigate and research on certain topics from the Mathematics curriculum. On the one hand, books were available, but there were complaints among teachers across the country that they did not suit their needs. Some of the books were not challenging to the average learner and others lacked in-depth interrogation of the content. It is for this reason that Lewin et al. (2003) view policy as a political object which disregards real issues on the ground. When drafting policy, the politicians ignore the challenges teachers would face in the schools whilst implementing the curriculum. As mentioned earlier, such challenges include resources and basic facilities like computers, photocopying machines, basic stationery, and library facilities and running water. Another challenge is a lack of knowledge on how to implement OBE. Teachers needed to be capacitated about the dynamics of OBE by way of making a plan to run nationwide in-service workshops for the teachers. The learner-centred paradigm was relatively new to the teachers, hence there had to be a plan in hand to conduct demonstration lessons thereby affording the teachers intensive hands-on experiences. For teachers to successfully implement a new curriculum based on a radically different philosophy of learning, they needed lots of professional development support. Many researchers have called for classroom based support where teachers work closely with mentors as they try to negotiate the complexities of driving the new reform curricula (Bansilal, 2010; Maoto & Wallace, 2006; Modiba, 1996).

In Eswatini where the study is undertaken, the Ministry of Educucation and Training (2011) policy document is quite forthright in its curriculum documents that the approach to teaching Mathematics at Primary school level should be grounded on the learner-centred pedagogy. One of the objectives of the curriculum directly points out that the Primary school Mathematics should provide a learner-centred inclusive curriculum. However, the document is very limited in details about how this important shift can be facilitated by teachers. Neither does it provide any details and guidance on how teachers could be supported to achieve this objective. It does not provide any elucidation of a working definition or common understanding of what is meant by learner-centred practices. Also, it does not state how the teachers should conduct their teaching of Mathematics within the framework of learner-centred teaching. Similarly, the Ministry of Educucation and Training (2013) Primary school Mathematics syllabus document which is informed by the policy document in turn, also advocates for the implementation of learner-centred teaching in Primary schools in Eswatini. Yet again, this document only defines learner-centred teaching, but does not explain how teachers should conduct their lessons within a learner-centred teaching context.

It is a concern that the Eswatini documents do not provide any more details or guidance to teachers on how to conduct learner-centred teaching, considering that practicing teachers often do not understand the philosophy underlying learner-centred teaching (Vavrus et al., 2011). According to Vavrus et al., the contributing factor to teachers' limited understanding of learner-centred teaching may be due to policy makers adopting the philosophy without putting in place sufficient measures to educate and train education practitioners about its dynamics. The policy makers would simply adopt it in order to appease international donors. However, the success of the implementation of any new initiative depends on the amount of planning that goes into working out the details and developing the support structures to enable the initiative to work well.

It is likely that for such policy makers it is sufficient to stipulate that teachers should adopt learner-centred teaching practices and they did not recognize it as their responsibility to support practicing teachers by way of conducting in-

service workshops for them. A further problem that mitigates against a sound implementation of a learner-centred approach by teachers is the experiences of these teachers while they were being trained at college. Vavrus et al. (2011) highlight that one factor which provides a challenge to practicing teachers' implementation of learner-teaching is due to failure of teacher training institutions to model it whilst the teachers are still at college.

However, learner-centred teaching is not without some criticism, as Nykiel-Herbert (2004) argues, that learner-centred practices may pose a challenge to learners living in disadvantaged and isolated areas who have little access to experiences outside of their local communities. This means that some learners will not learn much from one another in learner-centred practices because they may have very similar everyday experiences and share the same cultural experiences. Other scholars like O'Neill and McMahon (2005) mention that there may be difficulties with regards to implementing learner-centred practices because of a lack of resources and learners' belief systems. Such resources may include things like basic stationery, photocopiers, computers, library services and possibly running water. The issue of learners' belief systems incorporates their preconceptions which may be resistant to understanding new concepts.

Whilst in many African countries, learner oriented teaching practices are referred to as learner-centred practices, these practices can often be referred to by other names. For example, in many countries such as France, China, USA and Hong Kong, it is referred to as effective teaching practices. The phrase effective teaching is often used in research studies as well as in education reports and mean the same thing as learner-centred practices and countries view it as good teaching practices. In China, for example, Huang, Li, and He (2010) mention that when educators refer to effective teaching practices they mean learners' acquisition of knowledge and skills. In essence, the Chinese idea about knowledge resonate with how other education researchers view knowledge during learner-centred practices.

On the same note of effective teaching Meng, Muñoz, and Wu (2016) pointed out that in Eastern countries' teaching, learners' engagement during the lesson is highly valued whilst learners' participation through small group discussion is

less valued. This does not mean that teachers do not use group work in their lessons, rather their emphasis is on learners' active participation in learning situations. Their priority is not necessarily group work during lessons rather it is learners' active engagement. In other words, key to effective teaching is learners' engagement during the lesson. Webb et al. (2009) found that whether teachers conduct whole class instruction or small group discussions, effective teaching depended on the extent to which they probed learners thinking. According to them, effective teaching is about teachers probing leaners' explanations to uncover details or push them further about their problem-solving approaches in either collaborative group work or whole class instruction. Nevertheless, what can differ in the different conceptions of effective teaching is the role of the teacher during the lesson.

According to Ernest (1989) there are three teaching models that describe the teacher's role during effective teaching in any classroom lesson (see Table 2.1 below).

Table 2.1 Teaching models describing the teacher's role

Teacher's role in the classroom	**Characteristic of the teacher**
Instructor	Focuses on learners' skill and correct performance.
Explainer	Focuses on learners' conceptual understanding.
Facilitator	Focuses on learners' problem-solving performance.

The teacher's roles in the table above are informed by his/her beliefs about the nature of Mathematics, which the teacher transforms into his classroom practice. As an instructor, the teacher strictly follows the textbook whilst teaching without any modification. S/he is an information provider to the learners. In turn, learners are supposed to follow and conceptualize the information presented to them without interrogating it. If the textbook is wrong it is likely that learners will learn the wrong information. An explainer is the type of teacher who clarifies and modifies information that s/he presents to learners so that they achieve conceptual understanding. During his/her lesson, learners are receptive

of the information presented to them. Finally, a facilitator is the type of teacher who believes in learners' active construction of knowledge. S/he engages learners into the problem situation by guiding and assisting them as they work on a given task. Furthermore, as a facilitator the teacher asks learners probing questions in order to get more information from them. Basically, a facilitator is a manager of learners' learning whilst learners are in deep thought or interacting with one another.

Kaiser and Vollstedt (2007), pointed out that perceptions of the roles of the teacher differ across the world. They mention that the three different roles (instructor, explainer, and facilitator) of a teacher are generally geared towards understanding. In other words, all the roles are a teacher's effort to help a learner understand mathematical concepts. They are generally focusing on the teachers' perceptions about effective teaching of Mathematics; hence all are a vehicle to achieving conceptual understanding. Furthermore, Kaiser and Vollstedt (2007) mention that the role of the teacher in China, Hong Kong, and France is that of an instructor. According to them, in these countries, the teachers provide learners with the knowledge needed for correct performance. Kaiser and Vollstedt also mention that in these countries, teachers enable learners to find mathematical information on their own.

In the US, Kaiser and Vollstedt (2007) found that teachers engage learners in problem-solving tasks hence they assumed the roles of facilitator. Strangely, in Germany the authors, Kaiser and Vollstedt, found that the content is presented and explained by the teacher hence the teacher assumed the role of both an instructor and explainer. And finally, in Australia and England, teachers believed that an effective teacher is somewhere between an explainer and facilitator (Kaiser & Vollstedt, 2007). In these two countries, Kaiser and Vollstedt found that teachers encourage their learners to solve mathematical problems on their own and teachers also explain how the mathematical concepts are related to one another.

Seemingly, the above mentioned countries differ in the way they view the role/s of the teacher in the classroom, however, despite the different terminologies the constructs learner-centred teaching and effective teaching are underpinned by

the same purpose of ensuring that learners are able to develop the knowledge and skills that they need. Hence my argument is that both learner-centred teaching and effective teaching have a strong link with meaningful learning as in both constructs, the teacher is attempting to enable knowledge construction by learners.

2.3 LEARNER-CENTRED TEACHING STRATEGIES INFLUENCE IN INSTRUCTIONAL PRACTICES

There are various strategies that are used by Mathematics teachers in order to enable conceptual understanding during their day-to-day classroom practices. Umugiraneza, Bansilal, and North (2017) found that in South Africa, although teachers were familiar with progressive teaching strategies such as classroom discussion, group work and experiments, they focused widely on strategies such as expository, chalk and talk, question and answer. However, research has indicated that teaching strategies that involve active teaching methods like investigation, discovery method, problem solving, and collaborative learning are more effective than traditional strategies in the teaching of Mathematics, because they enable learners to deepen their conceptual understanding. These strategies are rooted in the Vygotskian socio-cultural notion that views learning as taking place through social interactions (Firmender, Gavin, and McCoach (2014) wherein effective learning is facilitated. According to Vygotsky (1978), mental operations are initiated in an individual through active social interaction with more competent peers and adults. Effective learning is therefore necessitated by an effective teacher.

An effective Mathematics teacher is one who can stimulate a learner to learn the concepts of Mathematics (Clements & Battista, 1990). His/her teaching strategies should enable learning amongst learners in a constructivist classroom. According to Clements and Battista, a constructivist classroom is where learners are actively involved in the sharing of knowledge as they socially interact with one another whilst the constructivist teacher guides and supports them. The constructivist teacher should offer meaningful and appropriate tasks, and enable opportunities for discussion among learners (Clements & Battista, 1990). On the other hand, learners must be communicating about Mathematics with one

another and making sense of the Mathematics. In this study, effective learning has the same meaning as meaningful learning because both constructs focus on conceptual understanding.

2.3.1 Qualities of an effective teacher

Hattie (2003) identified five major qualities of excellence of an effective teacher. According to Hattie, an effective teacher is one whose teaching strategies has positive effects on the learner's learning. During his/her teaching, an effective teacher enables a powerful achievement of meaningful learning amongst his/her learners. Below are Hattie's five major effective qualities that underpin an effective teacher which he refers to as dimensions of an expert teacher:

- Identifies essential representations of their subject
- Guides learning through classroom interactions
- Monitors learning and provides feedback
- Attends to affective attributes
- Influences learners' outcomes (Hattie, 2003, p. 6)

A teacher who identifies essential representations of his/her learners is one who makes use of prior knowledge with regards to the learner. Such knowledge may be within Mathematics itself, or learners' everyday knowledge, or knowledge drawn from other subject disciplines. All these types of knowledge would serve as basis for understanding new knowledge. In short, this type of teacher possesses a cohesive form of knowledge that s/he is able combine with new content according to the needs of learners to enable meaningful learning among them. The challenge with this type of teacher is that his/her learners may be coming from different backgrounds such that the prior knowledge s/he has decided to use may not be all of the learners. Hattie also identified an effective teacher whose quality is guiding learning through classroom interactions. This type of a teacher allows class engagement such that there is effective learner-learner and learner-teacher interactions. Here, learners are at liberty to question and their errors are appreciated by the teacher thereby allowing for appropriate feedback. One of the most important quality of a teacher identified by Hattie is monitoring and providing feedback. According to Hattie, a teacher who is able

to monitor his/her learners is the one who can identify learners' difficulties during a lesson and their level of understanding. S/he is skilful in observing and assessing the level of understanding of learners during the lesson. Through monitoring learners' problems as they engage with a problem, the teacher would provide prompt and appropriate feedback in order to enable understanding. In any classroom situation, feedback is essential to foster effective learning; basically corrective feedback is the most powerful type of feedback where clarification, elaboration, and learners' evidence is sought by the teacher.

Hattie (2003) mentions that feedback is the most powerful single moderator that enables understanding. For a teacher to enhance understanding among his/her learners there must be relevant and proper feedback. In the same vein, Hattie and Timperley (2007) mention that feedback is one of the most powerful influences on learning and achievement. According to them feedback can be used in a classroom situation as a corrective measure to improve and enhance learning. It is most powerful when learners are engaged in a problem or task situation. Hattie and Timperly mention that for feedback to be more effective the learner's response must be faulty. In other words, its main focus is on errors that are made by learners during a lesson otherwise feedback is not effective when there is a complete misunderstanding or lack of information among them. Furthermore, Hattie and Timperly point out that feedback can as well be understood as information provided by a teacher or learner regarding one's performance or understanding. This implies that on one hand a teacher can provide a corrective information to a learner and on the other hand a learner can provide an alternative strategy to solving a problem to his/her peers as they engage in a task situation during whole class discussion or small group discussion. In essence, feedback provides information that bridges the gap between what the learner attempts to understand and what s/he already knows. Feedback can take the form of verbal comment or probing questions on individual learners or a group of learners. However, giving feedback needs the teacher's high level of skill. Furthermore, the classroom teacher may not provide effective feedback to every learner in the class particularly if there is a large number of learners (McDonough, 2004).

Another quality identified by Hattie (2003) is attending to affective attributes wherein the teacher treats learners equally, respects and cares for them during lessons. This is about creating a conducive atmosphere for learning in class. Here, the teacher takes special care about his/her learners' successes and failures. However, learners may take advantage of a teacher who is too much respectful to them and begin to misbehave which may affect their concentrations. The last quality of an effective teacher identified by Hattie is about influencing learners' outcomes. This is where the teacher constructs an appropriate and challenging task, and gives it to his/her learners to work out. The task is aimed at meeting his/her instructional objectives for the topic. As learners work on the given task, the teacher monitors the proceedings. Here, s/he is not supposed to dominate the lesson rather learners actively participate the lesson progresses. The task s/he gives to learners is not just to keep learners busy, rather to involve them in the lesson meaningfully in order to facilitate learning. It can be pointed out that constructing and designing a task oriented problem can pause a reasonable amount of challenge to a teacher.

All the above dimensions of an effective teacher are significant in enabling meaningful learning. However, Hattie (2003) argues that too few of the dimensions have been put into practice by classroom teachers. Despite all of Hattie's dimensions of an effect teacher, he still has to possess pedagogical content knowledge. According to Shulman (1987) pedagogical content knowledge refers to the teacher's competency on the knowledge of the subject matter and knowledge of instructional practice. So for the teacher to facilitate learners' conceptual understanding of Mathematics, s/he needs to have knowledge of the subject and effective teaching strategies.

2.4 TEACHERS ENACTING LEARNER-CENTRED PRACTICES

As discussed earlier, one of the roles of a teacher is to facilitate the learning process. In this role of the teacher, his/her attributes are: motivating learners to learn, encouraging learners to take full control of their learning, communicating with learners, and supporting learners in their attempt to make meaning. Central to all the above mentioned attributes is the use of appropriate questioning techniques that would enable meaningful learning among learners. In other

words, in order to facilitate learners' constructions of mathematical knowledge, the teacher needs to ask them appropriate and judiciously selected questions that are relevant to the task at hand. The teacher needs to develop his/her questioning skills in order to enhance learners' achievement. According to Marzano, Pickering, and Pollock (2001), the teacher's classroom practices that involves questioning is more effective than one without questioning. As the teacher asks learners some questions, their mathematical thinking and participation are stimulated hence enabling learning. In a way, this implies that effective questioning can lead to meaningful learning. Now the question is: What kind of questions should the teacher ask leaners in order to foster effective learning?

Badham (1994) identified four main categories of questioning that classroom teachers can use to promote effective learning. The first category of questioning Badham identified is: Starter questions. These questions basically direct learners' thinking to the new knowledge and they seek multiple responses from learners in order to initiate a discussion (Badham, 1994). For example if the topic for the day is "Addition of fractions with different denominators", one of the questions that the teacher may ask learners would be: Give me an example of a pair of some fractions which have different denominators. This question would give learners a starting point so that they begin to think about new knowledge that they are about to learn. To respond to this question it is expected that learners identify such fractions. Starter questions take the form of 'pivotal' questions wherein learners have to think and focus their attention to the new topic.

The second category of questioning that was identified by Badham is: Questions to stimulate mathematical thinking. According to Badham (1994), these questions help learners to make connections between previous knowledge and experiences with the new knowledge. For example, in following up on the question about a pair of fractions with different denominators, one could ask about how these fractions could be represented as fractions with the same denominator. This would get them ready to relate the new knowledge to an already known fact of adding fractions with like denominators. Such questions help learners to see patterns and relationships between what they already know and what is new to them. Basically the teacher asks learners this type of question

in order to find out what learners already know and to help them make links to what they know (Ausubel, 1978). The teacher is expected to spend some time at this stage of the lesson, making sure that learners' prior knowledge is confirmed.

The third category of questioning is: Assessing questions. In essence these are follow-up or probing or leading questions where the teacher perceives learners' responses as inadequate or inappropriate. A teacher asks such questions when learners are engaged into a task or problem situation. Examples of assessing questions are: How did you….? Why do you think…? What if…? What about…, etc. These type of questions allow the teacher to get learners' clarification, elaboration, to see what they understand and to stimulate their thinking (Badham, 1994). Such questions involve cognitive manipulation of information in order to support an idea or a solution to a problem. The teacher may ask probing questions to an individual learner or group of learners or the entire class to get more information or think and express their ideas in-depth. As learners respond to the teacher's assessing questions, it is important for the teacher to give timely feedback which could be simple comments such as right, or correct, or more corrective ones as a way of moderating their responses.

The last category of questioning is: Final discussion questions. According to Badham (1994), such questions allow learners to share and compare their solutions, and the methods they used to arrive at the solution. At this stage of the lesson, the effort of the class is drawn together to share meaning. Learners think about their peers' mathematical ideas and methods which in itself is key to effective learning. Examples of final discussion questions are: Which groups have the same solution? Which group has a different solution? Are your results the same? (Why/why not?); Is there another strategy of finding the solution? During all the above discussed categories of questioning, wait time is essential in stimulating learners' thinking after the teacher has paused a question (Shahrill, 2013). In other words, the teacher should give learners enough wait time to allow them to think before responding to a question that s/he has posed. This would lead to learners' active participation and giving thoughtful responses.

From the discussion thus far, it can be argued that questioning is a fundamental instrument of enabling meaningful learning. The teacher should be competent with content knowledge and have good questioning skills. The contention is that having conceptual understanding of the subject Mathematics would facilitate the teacher' good questioning skills. This means that for the Mathematics classroom teacher to ask learners appropriate questions during his/her lessons, s/he must have full knowledge of the subject matter. The teacher must be an expert in the area of Mathematics otherwise it will not be possible for him/her to ask learners good relevant questions as the lesson progresses. However, a teacher may have inadequate or no training in questioning techniques during his/her pre-service training. This would affect learners' classroom participation and academic achievement as the teacher will not be competent enough on the art of questioning techniques. His/her empowerment at pre-service training on asking learners some questions during a lesson would improve his/her practice hence potentially enable meaningful learning.

2.4.1 The use of manipulatives

One of the innovative teaching strategies used by some classroom teachers is manipulatives. The teachers use manipulatives when mediating mathematical concepts. Their belief is that the use of manipulatives would help learners cope with the abstractness of mathematical concepts (Tall, 2008). In other words, by using manipulatives they believe that abstract mathematical concepts would be more accessible to the learners. Hence during the teaching of Mathematics, the use of manipulatives is associated with effective teaching.

Manipulatives is a word that is used when educators refer to concrete objects such as Dienes blocks, geoboards and rubber bands, and Cuisenaire rods that can be used in the teaching and learning of Mathematics (Clements & McMillen, 1996). Clements and McMillen mention that though learners who use manipulatives in their Mathematics class usually do better than those who do not use them, but this is only true for certain topics. According to them, manipulatives do not guarantee success in the learning of Mathematics. They acknowledge the idea that manipulatives have an important place in learning Mathematics, but they point out that manipulatives do not carry the meaning of

the mathematical idea. Their argument is that learners sometimes learn to use manipulatives only in a rote manner. However, in rote learning, the current knowledge is not linked to pre-existing knowledge hence there is no meaningful learning. Clements and McMillen (1996) explain that at times physical actions with certain manipulatives may suggest mental actions different from those that teachers wish learners to learn. For example, when using a number line as a manipulative to find the sum of 7 and 5, learners locate 7 on the number line and start to count 1, 2, 3, 4, 5 and read the answer as shown below.

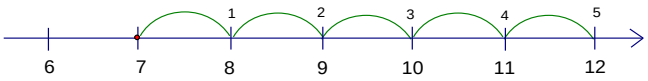


Figure 2.1 Number line for finding the sum of 7 and 5

Such a procedure does not help them to solve the problem mentally hence are not using the number line as a tool. The expected procedure would be to count 8, 9, 10, 11, 12 or rather 8 is 1, 9 is 2, 10 is 3, 11 is 4 and 12 is 5 so that it matches the mental activity intended by the teacher. Clements and McMillen's (1996) arguments imply that not all manipulatives are sufficient to guarantee meaningful learning. In other words, it does not mean that if learners use manipulatives in their Mathematics class, meaningful learning is guaranteed rather learners should make connections between manipulative models and real life situations, and mathematical concepts in order to attain conceptual understanding. On the same note of manipulatives, Clements and Battista (1990) point out that teachers use them as a vehicle to get to the abstract, symbolic and established Mathematics.

2.5 THE GAP IN LITERATURE

An observation from the above discussions is that some of the literature cited is old, especially Ausubel et al.'s (1978) meaningful learning construct. Nevertheless, my argument is that it is basically important to build current academic knowledge on knowledge that had been found before despite its age.

Furthermore, the most important factor in the emergence of new knowledge is combining it with old knowledge base.

However, none of the literature cited in the discussions above addressed issues of constructions and enactments of learner-centred practices by Mathematics classroom teachers, in Eswatini. This study therefore intends to explore Primary school Mathematics teachers' constructions and enactments of learner-centred practices and the extent to which their personal enactments of "learner-centred" practices enabled meaningful learning at Grade 6 level in Eswatini.

CHAPTER 3

THEORETICAL FRAMING

3.1 INTRODUCTION

This chapter provides a theoretical framework for this study. It has used Vygotsky's socio-cultural theory of learning, Ausubel et al. (1978) notion of meaningful learning theory are used as a lens through which to both scrutinize and appreciate teachers' construction and enactments of learner-centred practices. The reason to use a theory for this study is because it explores teachers' constructions and enactments, and Jaramillo (1996) states that the teacher as a practitioner uses theory to construct the curriculum and instructional strategies. That being the case, it is imperative to use a particular theory when engaged with activities that deal with the teacher and his or her practices. Vygotsky's socio-cultural theory is basically a learning theory but the researcher has used it for this study that explores teachers' constructions and enactments of learner-centred practices.

The chapter thus presents the theoretical foundations to the study, unpacks the learner-centred practices and presents sections that explore and describe meaningful learning from a selected literature.

3.2 THEORETICAL CONSIDERATIONS

This qualitative study seeks to explore Mathematics teachers' constructions and their enactments of leaner-centred practices. Of particular interest in the study is an in-depth understanding of teachers' conceptions of learner-centred practices and the extent to which they enabled meaningful learning as they engaged learners in their teaching of Mathematics. Vygotsky's (1978) socio-cultural theory of learning and Ausubel et al. (1978) notion of meaningful learning theory both provide key theoretical bases that underline the study.

Di Napoli (2004) argues that the learner-centred philosophy is a paradigm that reflects views about teaching, learning, and knowledge acquisition. On the same note of learner-centred philosophy, Novak and Gowin (1984) state that learner-centred philosophy provides a framework for a variety of teaching methods

geared to improve learning. This means that when teaching within the learner-centred philosophy, different types of teaching methods are used and each chosen method must be consistently informed by the learner-centred philosophy. When teaching within the learner-centred philosophy, the teacher acts as a facilitator of the learning process and learners work in collaboration with one another to pursue conceptual understanding (Blumberg, 2008). The teacher can as well be viewed as a manager of the learning process wherein s/he provides guidance and support to learners in their plight to seek meaning within a learner-centred setting. According to Vavrus et al. (2011), learner-centred philosophy places an emphasis on the learner who is doing the learning and the teacher's role is to help learners access and process knowledge. The authors are of the view that learner-centred philosophy,

> Is an approach that informs the practices of teaching based on the assumption that people learn best by actively constructing and assimilating knowledge rather than through the passive addition of discrete facts to an existing store of knowledge (p. 27).

This means that within the learner-centred philosophy, learners actively construct knowledge whilst the teacher facilitates the learning process rather than present knowledge; hence the teacher no longer assumes the traditional role of knowledge transmitter. Furthermore, Vavrus et al. (2011) report that learner-centred philosophy draws deeply upon constructivism theory of learning with the notion that learning takes place when learners are actively engaged in a learning process. Basically learner-centred philosophy has some relations with the social constructivist view on learning, which emphasizes learners' active participation in the learning process in learner-centred practices. This means that the learner-centred philosophy is based on a constructivist theory of learning where the teacher engages learners in the learning process. Learners actively participate during the lesson in their plight to seek conceptual understanding. In the process they construct their own knowledge and use it as means to build new ones. It can be argued that the knowledge that they use to build new ones can be interpreted as the knowledge that learners already have in relation to the new ones. When learners construct new knowledge, the pre-

existing knowledge is important for the formation of a connection between the pre-existing knowledge and the new one.

According to Vygotsky's (1978) theory of socio-cultural development, learning occurs in and through socially mediated activities and language plays a key role in mediation. He argues that knowledge is constructed by learners within a social setting. This means that learners construct meaning individually or socially when they are in the learning process. Vygotsky (1978) placed emphasis on social and linguistic influences on learning, and in particular on the role of the teacher in the education process. He advanced a concept, known as 'the Zone of Proximal Development' (ZPD) to provide some measure of learners' cognitive development related to instruction. Vygotsky's notion of ZPD is significant in understanding how learners actively construct knowledge with assistance by the teacher or an adult or a capable peer during learner-centred practices. He defines the ZPD as:

> The distance between the actual development level as determined by independent problem solving and the level of spontaneous development as determined through problem solving under adult guidance or in collaboration with more cable peers (Vygotsky, 1978:86).

Here, Vygotsky implied that with appropriate teaching, there may be potential for a learner to reach higher conceptual understanding within the zone itself than s/he would be able to achieve without instruction. In the zone therefore, the learner will actively construct his/her own mathematical knowledge as the teacher assists him/her during the learning process. According to Vygotsky (1978), there is no single zone for each learner; rather a zone is created for every concept. This means that for every new mathematical concept being introduced, there is a zone such that the learner has to integrate new knowledge with his/her relevant developed cognitive structure. The teacher is supposed to create classroom situations in learner-centred practices through which a learner could construct mathematical knowledge. Furthermore, the teacher has to help the learner to bridge the gap between what s/he already knows and what is to be learned. Vygotsky contends that if the teacher teaches to current developmental levels, s/he condemns a learner to remain at these levels. This suggests that if the teacher teaches a learner what s/he already knows, it is unlikely that the

learner will construct 'new' mathematical knowledge. For the learner to develop cognitively, the teacher needs to be constantly in advance of his/her development, leading and directing it. So basically in a learner-centred classroom setting, learning will occur with the support of the teacher or competent peer.

Vygotsky's theory of socio-cultural development within his notion of ZPD recognizes knowledge resulting from the teacher's role of mediation and negotiation. It can therefore be argued that Vygotsky's concept of ZPD and the social construction of mathematical ideas are of value in viewing learner-centred practices, constructions, and personal enactments of Mathematics teachers in their teaching practices. Now the question is: What relation does learner-centred practices have with the notion of meaningful learning?

The main objective of education is to engage learners in meaningful learning which occurs when learners are making meaning of what they are being taught (Wong, 2015). Classroom teachers play an important role in facilitating making meaning by learners. They support learners in their attempt to achieving meaningful learning. According to Kostiainen et al. (2018), meaningful learning is a concept describing experiences that learners believe to have a particular meaning to them. Such experiences may incorporate for example situations where:

- The teacher links theory and practice during practical activities. In the context of education, theory here involves knowledge of the concepts that include principles and conceptual definitions i.e. the content knowledge that is being taught, whilst practice is a variety of learning experiences that are either meaningful or meaningless to learners.
- Learners' engagement in task situations that have been given to them by the teacher.
- Learners' being successful in solving mathematical problems, which according to them have special meaning.

Nevertheless, this does not mean that all experiences may be meaningful to learners. Whilst some learners may be successful in problem solving, others may not, hence they would perceive the problem solving situation as

meaningless to them. Kostiainen et al.'s (2018) basic claim about learning experiences is that they become meaningful to learners only when learners give meaning to them. In other words, meaningful means some knowledge that is understandable to the learner. It can be argued therefore that for meaningful learning to occur, learners must be engaged into some learning processes so that they feel some experiences.

On the same note of meaningful learning, Wong (2015) identified a combination of five attributes that would generate meaningful learning as depicted in the diagram below:

Figure 3.1 Five attributes for generating meaningful learning (adopted, Wong, 2015: p.182)

According to Wong (2015), meaningful learning incorporates combinations of active learning, constructive learning, intentional learning, authentic learning, and cooperative learning. In active learning, learners explore and manipulate objects, and observe the results of their actions. In that way they construct their own meaning as they manipulate and interpret the environment. Hence, Wong points out that meaningful learning requires learners' engagement in task situations in which they are hands-on and seeing the results of their actions. However, learners' manipulation of task situations and observations are not sufficient for meaningful learning (Wong, 2015). It is for this reason that Wong points out that learners need to also articulate their hands-on activities and observations and he refers to this as constructive learning. During constructive learning, learners integrate their new experiences with what they already know

(Wong, 2015). The next attribute that generates meaningful learning that was identified by Wong is intentional learning. This attribute is about learners associating what they are learning to fulfil their career aspirations or trying to achieve a cognitive goal, for example understanding how to add fractions with different denominators. Wong also identified authentic learning wherein mathematical problems are situated in real-life contexts. In that way, it is assumed that learners can better understand the problem hence they would be in a position to transfer their understanding to new situations. The last attribute to meaningful learning is cooperative learning. Essentially, this is about collaborative learning where learners engage on a task or problem situation in small groups in order to accomplish a common understanding. The above attributes, which according to Wong generate meaningful learning, do not happen in isolation; rather they have a connection with one another.

However, in cognitive development, meaningful learning is viewed in terms of the acquisition of knowledge. According to Novak (2002), for meaningful learning to take place the knowledge learned must be relevant to the existing knowledge. The new knowledge being introduced to the learners must be conceptually related to what learners have learnt within the same knowledge base. For example, when teaching addition of mixed fractions/numbers, learners must have learnt addition of common fractions and must have been introduced into the concept of mixed fractions.

On the same note of meaningful learning Ausubel (1962) argues that in any educational classroom setting, meaningful learning takes place when new connections are made between the learner's own relevant cognitive structure and the new knowledge to be learnt. His argument seems to resonate with Novak's (2002) notion of meaningful learning in education. Novak views meaningful learning as learners' attempt to link concepts they have learnt and to those that are relatively new to them. Hence, for meaningful learning to occur they must be an integration of new concepts with the learner's relevant pre-existing concept ideas. However, Agra et al. (2019) found an extended meaning of meaningful learning.

According to Agra et al. (2019), meaningful learning is

> a learning process, in which the learner is motivated to learn, understands, reflects and attributes new concepts, starting from previous knowledge and experiences, modifying the existing meanings, by means of the organization and integration in the cognitive structure of the previous and new concepts, making them meaningful, which, necessarily, are transferred to other situations that experience (p. 248-255).

In addition to relating new knowledge with pre-existing knowledge as articulated by Ausubel (1962) and Novak (2002) about meaningful learning, Agra et al. (2019) mention that a learner must be motivated to learn. By saying that the learner must be motivated what they mean is that s/he must be influenced to relate new ideas with pre-existing ideas during the learning process. Another addition by Agra et al. (2019) to the meaning of meaningful learning is about the learner being able to transfer what s/he has learnt to new situations according to its usefulness for example, to his/her everyday life or to other concepts within Mathematics or other subject disciplines. This means that when the learner has learnt meaningfully, s/he must be able to use that knowledge to new situations.

Though Ausubel indicates that meaningful learning applies to reception (expository) learning in classroom settings, his theory is helpful in the current study because it provides a framework within which one can view and describe teachers' conceptions of meaningful learning in their teaching practices. Thus Ausubel's notion of meaningful learning will shed some light on how Mathematics teachers will enable meaningful learning.

It is somewhat difficult to distinguish between the two phrases 'meaningful learning' and 'learner-centred practices', however, I will briefly try to disentangle the meanings. In essence, meaningful learning is an outcome that can be achieved as a result of the teaching of mathematical concepts within learner-centred practices. In a way learner-centred practices are the context at which meaningful learning takes place. During his/her teaching, therefore the teacher has to operate within learner-centred practices.

In retrospect, there is a strong link between learner-centred practices and meaningful learning. The link is brought about by learners' pre-existing knowledge which can be considered as a necessary requirement for learning new concepts. Within the learner-centred framework, the teacher negotiates learners' constructions of new knowledge which they are supposed to associate with pre-existing knowledge hence enabling meaningful learning (Ausubel, 1962), and learner-centred practices form context at which meaningful learning occurs.

According to Ausubel (1962), the teacher should ensure that a learner already possesses appropriate knowledge in his/her cognitive structure that s/he can assimilate the new knowledge with. What this implies is that in learner-centred practices, the teacher should confirm and emphasize the learner's relevant prior knowledge. For example, when teaching place value to the thousands, one's appropriate prior knowledge would be place value to hundreds. Here, the teacher has to make sure that learners have a firm understanding of place value to hundreds. This would enable them to assimilate hundreds to place value of thousands.

What emerges in the foregoing is that meaningful learning can involve active learning, constructive learning, intentional learning, authentic learning, and cooperative learning within learner-centred practices. Meaningful learning can as well be viewed as relating prior ideas with pre-existing ideas within learner-centred practices. And in turn, learner-centred practices would involve learners collaborating with one another as the teacher facilitates the learning process. Learner-centred practices and meaningful learning, therefore, cannot be divorced from one another because learner-centred practices provide a context at which meaningful learning occurs. Thus, in the current study more understanding is needed on how Mathematics teachers make their meaning of learner-centred practices and the extent to which they enable meaningful learning. The diagram below illustrates the framework that draws together learner-centred practices and meaningful learning.

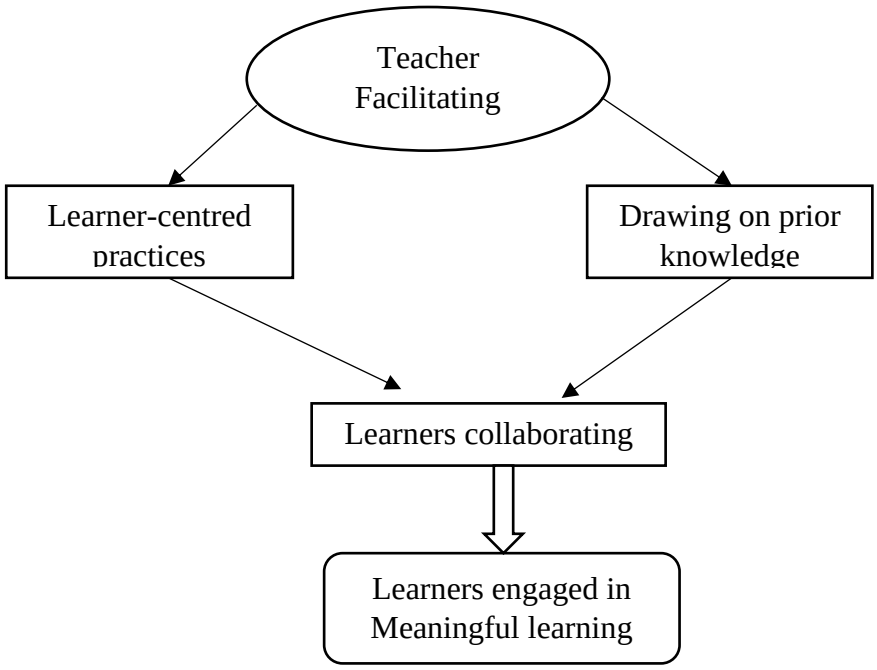


Figure 3.2 Framework for learner-centred practices and meaningful learning

The above framework indicates that the teacher plays the role of facilitator during learner-centred practices. In other words, s/he is the manager of the learning process. As the teacher facilitates the learning process, he/she draws in learners' prior knowledge whilst learners collaborate with one another. Thus, as learners are engaged in small group activities, in their plight to achieve conceptual understanding, meaningful learning is enabled.

3.3 MEANINGFUL LEARNING

This section introduces the different learning theories that underpin meaningful learning.

3.3.1 Piaget's learning theory

Ginsburgh and Opper (1969) assert that one can derive several principles concerning learners' learning and understanding from Piaget's theory of genetic epistemology. According to Piaget (1970), learning is not simply imposed by environmental forces. He argues that learning is not simply shaping but rather the learner takes an active role in his/her own learning. S/he participates during a lesson by way of engaging himself/herself with a given task or problem. Whilst the teacher monitors the lesson, the learner constructs profound knowledge. Piaget maintains that the learner assimilates environmental events

into his/her cognitive structure. Here, cognitive comes from Latin 'acquiring knowledge' or 'coming to know'. By cognitive structure Piaget meant a structure of interconnected ideas that exist in the learner's mind, which he called a schema or mental concepts. On the same note of schema, Quine and Ullian (1978) argue that any individual has a web of beliefs. They likened schema to a web of beliefs. Quine and Ullian argue that beliefs are linked to one another in a vast network and form a single logical view of reality. In a way, believing is coming to know where concepts that are related are linked to one another in a hierarchical form which is synonymous with Piaget's notion of a schema.

Marshall (1995) contends that a schema is a mechanism in human memory that allows for the storage, synthesis, generalization, and retrieval of similar knowledge. A schema therefore allows a learner to organize similar knowledge in such a way that the learner can easily recognize additional knowledge. Every schema is coordinated with other schemata. According to Greeno, Collins, and Resnick (1996), schemas are activated when a learner tries to understand, or make sense of a new situation. A learner does not only interpret knowledge, but s/he organizes and structures this knowledge into large units of inter-connected concepts. In the construction of his/her own knowledge, a learner creates cognitive structures that enables him/her to understand their environment. Learning therefore essentially involves the interaction between a learner's schemas and new knowledge (Olivier, 1989). Furthermore, Olivier contends that from a constructivist perspective, knowledge cannot be transmitted from the teacher to the learner ready-made but rather the learner constructs his/her own knowledge. And what the teacher does is to negotiate and mediate the construction of knowledge by a learner. The key aspect of the learner's construction of knowledge is the interaction of new knowledge and the learner's existing knowledge base. The nature of this interaction involves what Piaget describes as interrelated mental processes of assimilation and accommodation. Below is an account of the concepts of assimilation and accommodation which have a strong link with meaningful learning as learners attempt to learn new concepts.

3.3.1.1 The process of assimilation

By assimilation Piaget (1970) refers to the way in which the learner transforms incoming knowledge so that it fits within his/her existing cognitive structure. In other words, the learner creates mental knowledge structure that allows him/her to understand his environment. This will normally happen when the teacher introduces new knowledge to the learner and in turn s/he makes some effort to understand it. Olivier (1989) explains that if some new, but recognizably familiar knowledge presented is encountered by the learner, this new knowledge can be incorporated directly into an existing schema that is very much like the new knowledge. In other words, the new knowledge is interpreted in terms of an existing structure of knowledge (schema) making it to fit to what the learner already knows. The learner's cognitive structure is therefore expanded due to the new knowledge that has been integrated with the existing knowledge. In the light of the foregoing, it can be argued that for meaningful learning to occur, new information must be interrelated and integrated with the knowledge structure that already exists in the mind of the learner. S/he assimilates environmental information into his/her own cognitive structures. The new knowledge must interact with the learner's prior knowledge and eventually placed in his/her cognitive structure resulting in what Ausubel et al. (1978) refers to as meaningful learning.

3.3.1.2 The process of accommodation

During Piaget's (1970) notion of accommodation, the learner's cognitive structure is changed to fit incoming knowledge. His/her existing schema is modified to fit reality. According to Piaget, this process is caused by the new knowledge which may be quite different from the existing schema and not adequate to assimilate the new knowledge, as discussed earlier, such that it becomes necessary to re-construct and reorganize the existing schema. Furthermore Piaget argues that during the process of accommodation, the cognitive structure is expanded, broadened, or generalized as it incorporates new knowledge. And the re-construction of the pre-existing schema leaves previous knowledge intact. In essence, the pre-existing knowledge is re-structured without necessarily changing what already existed. As the learner continually

accommodates knowledge by re-constructing and re-organizing his/her existing schemas, there is interaction of prior knowledge with relevant pre-existing knowledge and the former is eventually linked to the latter by re-construction hence meaningful learning occurs as in assimilation. The diagram below depicts the processes of assimilation and accommodation as a learner attempts to achieve conceptual understanding of addition of fractions with different names.

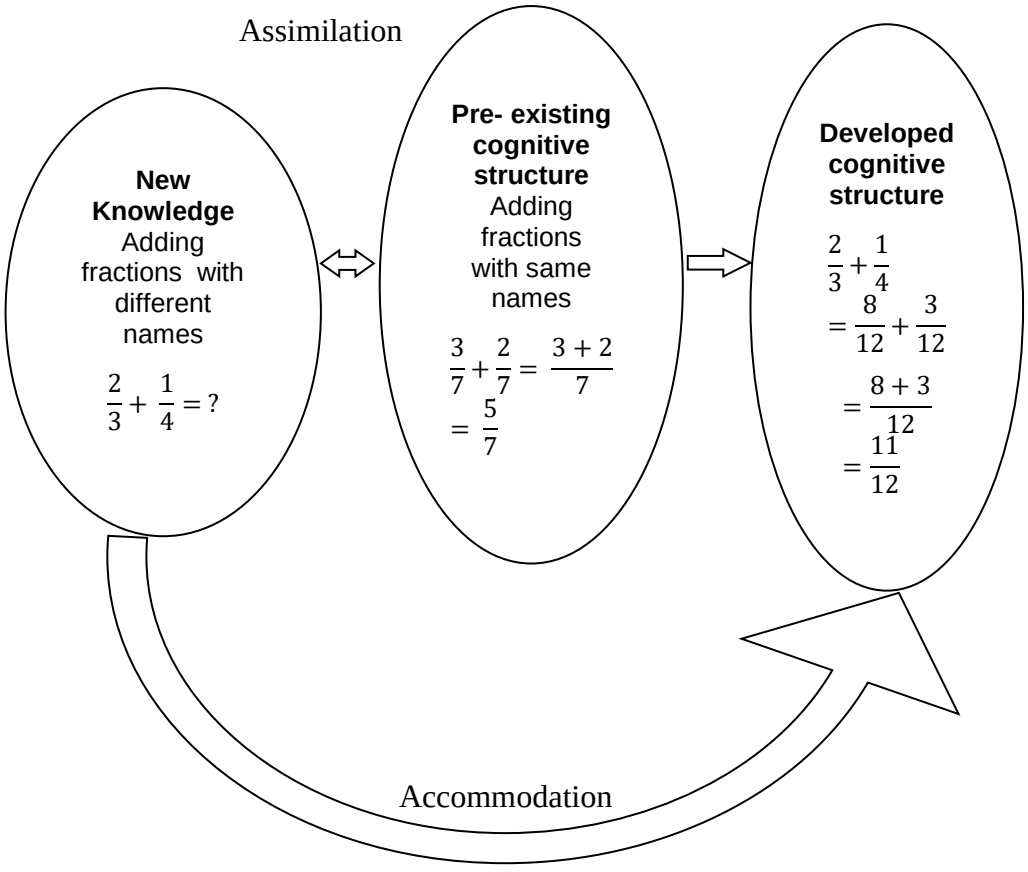


Figure 3.3 Illustration of assimilation and accommodation

In the above diagram, the learner is required to conceptualize addition of fractions with different names. Both addends of the fractions with different names are common fractions as in the addition of fractions with same names. Here, the learner contrasts the addition of the fractions with different names into

his/her existing schema of addition of fractions with same names. The learner realizes that the denominators of the fractions are different hence s/he accommodates the addition of fractions with different names by converting them to equivalent fractions with same names (re-construction). S/he then adds the resulting fractions as in the addition of fractions with same denominators. In that way s/he re-constructs and re-organizes his/her schema and ends up with a developed cognitive schema.

It can be noted that in both Piaget's mental processes of assimilation and accommodation, new knowledge interacts with relevant pre-existing aspects of a cognitive structure. Both the newly acquired knowledge and the pre-existing structure are modified in the process to fit each other. This is what Ausubel et al. (1978) referred to as meaningful learning in his assimilation theory of learning. These processes of assimilation and accommodation can be used to explain how learners learn new concepts as the teacher facilitates conceptual understanding during learner-centred teaching. During the two processes the learner's experiences are taken into what s/he already knows (assimilated) and his/her past understanding is subsequently changed (accommodated) to new experiences. Basically, the aforementioned Piaget's processes of assimilation and accommodation lead to the construct of understanding with regards to Ausubel's construct of meaningful learning.

3.3.2 Ausubel's view of meaningful learning

Ausubel et al. (1978) advanced a learning theory which describes meaningful learning extensively. They called it Assimilation Theory hence it inherited the name Ausubel's Assimilation Theory. Ausubel accepts Piaget process of assimilation in verbal instruction but eliminates the notion of physical, concrete objects in instruction. He holds the conception that learning of new knowledge relies on what is already known by the learner.

According to Ausubel et al. (1978), in order for a learner to learn meaningfully, s/he must relate new knowledge to relevant concepts that s/he already knows. This means that for meaningful learning to take place, prior knowledge must interact with relevant existing knowledge in the learner's cognitive structure. The learner must associate either his knowledge from everyday experience or

mathematical knowledge that s/he has learnt previously with the new knowledge. And both of which must be relevant to the new knowledge. Ausubel et al. (1978) state that for meaningful learning to take place, the learning task or problem must be associated with what the learner already knows. However, culture, everyday experiences and inappropriate construction of previous mathematical knowledge may affect the way a learner associates them with new knowledge. This may result in a formation of misconceptions in his/her cognitive structure.

Basically, Ausubel et al.'s (1978) contention about meaningful learning is that it occurs when the learner acquires new information through linking it with relevant knowledge that s/he has already learnt. Clements and Battista (1990) concur with Ausubel et al. and they mention that a learner makes ideas meaningful when they integrate them into their existing structures of knowledge. Ausubel et al. point out that meaningful learning does not occur arbitrary or haphazardly rather the learner must relate the new knowledge or concepts to what s/he has already conceptualized. For example, if a learner learns that a mixed fraction is a rational number, that information relates to his/her information about rational numbers. And that a rational number can be expressed in the form $\frac{a}{b}$ such that a and b are integers but $b \neq 0$. Here, the connection between a mixed fraction and rational number is not arbitrary. However, there is existing knowledge which is rational numbers and new knowledge which is mixed number. According to Ausubel et al. (1978), the new knowledge is assimilated into the learner's own cognitive structure and, both the newly acquired knowledge and the learner's pre-existing structure are modified to form a new look cognitive structure.

3.3.3 Understanding

From a constructivist perspective on learning about Piaget (1970), learners construct knowledge by themselves not by swallowing ready-made knowledge from the environment. Furthermore, knowledge does not simply arise from experience; rather it arises from the interaction between a learner's experience and his/her pre-existing set of knowledge. The learner is therefore not seen as passively receiving knowledge from the environment. The learner is an active

participant in the construction of his knowledge (Hatano, 1996). However, the focus in this section is on the issue of learners' understanding in Mathematics education.

Skemp (1976) distinguished two kinds of understanding and he called them instrumental understanding and relational understandings. By instrumental understanding, Skemp referred to rules/procedures without meaning/reasons. This means that the learner would perform some computations/calculations without some justified explanation(s). In essence, this is some kind of understanding where rules, methods, or algorithms (mathematical procedures) are applied to mathematical problems which give some quicker results for the teacher in the short term (Skemp, 1976). During instrumental understanding, Skemp mentions that no attempt is made to link the new concepts with what has been learnt previously. By relational understanding Skemp referred to the understanding that is associated with many other existing ideas in a meaningful system of mathematical concepts and procedures. This means that the learner knows what to do and has reasons for doing that which is more beneficial in the long term and also aids motivation (Skemp, 1976). It can be argued that Skemp's construct of relational understandings have some relevance on meaningful learning in learner-centred practices. The two constructs can be explained using the example below.

Suppose the learner is introduced to the concept of adding fractions with different names/denominators using the problem $\frac{2}{3} + \frac{1}{4} =$ _____ as an example. The table below illustrates the differences in the different approaches.

Table 3.2: Relationship between instrumental and relational understanding

Instrumental understanding	**Relational understanding**
$\frac{2}{3}+\frac{1}{4}=$ To find the sum of the fractions, find the L.C.M. of the numerators (3 & 4). Divide the L.C.M. by each of the denominators and multiply each dividend by the corresponding numerator. Add the results and make sure they share the same denominator (the L.C.M.). $\frac{2}{3}+\frac{1}{4}$ $=\frac{8+3}{12}=\frac{11}{12}$	$\frac{2}{3}+\frac{1}{4}=$ Learner converts the fractions into equivalent fractions with same denominators and adds them just like when adding fractions with same denominators. $\frac{2}{3}+\frac{1}{4}=\frac{8}{12}+\frac{3}{12}$ $=\frac{8+3}{12}=\frac{11}{12}$

From the above table, the learner who relies on instrumental understanding only would apply rules/procedures without meanings and explanation while the one with relational understanding would make links with other procedures or make conceptual connections (i.e. adding fractions with same names) to work out the problem. Skemp (1976) asserts that:

> Learning relational mathematics consists of building up conceptual structure (schema) from which its possessor can (in principle) produce an unlimited number of plans for getting from any starting point within his schema to any finishing point (p. 20-26).

Skemp's assertion implies that relational understanding involves connecting concepts. He also claims that instrumental understanding is useful when a learner knows how to do a specific task quickly, and is not too concerned about how this task fits into other concepts. This is what Olivier (1989) refers to as rote learning. Olivier argues that in rote learning the new knowledge is so different from any available schema such that it is impossible to link it to any existing schema i.e. neither assimilation nor accommodation is possible. Olivier elaborates that in rote learning; the learner creates what he terms a new 'box' and tries to memorize the new knowledge. Though the memorized knowledge may be used say to recall sequences of objects such as cell phone numbers, it can be argued that there is no understanding in rote learning because the current knowledge is not linked to any pre-existing knowledge. Also, this kind of learning (rote learning) does not serve learners well when they need to apply

Mathematics to solve problems outside of school work or when they need to apply their mathematical knowledge to learn more advanced Mathematics (Feikes, Schwingendorf, & Gregg, 2009). On the same idea of current and pre-existing knowledge, Ausubel et al. (1978) contend that rote learning occurs if the learner lacks the relevant prior knowledge necessary for making the learning task potentially meaningful. However, they caution that rote learning can also incorporate new knowledge into the pre-existing structure but without interaction. It can thus be noted that there is no meaningful learning in either instrumental understanding or rote learning.

Whilst in the 1970's Skemp had described knowledge outcomes in the teaching and learning of Mathematics in the education literature as instrumental and relational understanding, but since the mid 1980s the most predominant perspectives of knowledge outcomes have been conceptual knowledge and procedural knowledge (Star & Stylianides, 2013). The terms conceptual and procedural knowledge may be viewed as being extensions of Skemp's original constructs of instrumental and relational understandings. According to Star & Stylianides, conceptual knowledge denotes knowledge of concepts that involve a coherent of principles and definitions that learners can apply to different contexts. Furthermore, conceptual knowledge is related to meaning and making connections between different ideas. With regards to procedural knowledge, Star and Stylianides (2013) point out that it denotes knowledge of procedures that involve action sequences, rules and algorithms used to solve mathematical tasks or problems. Basically, procedural knowledge denotes the use of mathematical rules without necessarily knowing the reasons why or how the rules work.

Unlike in Skemp's notion of instrumental and relational understanding, the constructs of conceptual and procedural are viewed as forming a knowledge web within each. This means that the knowledge within each one of them is interrelated either in principles (in the case of conceptual knowledge) or action sequences (in the case of procedural knowledge). However, the action sequences are such that doing one step triggers the next step in the sequence as described in Action, Process, Object and Schema (APOS) theory. Hence the knowledge web triggered by procedural knowledge is just a sequence of how different

actions lead to the next. It can therefore be argued that the construct of conceptual knowledge has a strong connection with meaningful learning during learner-centred practices. It is conceptual knowledge that fosters meaningful learning. Conceptual knowledge would value the aspect of prior knowledge during the teaching and learning of Mathematics because of the inter-connection of knowledge within it.

On the same construct of understanding, Usiskin (2012) acknowledges Skemp's arguments about instrumental and relational understanding but he differed slightly from the latter's stand-point. He says that he agrees with Skemp that instrumental understanding and relational understanding are different but he disagrees that they are different objects. Usiskin argues that he views them as different aspects of understanding the same mathematical concept. He detailed five strands of understanding a mathematical concept from the learner's perceptions and he called them dimensions of understanding a Mathematics concept.

> We view there to be at least five aspects to this understanding. In this view, a person has full understanding of a mathematical concept if he or she can deal effectively with the skills and algorithms associated with the concept, with properties and mathematical justifications (proofs) involving the concept, with uses and applications of the concept, with representations and metaphors for the concept, and with the history of the concept and its treatment in different cultures" (Usiskin, 2012, p. 19).

Now the question is: What does Usiskin mean by the dimensions of a mathematical concept? Below is a description of the five notions of Usiskin's dimensions of understanding.

Dimension 1: Skills-algorithm understanding

According to Usiskin this understanding is where different learners may exhibit different ways of getting to a correct solution of a problem. The learners' understanding may be influenced by prior knowledge that they possessed.

Dimension 2: Property-proof understanding

This is about identifying and using appropriate mathematical properties when working out a problem. For example, when learners are asked to work out the

problem $\frac{y^2}{4} \div \frac{1}{6y^3}$, they need to use the concepts of reciprocal, the product rule of indices and simplifying common fractions. Working out the problem therefore is not arbitrary but requires the identification and use of different mathematical properties.

Dimension 3: Use-Application understanding

According to Usiskin, in Mathematics, a learner needs to deal effectively with understanding both the concept and its application. The application of the concept should not be viewed as higher order. Usiskin points out that application problems do not necessarily require higher order thinking and he strongly believes that such problems basically require a different kind of thinking.

Dimension 4: Representation-metaphor

Whilst Usiskin acknowledges the importance of the Dimensions of understanding 1, 2 and 3, however, he mentions that they do not carry the actual true understanding of Mathematics. His argument is that learners should represent mathematical concepts pictorially or display them concretely. For example when learners are given 7 + 5 to work out, they can make an illustration of the sum using diagrams or use counters to demonstrate their understanding.

Dimension 5: History of the concept

This is a dimension of understanding which according to Usiskin is about the history of the concept and its treatment in different cultures. Some mathematical concepts are understood as per their cultural origin, for example, the origin of Ethno Mathematics from different cultures. Also, different countries represent some mathematical symbols in a different way and one example is the way some countries represent coordinates. Some countries represent coordinates as (9, 8) whilst others as (9; 8). Both notations represent different dimensions of understanding.

Usiskin asserts that the five aspects of dimensions of understanding are connected when applied to a particular mathematical concept and they can be mastered independently of each other. According to him, learners come to understand a mathematical concept if they can deal effectively with all the five notions of dimensions of understanding. His constructs of dimensions of

understanding are more of an extension of Skemp's notions of instrumental and relational understanding in the sense that they can be applied to a mathematical concept coherently. It can be argued that Usiskin's dimensions of understanding have a strong link to the construct of meaningful learning because of their inter-connectedness when applied to a mathematical concept. This is because core to meaningful learning is pre-requisite knowledge and new knowledge which should be integrated for effective learning to occur.

It can be pointed out that there is no clear cut meaning of the construct of understanding in Mathematics education hence the construct of understanding is an ongoing debate. Nonetheless, in this study, understanding is considered as a process where learners make appropriate connections between their experiences and new knowledge.

3.3.4 Intellectual need

Harel (2013) contends that learners must see a 'need' for learning Mathematics that is offered by classroom teachers. By 'need', Harel meant intellectual need not just social or cultural needs. He argues that intellectual need is learned and ought not to be taken for granted in the teaching of Mathematics. Basically, by intellectual need he is referring to the need of the learners not the need of the teachers, and the learners' resources being the learners' conceptions not teachers' conceptions. According to Harel, intellectual need depends on the context of the learners i.e. learners' background and their pre-existing ideas. This would occur in during learner-centred practices. Harel (2013) identified five categories of intellectual needs in modern Mathematics practices.

Category 1: Need for certainty

According to Harel the need for certainty is the need to prove or remove doubts about a fact or conjecture. The proof (or just a way of understanding) must be consistent with those shared and practiced by the Mathematics community. Once the learner removes the doubts, then s/he understands the concept hence gains new knowledge. This practice of proving or achieving certainty occurs in everyday life as learners attempt to construct mathematical ideas. For example, doubts about $a^0 = 1$ (where $a \in \Re$ and $a \neq 0$) can be removed using specific examples as follows:

$4^3 \div 4^3 = 4^{(3-3)}$ (rule of division of powers of the same base)

$= 4^0 =?$

But $4^3 \div 4^3 = \frac{4 \times 4 \times 4}{4 \times 4 \times 4}$ (using ordinary expansion)

$= 1$ (cancelling)

$\therefore\ 4^0 = 1$, hence $a^0 = 1$

Category 2: Need for causality

This need, as Harel points out, goes beyond achieving certainty. It seeks to explain or justify mathematical ideas rather than removing doubts as in the need for certainty. In brief, the need for causality provides a reason or causes for truth – the cause that makes the idea true. If we say some idea is true, then the question is: Why? Learners must therefore seek to understand the explanation within the mathematical discipline. As an example, let us consider the following different workings (A, B and C) to finding a solution to the problem $\frac{2}{3} + \frac{1}{5} =$

Working A: $\frac{2}{3} + \frac{1}{5}$

$= \frac{2\times5+1\times3}{3\times5}$ (cross multiply numerators & denominators; multiply denominators together)

$= \frac{10+3}{15}$

$= \frac{13}{15}$

Working B: $\frac{2}{3} + \frac{1}{5}$

$= \frac{(15\div3)\times2+(15\div5)\times1}{15}$ (find LCM of 3 & 5; divide LCM by each of the denominators and multiply the quotient by the respective numerator)

$= \frac{10+3}{15}$

$= \frac{13}{15}$

Working C: $\frac{2}{3} + \frac{1}{5}$

$= \frac{2}{3} \times \frac{5}{5} + \frac{1}{5} \times \frac{3}{3}$ (converting fractions to equivalent fractions with the same denominators)

$= \frac{10}{15} + \frac{3}{15}$

$= \frac{10+3}{15}$ (add the numerators & keep the denominator as in addition of fractions with same denominators)

$= \frac{13}{15}$

All the workings above are mathematically correct, but **Working C** reveals the reason or rather cause for why convert the fractions to equivalent fractions with same denominators. This reason has more intellectual value than the algorithms in **Workings A** and **B** hence provides both certainty and understanding of cause.

Category 3: Need for computation

This is where symbolic algebra is used to quantify and calculate values of quantities and relations (Harel, 2013). According to Harel, in the need for computation, learners represent everyday situations or experiences into symbols. They then manipulate the symbols as if they have a life of their own and use them to perform some computations. Basically, the need to compute refers to the learners' desire to quantify, manipulate, and compute by means of symbolic algebra. Harel's concept of the **need for computation** is strongly linked to the Realistic Mathematics Education (RME) notion of horizontal and vertical mathematization where learners solve mathematical problems situated within everyday situations or problems within Mathematics as a subject discipline.

Category 4: Need for communication

According to Harel, this need is divided into two reflexive needs and calls them the need for *formulation* and the need for *formalization*. In essence, the need for communication occurs in a Mathematics discourse. A mathematics discourse includes how we use language to listen to Mathematics, act in a Mathematics class and use the Mathematics register (Gee, 1996). The Mathematics discourse develops out of formal and informal communication of mathematical ideas. By the need for formulation, therefore, Harel refers to transforming spoken language into algebraic expressions. One example of the

need for formulation is the use of "the difference between eight and three" in spoken English which can be translated into the mathematical expression 8 – 3 and can be easily computed. Whilst by formalization Harel refers to the act of externalizing the exact intended meaning of an idea or concept. In this way the learner gains control over the idea so as to be able to talk like a mathematician (Pimm, 1987). Pimm calls this a Mathematics register. According to him a Mathematics register is a set of meaning that belongs to language of Mathematics. This set of meanings that constitutes a register does not refer only to words and structures but also to the styles of meaning and modes of argument. For example the phrases/words 'take away', 'top heavy', 'combine', 'divide into', etc. have an everyday usage or meaning and an altered meaning or grammatical meaning in a mathematical discourse. When learners are learning Mathematics in school they are therefore attempting to acquire communicative competence in the Mathematics register.

Category 5: Need for structure

Harel mentions that the need for structure includes the need to reorganize learnt ideas or concepts into a logical structure. This need resonates with Piaget's interrelated concepts of assimilation and accommodation as discussed earlier in the chapter. Harel's notion of 'reorganize' is synonymous to accommodation which is the process by which a learner's existing schema is modified to fit incoming ideas or concepts. The verb 'organize' in 'reorganize' means there are some ideas or concepts already existing as in Piaget's pre-existing schema.

From the discussion thus far, what stimulates intellectual need depends on learners' reinvention of mathematical ideas with the guidance of the teacher which is analogous to the notion of RME. Here, the teacher needs to facilitate and guide the learners as they attempt to reach conceptual understanding. And all Harel's constructs of intellectual need would lead to meaningful learning.

3.3.5 Realistic Mathematics Education

In the nineties, many countries across the world wanted to reform their mathematics education so that it was meaningful to the learners. Black and Atkin (1996) had found that 13 different countries had projects that stressed the wish to make the content of the Mathematics in school more like 'ideal

Mathematics'. The Netherlands was no exception as it started its reform movement in the early seventies when the first ideas for Realistic Mathematics Education (RME) were conceptualized. RME is a teaching and learning pedagogy in Mathematics education that was first introduced and developed by the Freudenthal Institute in the Netherlands. De Lange (1996) mentions that this pedagogy had been adopted by many countries across the world such as England, Germany, Denmark, Spain, Portugal, South Africa, Brazil, USA, Japan and Malaysia. According to Van den Heuvel-Panhuizen (2000), the present form of RME was mostly determined by Freudenthal's (1977) view about Mathematics. Basically, the concept of RME is one of the theoretical aspects of learning which has a bearing to the conceptual understanding of meaningful learning.

Freudenthal (1977) felt that Mathematics must be connected to reality and Mathematics as human activity. His argument is that learners should be given the opportunity to reinvent Mathematics by mathematizing its content from learners' everyday life experiences and by mathematizing its content from within the subject Mathematics. In both cases, the Mathematics content that is to be mathematized should be experientially real for learners (Gravemeijer, 2004). With regards to RME, Freudenthal (1977) asserts that it puts on offering the learners' problem situations which they can envisage (context). According to him, the contexts should be sufficiently real for learners to be able to engage with the contexts. The contexts assist in solving problems which make sense to the learners, but also critical that they reflect the Mathematics structures the teacher wants learners to work out. Dickinson, Eade, Gough, and Hough (2010) had noted that rather than beginning with abstractions or definitions to be applied later, one must start with meaningful contexts that can be mathematized. These contexts function as a basis for the learning process and for learners to make connections. Through staying connected with the context, learners are able to continue to make sense of what they are doing, and do not need to resort to memorizing rules and procedures which are meaningless to them (Dickinson et al., 2010). According to Dickinson et al., the contexts can be taken from the real world or from areas of Mathematics that learners have learnt, or from other subject disciplines as a starting point for learning the new content. This is what

Ausubel et al. (1978) refers to as meaningful learning because new information is being linked to relevant, pre-existing aspects of what the learner already knows.

However, Bansilal (2009) had argued that during the use of learners' everyday experiences, some learners may be disadvantaged. She had found that the learners may instead base their responses to their everyday experience. The question here is: Whose context is it? The intended context, therefore, may be out of learners' context.

RME also stresses to the idea of Mathematics as a human activity (Freudenthal, 1977) wherein the mathematics subject matter is sieved from a practical, real-life context. Furthermore, Mathematics must not be a subject matter that has to be transmitted rather Mathematics education should give learners 'guided' opportunity to're-invent' Mathematics (Freudenthal, 1977). Freudenthal subscribes to the constructivist perspective of learning Mathematics. He believes that a teacher cannot transmit knowledge ready-made and intact to learners but rather learners should create their own conception of reality under the guidance and supervision of the teacher. Freudenthal (1968) further explains that in Mathematics education, the focal point should not be on Mathematics as a closed system but on the activity and process of mathematization. In short, teachers should help learners to make connections between new mathematical ideas to previous aspects of Mathematics ideas that they have learnt.

Treffers (1987) formulated two types of mathematization explicitly in an educational context. He called them horizontal and vertical mathematization. Treffers argued that in horizontal mathematization, learners come up with mathematical tools which can help to organize and solve a problem located in a real-life situation, i.e. it involves a move from real world into the world of symbols in the context of Mathematics. On the other hand, Treffers described vertical mathematization as the process of reorganization within the mathematical system itself i.e. it involves moving within the world of symbols where learners find shortcuts and discovering connections between

mathematical concepts and strategies. The table below illustrates the two types of mathematizations described above.

Table 3.3 Relationship between horizontal and vertical mathematization

Horizontal mathematization	**Vertical mathematization**
Musa and Themba have similar amounts of cake. Musa gave Thandi $\frac{3}{7}$ of his cake and Themba gave her $\frac{2}{7}$ of his cake. How much cake did Thandi get from the two boys?	Find $\frac{2}{3} + \frac{1}{4} =$ Justify your answer.

In the mathematical problem on horizontal mathematization, the context gives meaning to the concept of adding fractions with same names. Learners may represent the problem by making paper cut-outs or any appropriate manipulative representation. Later, the presence of manipulative objects is no longer needed to answer the problem. On the other hand, in the problem on vertical mathematization, learners may use the concept of equivalent fractions and addition of fractions with same denominators to answer it. Here, learners use connections between Mathematics concepts to conceptualize the addition of fractions with different denominators.

In each of the mathematizations (vertical and horizontal), there is a link between pre-existing knowledge and new knowledge. With the context related-problem, the assumption is that context is meaningful to learners though this becomes a problem if learners are coming from different backgrounds or some learners may not be familiar with the chosen context. What is perceived as a context to one learner may not be a context to the other if they are coming from different backgrounds. Of note here is that both the constructs of horizontal and vertical mathematizations require the teacher to monitor the learning process. S/he, is in fact, supposed to be playing the role of a facilitator as learners attempt to learn meaningfully.

Gravemeijer (2004) elaborated on Freudenthal's (1977) RME principle by using instructional design to reform Mathematics education. Gravemeijer argues that

by using instructional design, learners develop a framework of relations or rather connections within Mathematics to do a problem easily by inventing the necessary tools for themselves. For example, in the problem $\frac{3}{4} \times \frac{8}{11}$ =, the procedure is multiplying the numerators and denominators and simplify to get$\frac{6}{11}$. However, learners can solve the problem by dividing the 8 by 4 to get $3 \times \frac{2}{11}$, and then multiply 3 by 2 and write $\frac{6}{11}$. What the learners have done here is to use flexible computation within the framework of number operations to arrive at the expected solution. Their operational procedure is tied to their pre-existing knowledge of simplifying fractions which is the fundamental basis of meaningful learning as perceived by (Ausubel et al., 1978). According to Gravemeijer's (2004) elaboration of RME, learners should be given a problem and allowed an opportunity to think about and discuss possible solutions to the problem.

Also, of note about the Freudenthal's (1977) RME reform to Mathematics education is that it resonates strongly with progressive approaches like problem-solving. Pólya (1945), who was the first scholar to discuss, analyze and promote problem-solving on a large scale, suggested the following stages for solving a problem for reforming Mathematics education.

- understanding the problem
- devising a plan
- carrying out the plan
- looking back

According to Polya, a learner begins with a problem. With the problem in front of him/her, s/he engages in minds-on activity to understand it. The learner then attempts to make a plan by finding the connection between given data or information and the unknown. Once the plan has been formulated, the learner may attempt to carry it out and finally s/he may examine the solution s/he obtained. It can be argued that Polya's stages of problem-solving are embedded in Treffers' (1987) notions of horizontal mathematization and vertical mathematization and are intrinsic in learners' activity as they engage in solving mathematical problems.

In education literature many researchers have attempted to clarify what is meant by problem-solving (Badger et al., 2012; Schoenfeld, 1992). Schoenfeld (1992) mentions that problem-solving has contradictory meanings and Badger et al. (2012) concur with him and they state that problem-solving is widely recognized for its value in everyday life but what it means remain elusive. To Badger et al. (2012), teaching problem-solving should focus on:

- Letting learners 'mathematize' situations which they have not met previously.
- Situations such that they are in accord with their pre-existing knowledge and situations that challenge them;

On the note of problem-solving, Ausubel (1962), argues that the most important single factor influencing learning as a learner is engaged into a problem situation is what s/he already knows. The learner's previous conceptions save as the basis for what s/he is about to learn. S/he needs to make connections between prior knowledge and knew knowledge to enable understanding. Still within the notion of problem-solving, Cockcroft (1992) advocated for it as a means to develop mathematical thinking as a yardstick for everyday living. What this means is that problem-solving can provide a learner with a context for learning Mathematics and enhancing transfer of knowledge to new situations in everyday life. Once a learner has been empowered with problem-solving skills, s/he can apply them to a variety of novel situations. Therefore, RME and problem-solving are so much inter-connected such that they both emphasize on a learner pre-existing knowledge for meaningful learning to occur.

In sum, though RME has been part of the Mathematics education research filed for a long time but it can shed some ideas on how Mathematics teachers can enable meaningful learning within the framework of learner-centred practices. According to Treffers (1987), RME is a theory in Mathematics education that stresses the idea of connecting Mathematics to learners' meaningful contexts (horizontal mathematization) and connecting Mathematical matter to a higher level (vertical mathematization). Both RME's horizontal and vertical mathematizations make strong emphasis on linking Mathematics to what the learner already knows (prior knowledge). Furthermore, the concept of RME

resonates with the notion of Poyla's (1945) problem-solving and both of which recognize the value of learners' pre-existing knowledge during the process of learning.

3.4 RELEVANCE OF SOCIO-CULTURAL THEORY TO THE STUDY

The socio-cultural perspectives discussed above are pertinent to this study because they articulate explicit roles of both the teacher and the learners in a learners-centred lesson. The teacher's role as a guide and mediator for learning is critical. The teacher as the knowledgeable other is the one to produce effective learning outcomes by skilfully working on the learners ZPD to meet the valid needs of the learners. Similarly the learners' active role in knowledge construction supported by appropriate scaffold is equally important in a learner-centred classroom.

3.5 CONCLUSION

The discussions above indicate that some countries refer to learner-centred teaching as effective teaching. However, the countries differ in the way they perceive the role of the teacher during the teaching and learning processes. But across the countries, the constructs learner-centred teaching and effective teaching mean the same thing. What is core in learner-centred teaching or effective teaching is that the teacher's role is a facilitator of the learning process. S/he guides, monitors and manages the learners as they collaborate with one another in their engagement with a carefully selected given task or problem situation. The learner-centred philosophy draws deeply upon social constructivism theory of learning. It has emerged that learner-centred practices has a strong link with meaningful learning because learner-centred practices are the contexts at which meaningful learning takes place and key to the two constructs is a learner's pre-existing knowledge. Meaningful learning is itself an outcome of learner-centred practices.

Though meaningful learning may be viewed as a construct describing learners' experiences believed to be having a particular meaning to them (Kostiainen et al., 2018), however, in cognitive development meaningful learning is regarded in terms of knowledge attainment. In particular, Ausubel et al.'s (1978) Assimilation Theory puts it clearly that for meaningful learning to be attained

there must be a link between prior knowledge and the learner's relevant pre-existing knowledge. Here, prior knowledge may be in the form of learners' everyday experiences or across subject disciplines or within Mathematics as a subject discipline. What is core in learner-centred practices is meaningful learning. The literature review has revealed that the teacher can enable learning during his/her lesson by engaging learners into meaningful group work activities, using appropriate questioning techniques, using manipulatives and providing corrective feedback as the lesson progresses.

CHAPTER 4

RESEARCH DESIGN AND METHODOLOGY

4.1 INTRODUCTION

This chapter presents an outline of the methods and procedures that were followed to put together the design of this study. It presents the research paradigm chosen, and the research methodology that was used. A qualitative research method was used to gather, record, and analyse data. Data collection strategies appropriate for a qualitative research design will be explained and a rationale for their choice will be given. A case study research design will be used to get Mathematics teachers' constructions and enactments of learner-centred practices at Grade 6 level in Eswatini. The following research questions were used to generate data for the study:

(a) The researcher believes that the case study design is suitable for this study as it is aimed at getting a rich, thick description of what actually happens in the Grade 6 Mathematics classrooms. What are Primary school Mathematics teachers' understandings of learner-centred teaching?
(b) How do the teachers' understandings of learner-centred teaching influence their instructional practices?
(c) To what extent do the teachers enable meaningful learning in their personal enactments of "learner-centred" practices?

The study was conducted in the Shiselweni Region which is located in the southern part of the country. This chapter explicates the research design and methods that were used in the study. Maree (2007) describes a research design as "a plan which moves from the underlying philosophical assumptions to specifying the selection of subjects, the data collection methods to be used and how data will be analysed" (p.70). A research design offers techniques that would be embarked on during the entire research process. In short, research design is planning what the researcher will do in the data collection process and should be congruent with the researcher's conception about reality. When it comes to research, there is a wide choice of research designs from which a researcher may select depending on his/her philosophical assumptions. Such is

depended on the research questions of the study and the type of data s/he wants to generate.

In the following sections, the researcher will focus his discussion on the aspects of the research design and methodology with regards to **Mathematics teachers' constructions and enactments of learner-centred practices.**

The sections that I pay attention to in my discussion are:

- The research paradigm
- Research design and methodology
- Methods of data collection
- Methodological framework
- Analysis of data
- Reliability and validity, and
- The limitations of the study

4.2 THE RESEARCH PARADIGM

A paradigm can be viewed as a person's belief system that guides the way on how things are done, or more formally, establishes a set of practices. This can range from thought patterns to actions. Choongwa (2018) defines a research paradigm as a set of assumptions or basic beliefs that explains how a researcher views reality or subjects that they want to engage a study with. As this study was concerned with knowledge constructions, it was underpinned by an interpretative paradigm which holds that reality can be co-constructed by the researcher and the subject and therefore, is subjective. In the study, I sought to gain an insight of the teachers' conceptions of learner-centred practices and meaningful learning in their teaching. Furthermore, its main aim was to understand and describe the teachers' constructions of learner-centred practices, and the extent to which their personal enactments of "learner-centred" practices enabled meaningful learning.

Working within an interpretive paradigm, I observed all three teachers' lessons in the natural classroom setting. At the same time, the lessons were video-recorded to capture information that would enable me to make meaning of the teachers' constructions of learner-centred teaching and meaningful learning, and how their personal enactments of learner-centred practices enabled meaningful

learning to occur. As an interpretivist researcher, I also conducted an in-depth interview with each of the three teachers on a one-on-one basis to augment and triangulate the recorded information.

According to Angen (2000), one of the characteristics of the interpretive paradigm is that interpretive approaches rely greatly on naturalistic approaches such as observations and interviews. To obtain the answers to the research questions, the study was conducted in a classroom-based environment which I considered to be the natural setting for both the learners' learning and the teachers' teaching. Interviews were also conducted immediately after the lessons within the teaching environment.

4.3 RESEARCH DESIGN AND METHODOLOGY

The study employed qualitative research methodology to gather, record, and analyse data. Basically, a research methodology refers to how the researcher will go about finding out knowledge and carrying out the study; this is influenced by the researcher's position on how s/he comes to understand this knowledge, based upon his/her assumptions about social reality. Choongwa (2018) mentions that research methodology is a collection of procedures by which researchers go about their work, describing and predicting the phenomena. In order to answer the research questions of the study, a qualitative research methodology was adopted because it is explorative and interpretative in nature as the main aim of the study was to gain an insight into the teachers' constructions of learner-centred practices and the extent to which their personal enactments of "learner-centred" practices enabled meaningful.

Qualitative research has its roots in social science and is more concerned with understanding a phenomenon. Its premise is that there are multiple interpretations of reality and that reality can be co-constructed by the researcher and the subject. Qualitative research is based on a naturalistic approach and is concerned with understanding a phenomenon in a real-world settings (Maree, 2007).

In the study, the phenomenon is Mathematics teachers' constructions and enactments of learner-centred practices**.** With regards to the phenomenon, the researcher does not interfere or attempt to manipulate the phenomenon of

interest. In the study, I observed each of the teachers as they conducted their lessons and I neither interrupted them nor interfered with their lesson proceedings.

Fraenkel and Wallen (1990) point out that qualitative research is context bound. Data gathered in qualitative research is directly collected from individual(s) or social community groups within their natural environment. This study was classroom-based as the researcher collected data from observing teachers teaching and interviewing them about the lessons they taught, therefore the researcher considered this to be a natural setting.

In the study I opted for qualitative research not because I perceived it to be better than any other research approach but because I found it to be appropriate for the nature of my study. Basically the study aimed to explain and describe Grade 6 Primary school Mathematics teachers' constructions of learner-centred practices and the extent to which they enabled meaningful learning in their personal enactments of "learner-centred" practices in a school setting. Leedy (1985) contends that qualitative research is concerned with human beings i.e. interpersonal relationships, personal values, beliefs, thoughts, and feelings. On the same note of qualitative research, Fraenkel and Wallen (1990) concurs with Leedy (1985), and mentions that qualitative research studies participants' perspectives, feelings, beliefs, and actions in natural situations

Furthermore, Leedy (1985) states that qualitative research attempts to attain rich and deep data from the respondents. To get an in-depth understanding of the phenomenon of Mathematics teachers' constructions and enactments of learner-centred practices, the research used a case study design. There are several definitions by different authors in education literature of a case study, however, all the definitions bring in a common element of unity, the study of a given phenomenon (Choongwa, 2018). Creswell (2013) defines a case study as a method of inquiry that focuses on a given phenomenon and uses defined boundaries in its framework, whilst Choongwa (2018) mentions that a case study is a scientific method of inquiry that enables a researcher to understand the in-depth characteristics of a phenomenon. The same construct of case study

is described by Nisbet & Watted as cited in (Cohen, Manion, & Morrison, 2000) as a specific instance that is designed to illustrate a more general principle.

In the context of educational research, it is argued that a case study is a research approach in which a group of learners, individuals, or other persons associated with the educational process are observed in great detail, and the data that is collected is analysed in order to signify educational issues (Bell, 2010).

The major advantage of a case study is that it allows the researcher an opportunity to concentrate on a specific instance or situation and studies it in-depth to identify the various interactive processes at work (Bell, 2010). Also, according to Yin (1994), a case study approach is preferred when the "how" and "why" questions are being asked. Yin (1994) elaborates that this happens when the researcher has minimal control over events and when his focus is on a current phenomenon within some real-life context. Yin's explanation of a case study approach fits well in the current study, since its main focus was on the teachers' conceptions of learner-centred practices and meaningful learning, and how their conceptions enabled meaningful learning. This phenomenon was investigated within a real-life situation which was the teaching and learning scenario in classrooms. In addition, the researcher had no control of what transpired in the classroom and was a participant observer of what was going on.

However, just like any other approach, a case study has its own shortcomings. Its major disadvantage is that generalization is not usually possible. For example, Bell (2010) argues that the value of the study of single events like in a case study is questionable. On the other hand, Maree (2007) points out that a case study research is incapable of providing a generalizing conclusion.

This is not to say that case studies are not worthwhile. Case study researchers come to a deeper understanding of the phenomenon of interest. Bell (2010) argues that case studies are valid forms of educational research if they are carried out systematically and critically, and if they are aimed at improving education, which is why I opted for a case study for the present study.

4.4 METHODS OF DATA COLLECTION

Data for this study was collected through classroom observations and teacher interviews. Three Grade 6 classes from three different schools were observed whilst their teachers were conducting Mathematics lessons of their choice. The class observations were accompanied by video recordings in an effort to capture all of what was happening as the teachers presented their lessons. The observations were followed by one-on-one interviews with each of the teachers by the researcher. All the interviews were done on the same day of the observations within the school premises and was conducted in a quiet classroom.

4.4.1 Sample and participants of the study

The study employed convenience sampling strategy, a non-probability sampling technique. This strategy consists of selecting a particular group of subjects on the basis of being accessible (Maree, 2007). The subjects must possess ideal accessibility and proximity to the researcher and they must be based on the convenience of the study. In other words, the subjects must be nearby, and easily available to the researcher until the data collection exercise has been completed. On the same note of convenience sampling, Choongwa (2018) mentions that because of the subjects being available and accessible, the sample strategy is ideal for both the researcher and the subjects to take part in the study. However Cohen, Manion and Morrison (2000), point out that the disadvantages with this type of sampling strategy are that the sample strategy does not represent the wider population, and is deliberately selective and biased. Another disadvantage with convenience sampling is that there is limited opportunity for equal participation of subjects, since sampling is only confined to the accessible population for the researcher (Choongwa, 2018).

The work station of the researcher was within the Nhlangano town, in the Shiselweni region of Eswatini. Hence the study was conducted in three schools which were located within two kms from the Nhlangano town because they were conveniently accessible to me. All the schools were co-ed, consisting of boys and girls. The fact that the schools were co-ed was purely coincidental. The Grade 6 learners were of mixed abilities regarding their performances in Mathematics.

Since the researcher sought to describe and explain learner-centred constructions of Mathematics teachers at Grade 6 level, three qualified and experienced Grade 6 Mathematics teachers were strategically selected to participate in the study. This was important because it diminished the possibility that their practices could be due to lack of teaching experience or irrelevant qualifications. Since experience and qualification do not necessarily equal good practice, the head teachers of the research schools were consulted. The highest qualification of all the teachers was a Diploma in Primary School Education and they all specialized in Mathematics at college where they were trained as Primary school teachers. It was in light of the aforementioned attributes that the teachers were conveniently chosen to participate in the study.

The three teachers whose data were collected were Swazi males from Eswatini. Coincidentally, the teachers were all males, and they all spoke both SiSwati and English fluently. I gave each participating teacher the names Milton, Themba and Sabelo as pseudonyms. This was done in the spirit of privacy and anonymity.

In the study, I focused on Grade 6 because it was an upper Grade from primary and was not a completing class. Normally in completing classes in Eswatini, classroom teachers start to focus on revision in preparation for external examinations, hence my reason not to use a completing class. Also, unlike in the lower Grades it is at the upper Grades at Primary school level in Eswatini that some head teachers prefer to allocate teachers to teach the Grades according to their areas of subject specialization at college. The head teachers do this against government policy, than at Primary school level where teachers should teach all the subjects.

4.4.2 Ethical issues

Research ethics deal with beliefs about what is right or wrong, proper or improper, good or bad in relation with the study being undertaken (Cohen et al., 2000). They are an important aspect of research, which ought to be adhered to by all researchers as it could impact their studies.

In this study, I addressed some of the issues of research ethics relevant to it by seeking permission to conduct the research in the Shiselweni Region from the

Director of the Eswatini Ministry of Education and Training where I outlined the purpose of the study and its educational benefits. Before entry into the research schools, I asked permission from the Heads and classroom teachers to conduct the study. Informed consent letters were written and hand delivered by myself to the relevant schools. Each letter provided reasons and purposes for the study. In turn, the teachers were all asked to provide their signed consent which they all responded to positively. The right not to participate in the study was explained to them. Copies of informed consent letters are found in Appendices. For the Head teachers, I promised to keep their names and their schools anonymous.

I also promised all the three class teachers of the research schools anonymity, including others it would directly affect, especially the Grade 6 learners of each of the research schools. The Grade 6 Mathematics classroom teachers who participated in the study were given a choice of whether to participate or not in the study. All of them agreed to participate. Their privacy was achieved by conducting the interviews in an empty class where no one apart from the interviewees (teachers) and me was present. In the entire study, I assigned pseudonyms to participant teachers in order to keep their names anonymous and confidential. Before I set out to do the interview with each of the three teachers, I explained to them the aim of the interview as it was a follow up of the lessons that were observed. I asked for permission to use a video and an audio recorder during their observations, and they agreed.

Before the resumption of each of the lessons, I introduced myself to the learners so that they felt more comfortable and participated freely during the lessons. I explained to them the purpose and aim of the study. Just like their Mathematics teachers, they were given a choice on whether or not to participate in the study. Permission was sought from the Grade 6 learners of all the research schools to use a video recorder during the lessons.

In sum, the researcher respected anonymity and confidentiality for all those whom the research affected including the names of the schools. The aim, purpose, and educational benefits of the study were explained to all the participants. Also, the data gathered during the research process was solely and

strictly used for the purpose of this study. McMillan and Schumacher (2010) point out that guaranteeing privacy, anonymity, and confidentiality means that access to participants' responses, behaviour, and information is restricted to the researcher and kept non-disclosed to the public. Additionally, observation notes, video recording flash drives, audio recording tapes, all transcripts and copies of lesson plans have been kept in a secure place for the duration of the study, and will be kept secure for a further period of five years in compliance of the UKZN Research Ethics Policy. The purpose of the confidentiality and data storage measures is to ensure and protect the privacy and participants' anonymity. Thereafter, the transcripts, observation notes, one-on-one interviews notes with the teachers will be shredded and disposed of at the Town Cancel waste centre of Nhlangano town in Eswatini. Also, the recordings which have been stored on tapes and flash drives will be incinerated and disposed as well.

4.4.3 The research instruments

The tools for data collection were classroom observations and teacher interviews which are further detailed below.

4.4.3.1 Classroom observations

The first data collection technique that was used in the study was observations. In particular, I used an unstructured non-participatory form of observation wherein the researcher remains an outsider and a spectator only (Choongwa, 2018). According to Maree (2007), observations enable the researcher to gain an in-depth understanding of the phenomenon being observed. This implies that observations capture natural behaviour as it happens thereby allowing the researcher to hear, see and perhaps begin to experience reality as participants do. McMillan and Schumacher (2010) mention that observations reveal characteristics and elicit data that is nearly impossible with other means or approaches. However, Maree (2007) points out that not all behaviours and behavioural patterns can be observed in a non-participatory form of observation. Maree also states that during lesson observations, the researcher does not become immersed in the research situation.

In this study, my lesson observations focused primarily on the teachers' practices in the classrooms mainly focusing on how the teachers teach Mathematics in their learner-centred practices. I also sought to explore and describe participants' actions and behaviours.

During the teachers' lesson presentations, I was a non-participant observer. I sat at the back of the class observing the lesson whilst each of the teachers was teaching. Apart from the teacher, there was a cameraman whom I hired to video record the teachers' lessons. I also took some observation field notes on things that I saw and heard as the lessons progressed. I aimed to not interfere with the dynamics of the teaching processes. In particular, my lesson observations were guided by, but not restricted to the following:

- Whether the teaching methods employed by the teachers were informed by the learner-centred approach.
- The role(s) taken by the teachers in the lesson(s).
- The learners' involvement in the formulation of the problem.
- Whether learners were working in pairs, threes, fours, etc during the lessons.
- Whether the learners were taking control of their own learning.
- Whether the teaching promoted learners' involvement in decision making processes in the class.
- The teacher's understandings of learner-centred teaching.
- The teacher's understandings of meaningful learning.
- Aspects of the lesson that enabled it meaningful.

Apart from making lesson observations the lessons were video-recorded as a complementary source of information to the observations. Basically during video recording, verbal and non-verbal activities or scenarios are captured so as to facilitate data analysis. In essence, the data that is recorded using a video recorder is dense and contextual because it is captured from real people in real situations as they do real activities (DuFon, 2002). Furthermore, DuFon points out that a major advantage of using a video reorder to collect data is that the data content can be reviewed from the tapes by playing it repeatedly. This would allow the researcher to change focus and see things he had not seen during the observations. Furthermore, some of the processes going on during the lessons

may be too fast for a human eye hence video recording would be better placed to capture them. The video tapes for the three teachers were not transcribed, but they were presented in the form of a narrative account in Chapter 4 of the study report. The researcher played the video tapes several times and emerging patterns of the content meaning were reported in a form of a narrative account.

The lessons were video recorded despite the mere fact that placing a video camera in the classroom may be disturbing for the teachers as well as the learners. The video recording allowed the researcher to capture information that could be missed by the researcher when s/he takes the field notes because in reality s/he may not be able to 'see' everything that happens during the lesson presentations. Although observations require training (McMillan & Schumacher, 2010), in this study, I used my experience as a teacher educator when assessing pre-service teachers when they are engaged in both microteaching and teaching practicum.

Through the lesson observations and the filed notes, my aim was to collect data that would enable me to answer the research questions in relation to meaningful learning in learner-centred practices by the three selected teachers as they teach Mathematics.

4.4.3.2 The interviews

The second data-collecting method was an interview schedule. Choongwa (2018) describes interviews as a form of data collection method that uses some form of first hand human vocal interactions. These interactions are some form of interrogation between two individuals or among some people which may elicit different views or ideas. Maree (2007) and, McMillan and Schumacher (2010) agree that interviews involve a two-way conversation between individuals in which the interviewer asks the respondent questions to collect information to learn about the ideas, beliefs, views, opinions and behaviours of the respondent.

In this study, interviews were used to get an understanding and an insight into Grade 6 Mathematics teachers' constructions of learner-centred teaching and meaningful learning in their learner-centred practices. According to McMillan and Schumacher (2010), an interview schedule has the following advantages:

- It is a flexible method of questioning that allows for further probing, clarifications, and explanations hence encouraging more complete information than would be available in say, written form.
- It is possible to channel the respondent's thinking to areas of concern in order to identify relevant constructions s/he holds.
- Both non-verbal and verbal behaviour can be noted in face-to-face interviews.

However, McMillan and Schumacher (2010), argue that some of interview schedule's disadvantages are that:

- It has a potential for subjectivity and bias. The interviewer may ask probing questions to support a particular point of view, and his/her interpretation of what the respondent stated may be inaccurate.
- It lacks anonymity because the interview involves one-to-one conversations.

Also, there is a danger of interviews becoming ordinary conversations without any desirable results hence only few people could really conduct them well.

While I was not experienced in conducting interviews in research, I did try to overcome these disadvantages by being more objective as I asked the teachers probing questions to elicit information from them.

Semi-structured interviews with open-ended questions were used to enable interview conversations. According to Alsaawi (2014), a semi-structured interview is a form of data collection technique which is a mix of both structured and unstructured interviews. Choongwa (2018) elaborates that the questions when using semi-structured interviews, are pre-planned prior to the actual interview, but the interviewer gives the interviewee the opportunity to elaborate and explain particular issues through the use of open-ended questions. During the interview I allowed the teachers to think about the questions that I posed before giving me their responses. I then continued to ask them probing questions depending on their responses. In that way I was able to get more information from them.

I used a semi-structured interview in the study because it would enable teachers to respond freely in their own terms (Cohen et al., 2000). In other words, it

allows the teachers freedom to talk about what is of central significance to them rather than to the interviewer. In a semi-structured interview, questions are phrased in order to allow for probing and they also allow for individual responses. It can be argued therefore that, generally, interviews provide a variety of ways for gaining insights into aspects of teachers' cognitive structures. Whilst semi-structured interviews give the researcher appropriate chances to ask as many questions as possible on particular issues which might be unstructured, their main disadvantage is that they may obstruct the depth and richness of the responses (Choongwa, 2018). It can be pointed out that semi-structured interviews are time consuming as they have to be audio recorded and transcribed for analysis.

In this study, three Grade 7 Mathematics teachers were interviewed. The interviews were semi-structured, with open-ended questions and each interview with the teachers lasted for about 30 minutes. The interviews gathered information on teachers' conceptions of learner-centred teaching and their constructions of meaningful learning. The teachers were interviewed separately in their respective schools, within school hours and after each lesson observation. The interviews were conducted in an empty classroom with only the interviewee and the researcher present.

During the interviews, I told the teachers to use either SiSwati, which is the vernacular language in Eswatini, or English, which is the medium of instruction in Eswatini where the study was conducted. This was done so as to give them the opportunity to express their ideas freely using the language they were comfortable with. However, all three teachers chose to respond in English. In instances where the teacher was not clear, the researcher asked for clarifications from the teacher. All the interviews that were conducted were audio-recorded by the researcher. The audio recordings were fully transcribed (see Appendices for copies of the interview transcripts), and the transcripts were used in the data analysis.

Fraenkel and Wallen (1990) point out that audio-recording interviews in research has advantages, especially during the data analysis process. According to them some of the advantages are:

- The interviewer may miss much that goes on in an interview hence audio recording them would be fruitful.
- The tape produced may be replayed for continued study and analysis.
- Experts or interested others can hear what the researcher audio recorded and offer their insightful advice accordingly.

It is on the basis of the above advantages that, in the study, I opted to audio record the teacher interviews. Even more so, writing the interviewee responses down using paper-and-pencil would be time consuming and can distract the researcher hence the benefits of audio recording. The interviews focused mainly on the following (see detailed interview schedule in Appendices)

- The teachers' understanding of learner-centred teaching.
- Their experiences about learner-centred teaching
- The teaching strategies used by the teachers during the observed lessons.
- Reasons for the choice of the strategies used.
- The use of prior knowledge by the teachers in the lessons.
- How the teachers attempted to incorporate prior knowledge.
- How was prior knowledge probed by the teacher?
- Their rationale for using/or not using prior knowledge?
- The teachers' understanding of the construct, meaningful learning.
- The teachers' reasoning about particular incidents observed during the lessons that may have or may not have led to meaningful learning by the learners.
- How the teachers enabled meaningful learning in their lessons?
- Whether the teachers used concrete materials in his/her teaching.
- Reason(s) for using concrete materials in his/her teaching.

Through the semi-structured interviews, my aim was to collect data that would enable me to answer the research questions in relation to meaningful learning in learner-centred practices by the three selected teachers as they teach Mathematics.

4.5 DATA ANALYSIS

In this study, the data material consisted of classroom observations, lesson plans, and transcripts of interviews. Furthermore, the data was illuminated by the research questions and the problem statement. In the study, on one hand, the data obtained from the lesson observations were synthesized and used to describe and explain learner-centred practices of the three selected teachers. On the other hand, the data obtained from the interviews were used to describe and explain learner-centred teaching and meaningful learning constructions of the three selected teachers and how they enabled meaningful learning in their learner-centred practices. Furthermore, the data gave me a deeper understanding of what emerged in the observations with regards to learner-centred teaching and meaningful learning.

The data analysis in the study was both descriptive and interpretive. The first stage enabled drawing up stories from the video recordings that I collected during the lesson observations for each of the three teachers' lessons. Carter (1993) notes that a story is a mode of knowing that captures, in a special fashion, the richness and nuances of meaning in human affairs. In studying teachers, story has become a significant means of conducting research in the field (Carter, 1993). To generate the stories of the teachers, I drew upon Polkinghorne's (1995) construct of narrative analysis. According to Polkinghorne, a narrative in qualitative research is a story in which events and happenings are gathered and organized to generate data. Themes can therefore emerge from common elements across the data that has been generated (Polkinghorne, 1995). The outcome of a narrative analysis is a story. In this type of analysis the researcher's task is to configure the data elements into a story that unites and gives meaning to the data as contributors to a goal. It is worth pointing out that basically in qualitative research, a narrative account differs from narrative analysis. Polkinghorne (1995) points out that narrative analysis is about reformulating stories presented by people in different contexts based on their different experiences, whilst a narrative account is about a researcher telling a story based on his/her observation events and sequences that will eventually give meaning to the data generated.

In this study, the aim of the narrative account was used to get an in-depth understanding of the teachers' understandings and practices with regards to learner-centred teaching and meaningful learning. This exercise consisted of capturing some of the events and sequences as they were observed on the video clips. However, there were no word-for-word transcriptions of the video clips. These narratives were used together with data from the interviews to further explore the teachers' conceptions of learner-centred teaching and meaningful learning in their teaching practices.

By familiarizing myself with the data, in particular, the narrative account and by re-reading the transcriptions of the one-on-one interviews with the teachers, the following broad categories were initially interrogated.

Table 4.1: Categories from narrative account and interview transcripts

Categories	**Meaning**	**Evidence from data**
Teaching method used by the teacher in the lesson.	The choice of method chosen by the teacher is informed by the teachers' views of learner-centred teaching.	Learners were arranged in small or large groups.
Roles taken by the teacher during the lesson.	The extent to which the teachers grant learners autonomy in solving the problems.	Teacher was teaching whilst learners were sitting in small groups or the whole class. He observed individuals working out solutions in their groups with minimal intervention.
Teachers' questioning strategies during the lesson.	How were the learners involved in the lesson?	Teacher wanted individual responses from groups.
Confirmation of learners' prior knowledge or experiences.	Meaningful learning occurs when new knowledge is accessed through the lens of what the learner already knows as s/he constructs meaning.	Teacher used information that linked what the learner had learned to the new information in his introduction.

By examining the above categories, some central themes with respect to each research question emerged across the data set. According to Braun and Clarke

(2006), themes differ from categories in that themes capture key information and meaning within the data set with regards to the research question. Furthermore Braun and Clarke mention that thematic analysis is a useful and flexible method for qualitative research as it provides rich and insightful understanding of complex phenomena. However, its pitfall is that the researcher may have difficulty in deciding what aspects of the data set to focus on because things that can be said about it are broad (Braun & Clarke, 2006). Altogether there are three themes corresponding to research question 1, while there are three and five corresponding to research questions 2 and 3 respectively. These are presented in Chapter 5.

4.6 RELIABILITY AND VALIDITY

In qualitative research, the forms of quality assurance of reliability and validity concern trustworthiness. In what follows, I provide a discussion of the constructs reliability and validity in a qualitative research paradigm and give an explanation on how they are accounted for in this study.

4.6.1 Reliability

The construct reliability refers to the consistency of a research instrument used to collect data (Choongwa, 2018). In the context of research, an instrument is reliable if the same instrument produces similar findings when administered to different subjects from the same population, Maree (2007). In short, both authors agree that reliability is about an extent of an instrument being repeatable and consistent. Hence in qualitative research this would be a question of why the study should be trusted. This would incorporate the procedure of research strategies and meaning making of the data generated.

Thus, it can be argued that in qualitative research, reliability can be checked and enhanced by the use of different methods of data collection. This would permit the analysis and explanation of the data collected from different perspectives, thus reducing the possibility of bias by the researcher and sample thereby establishing worthiness of the data. In order to facilitate the validation of the data, the study was subjected to triangulation.

Cohen et al. (2000) defines triangulation as the use of two or more methods of data collection in research. Triangulation improves the objectivity of the study by the use of multiple data collection methods in one study of a single phenomenon to build on a single construct in qualitative research (Yeasmin and Rahman (2012). Thus, in the current study, two data collection instruments were used to generate data. The major instruments that were subject to triangulation were lesson observation and teacher interviews. In both instruments, audio recordings were created on soft copies. Also, the researcher took observational field notes as the lessons progressed. Lesson plans for the observed lessons of each of the three teachers were taken after they had taught their lessons.

Apart from the lesson observations and teacher interviews, the field notes and the teachers' lesson plans for the observed lessons were also used in the data analysis. Thus data were triangulated in this study over the use of observations captured on video camera, interviews, observational field notes, and Mathematics lesson plans.

4.6.2 Validity

In quantitative research, Maree (2007) defines validity as the extent to which it measures what it is supposed to measure. Additionally, Creswell (2015) defines validity in quantitative research as a research activity in which the researcher embarks on certain procedures to check for the accuracy of results.

However, in qualitative research, validity is viewed as the degree to which the researcher reflects reality as it is lived on by the participants in social contexts (Maxwell, 1992). Furthermore, Maxwell argues that validity is always relative to the purposes and circumstances of the research and dependent on some community of enquiry on whose perspective the account is based. Therefore, the appropriateness and usefulness of the inferences a researcher draws (Fraenkel & Wallen, 1990) in reference to particular settings reflects the validity of research methods.

There are quite a number of validity conditions that a researcher can use to ensure the meaningfulness of his/her study. However, Maxwell (1992),

mentions five categories of validity and these are descriptive validity, interpretive validity, theoretical validity, generalizability validity and evaluative validity. Of relevance to this study are descriptive validity, theoretical validity, and generalizability validity.

With regards to descriptive validity, Maxwell (1992) argues that most qualitative researchers are concerned with factual accuracy of their account of the things they saw and heard. In this study, descriptive validity was achieved in the sense that, during the interviews, teachers' words and utterances were recorded accurately using an audio recording device. The audio recordings were then transcribed (see Appendices). The researcher went through each transcript whilst listening to the audio recording to ensure that the transcription reflected the teachers' words and utterances. Extracts from the transcriptions were used to substantiate claims and these contributed to the trustworthiness of the study. Also, the interviews with the teachers were conducted privately in a closed environment. As such the interview transcripts accurately reflected what the teachers said hence the study could be considered to have descriptive validity.

According to Maxwell (1992), theoretical validity concerns the concepts used to explain the data and the relationships between them. Furthermore, he contends that theoretical validity depends on whether there is consensus within the research community about the validity of the terms and concepts. In the present study for example, theoretical validity was achieved by deriving and providing clear descriptions of the constructs **learner-centred teaching,** and **meaningful learning** using the literature as a basis.

Lastly, Maxwell (1992) argues that generalizability validity 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. In this study, being a case study, it is not possible to make generalizations about the findings applicable throughout Eswatini or in other countries. However, the transferability of the findings depend on the level of details about the methods, data collection, and analysis, and other researchers can study the details and decide whether the findings are applicable to their research setting.

4.7 LIMITATIONS OF THE STUDY

As is the case, any research could be affected by a number of factors. This study therefore is no exception as some limitations surfaced. The study focused on a small sample of three teachers from three different Primary schools in Eswatini and the findings can thus not be generalizable to other Grade 6 Mathematics teachers in the country and beyond. Rather, the findings will only be applicable to the three schools in Eswatini. Another limitation is that the study focused only on three teachers and it may have been richer if I had involved more Grade 6 Mathematics teachers and students from different schools in the country in the study.

Being a novice researcher, particularly my inexperience in interviews, provided a serious limitation. This is because when I looked at the interview transcripts, I realized that some questions needed more probing, but I did not realize this at the time when conducting the interviews.

Another limiting factor worth mentioning in the study is the issue of piloting my research instruments. Piloting research instruments has quite a number of advantages like removing ambiguity from the instruments, achieving the degree of accuracy, re-structuring or re-phrasing the major interview questions and so on. However, I could not pilot the interview schedule because they were specifically linked to the lesson observations.

4.8 CONCLUSION

This chapter has provided a description of the methodology and research methods used in collecting data for the study. In this chapter, I have shown how the two data collection instruments, the observations and interviews, complemented each other. Whilst observation does not offer opportunities for probing, the interviews give an in-depth study of teachers' constructions of learner-centred practices that emerged in the observation. The chapter has made an indication of themes that emerged in the study during the data analysis which corresponded with the research questions. In the chapter, I have similarly addressed issues relating to ethics, reliability, and validity in this study. The chapter has also provided a discussion of the limitations of the study. In the next chapter, I report on the data presentation and analysis.

CHAPTER 5

DATA PRESENTATION AND ANALYSIS

5.1 INTRODUCTION

This chapter focuses mainly on data analysis wherein the analysis consisted of only qualitative data sources in order to clarify and get an understanding of Mathematics teachers' constructions and enactments of learner-centred practices.

The sources of data were:

- Narrative account of the video clip of each teacher's observed Grade 6 Mathematics lesson.
- Teacher interview transcripts of the interviews that I conducted with each of the teachers immediately after they had taught their lessons.
- Lesson plans that the teachers used to conduct their observed lessons.

The three teachers who participated in the study were Milton, Themba and Sabelo. Below is each of the teacher's teaching where the focus was on the narrative account of his observed lesson. That was followed by the interview analysis of each of the teachers and the main nucleus of the analysis is the philosophy of each one's teaching. Lastly, I focus on each teacher's learning practices paying special attention to their understanding of meaningful learning.

5.2 MILTON'S TEACHING

In this section, I present and analyse the narrative account of Milton's video clip of the lesson that I observed him teaching. I also analyse his interview transcript of the observed lesson.

5.2.1 Background

Milton is a male Primary School teacher. His mother tongue is SiSwati and his second language is English. English language is the medium of instruction in Eswatini. Milton holds a Primary Teachers Diploma in Education which he attained in a period of three years. His area of specialisation is Mathematics and Science. In his second and third years of study at the college, he did teaching

practice for a period of six weeks each. Milton has also been a temporary teacher for three years before enrolling at college. At the time at which the research was conducted he had taught at Primary school level for three years. In his current school, Milton teaches Mathematics and Science. He has a passion for the subject Mathematics as it emerged in my interview with him.

Interviewer: *How was your teaching experience?*

Milton: *I enjoy teaching especially Math and Science in all I was teaching I taught Math and Science only. I enjoy it a lot.*

In Eswatini, Primary school teachers are "class teachers" meaning that they are supposed to teach all the subjects (Ministry of Education and Training Sector policy, 2011). But Milton has a privilege of teaching the subjects he specialised in at the college which are Mathematics and Science.

5.2.2 The research school

The school where Milton teaches is a public school. It is located 1 kilometre south of the main town in the region. Basically it is a practising school for one of the leading colleges in the production of Primary teacher's diploma in the country. In this school the student teachers from the college do microteaching and teaching practice. The school offers Grade 1 to 7 and is one of the best performing schools at Grade 7 level in the country**.** The medium of instruction in the school is English and the majority of the learners speak SiSwati which is their mother tongue.

5.2.3 Milton's lesson

Milton was teaching a Grade 6 Mathematics class. This was a mixed class of boys and girls. There were 40 learners in total and out of these; two boys were of the Asian origin. At the beginning of the lesson all the learners were sitting in their normal classroom positions facing the chalk board. They were quiet and waiting for Milton to start teaching them.

Milton let me in and showed me a seat with a chair and a desk at the back of the class. The seat was strategically positioned such that I could see all the leaners in the classroom. He then introduced my camera man and myself to the class and told them that we have come to observe and video tape them whilst he was

teaching as agreed earlier upon in the letters of consent. He reiterated that the aim of the exercise was for research purposes only and he told learners that the researcher will observe anonymity and confidentiality after the data had been collected.

Milton told learners that the lesson topic for the day was "C**onstructing a triangle"**. Its objective as he had written it in his Lesson Preparation Book was to construct a triangle using a pair of compasses, a ruler and a pencil when given its lengths. In his lesson, Milton had brought a metre ruler, a chalkboard pair of compasses and a big protractor as his only teaching materials. On the other hand each of the learners had a full set of Geometrical set of instruments. The following is what unfolded as he introduced the lesson.

Milton wrote the lesson topic on the chalk board. He then led learners into a question and answer discussion.

Milton: *By the way* w*hat does the word construct mean? Who can tell us the meaning of construct?*

Some of the learners raised up their hands but others starred at him. He immediately pointed to individuals whose hands were up.

L_1: *Construct is making or designing.*

Milton tried to rephrase what the learner had said and said: *construct has to do with doing something; you make or designing.* He further asked them: *What can the other person had to say*?

L_2: *It is to draw something or build something.*

Milton praised L_2 for his response and he reiterated it by saying; *when we say we are going to construct, it means we have to draw something*. Milton further asked the learners the meaning of a triangle: *What is a triangle? Do you know a triangle?* [Learners responded in chorus: *Yes*]. He further asked them: *What type of a shape is said to be a triangle?*

Learner: *A triangle is a shape that has three equal angles and three sides.*

Milton interjected and said: *Fine you are correct, and you are describing a certain type of a triangle which has equal sides and angles. What type of triangle is that one?*

Learner: ***…****is equilateral.*

Milton mentioned that he was not asking them about equilateral triangle but the meaning of triangle. *I am asking just a triangle. What is a triangle?*

Learner: *A triangle is a shape that has three angles and three sides.*

Milton: *Yes, when we speak of a triangle we mean a shape that has…how many angles and sides?*

Three angles and three sides. [Learners in chorus]

Without giving any explanation he quickly asked for a volunteer among the learners to come up front and draw a triangle on chalk board. One of the learners rose up, came to the chalkboard and drew a triangle. The learner drew a triangle using a metre rule and a piece of chalk. The diagram below shows the triangle that was drawn by the learner.

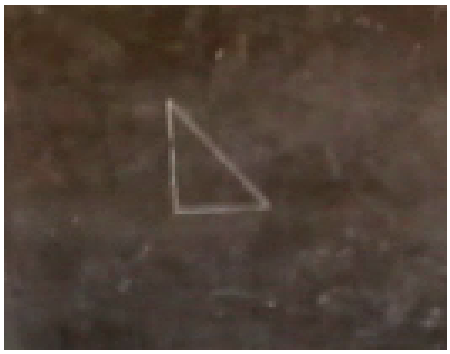


Figure 5.1 Triangle drawn by a volunteer learner on chalkboard

After the learner had drawn the triangle he asked the whole class: *Is that a triangle?* A few learners said *Yes*, however, one of the learners said *No akusiyo* [in SiSwati] - meaning that it is not a triangle. I made an observation that Milton did not follow-up the learner who said no. Instead he asked them the same question again. Incidentally Milton answered the question himself – *Yes, it is a triangle…now let's come back to the definition of a triangle. We said a triangle is a shape that has three sides.* He then confirmed with the learners whether it was indeed a triangle by letting them count the sides. He used a metre ruler to

point at each of the sides of the triangle that was drawn by the learner and learners counted after him; *one, two, three…which means that this is a triangle*. He mentioned that by definition, a triangle is a shape that has three sides. Milton went on to tell learners that a triangle also has three angles and he confirmed that by letting them count after him the interior angles of the triangle as he pointed at them using a metre rule; *one, two, three…so this is a triangle*. Milton then developed his lesson by mentioning the following:

Milton: *Because you are used to drawing triangles from ever since you started learning in Grade 1, now what I would like to introduce you to is that we are going to draw triangles using certain measurements that we are given. We are going to be given measurements.*

In the above extract, Milton was making a transition from his introduction to his lesson development. Also, what was noted during his introduction was that learners were seated in their normal whole class arrangement. He never engaged them into small group discussions yet. However, they participated in the lesson as individuals especially when he had paused a question. He would either point at a learner whose hand was up or that whose hand was not raised. Milton then wrote a task on the chalkboard as an example of a triangle with some known measurements.

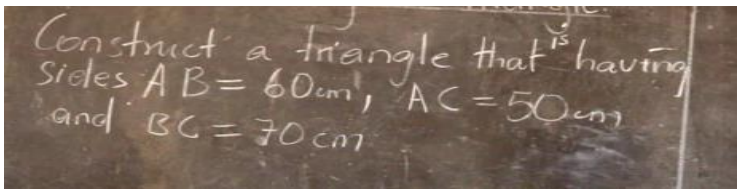


Figure 5.2 Task to construct a triangle with known dimensions

Milton pointed out to the learners that in the above task they were given the measurements of the sides of a triangle hence they were not supposed to draw the triangle anyhow. Meaning that they were supposed to draw an accurate triangle by construction. He elaborated that each and every side of the triangle should be measured. After realising that in the task the triangle had the sides labelled AB, AC and BC he told learners that he wanted to add something to the previous triangle drawn by one of the leaners which was missing.

Milton: *We have to label our lines. We did not label the lines*.

Here, he was referring to the triangle (Figure 5.3) whose vertices were not labelled. So he started labelling the vertices of the triangle whilst referring to them as lines. He confused vertices for lines but incidentally he labelled the vertices using the letters A, B and C not the lines. Below is the triangle after he had labelled it.

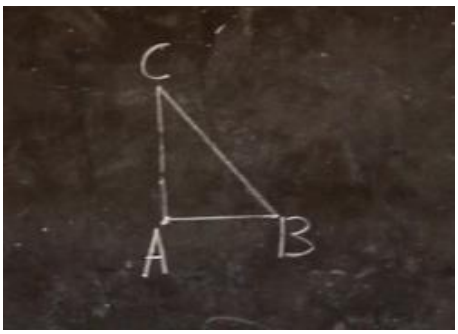


Figure 5.3 Triangle with labelled vertices

After he had labelled the triangle, he mentioned that what was missing in the triangle were the measurements only. Milton told learners that they were going to draw a second triangle which had measurements. Here, he referred learners to Figure 5.3. He eventually asked for a volunteer who could come to the chalk board and draw just the line segment AB=60 cm. A learner stood up, came to the chalk board and attempted to draw the line using a metre ruler and a piece of chalk. The learner first placed the ruler on the chalkboard vertically, however, Milton advised him to place it horizontally. He told the learner that AB should be drawn horizontally and he assisted him to place the metre ruler horizontally.

Figure 5.4 Learner being assisted by Milton to construct a triangle

Whilst the learner was constructing the line, Milton insisted that he should label it. After he had drawn and labelled the line, the learner attempted to construct the second line of the triangle, however, Milton took the metre rule from him. He confirmed the learner's line by measuring it himself and indeed he got 60 cm. He congratulated the learner for having drawn an accurate line. Milton then started explaining to the class how to construct the other sides of the triangle.

Milton: *This is the first side of our triangle. Right. The problem here is to find the third corner of the triangle because this would be the first corner* [pointing at A – the beginning of the line AB] *and this is the second corner* [pointing at B – the end of the line]. *So we have to locate the third corner. It is not easy to find it if we cannot use a certain instrument which is called a chalkboard compass.*

He took a chalk board compass from his desk and showed it to the learners. Milton told them that the compass would help them locate or find the position of the third corner of the triangle. He lamented that the two other sides of the triangle would be constructed using the compass. So he continued to construct the other dimensions of the triangle (AC=50 cm and BC=70 cm) whilst the learners were watching. Milton would only ask learners the lengths of AC and BC which were already stated in the task anyway. He emphasised to the learners that when constructing the two lines both the compass and metre rule have to be used. He then demonstrated to them how to draw AC and BC and said the following.

Milton: *We have to open the chalk board compass and measure a radius of 50 cm on the rule. After measuring the 50 cm, we have to make what is called an arc. Because we are measuring AC, our compass by the sharper side should lie at exactly on A because we are looking for the side AC, at the beginning of the line at A.*

He went on with the construction of the side AC by making an arc above the line AB and told them that it was an arc for AC. Milton proceeded to draw another arc with a radius of 70 cm from B such that they intersected above the

line AB. He told them that where the arcs meet was the position of the third corner of their triangle. He labelled the intersection C and drew straight lines connecting both A and B to C. Again he labelled the sides AC and BC as per their lengths from the task. Furthermore, he confirmed the lengths AC and BC by measuring them with his metre rule and indeed he found that they were correctly drawn. The diagram below shows the triangle that he constructed.

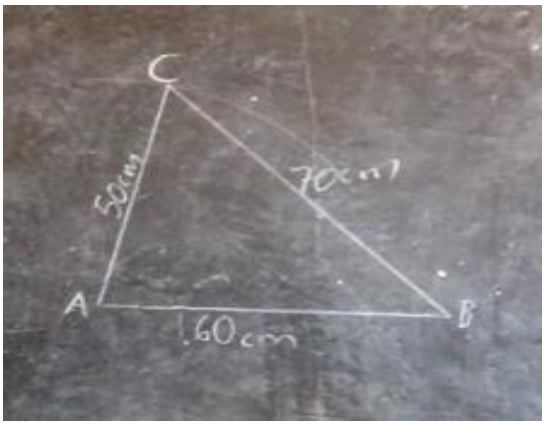


Figure 5.5 Triangle constructed by Milton as demonstration

Milton eventually told learners that they had drawn a triangle which had some measurements. He wrote another task about the construction of a triangle on the chalk board which was almost similar to the previous one. The dimensions of the new triangle for the new task were: AB=65 cm, AC=60 cm and BC=70 cm. Again as in the previous task, he asked for a volunteer among learners to draw the triangle with the above dimensions on the chalk board using a metre rule and a chalk board compass. Some of the learners immediately raised up their hands waiting for Milton to point at them. Milton pointed at one of the male learners whose hands were up to come and do the construction. He told the learner that the learners who were seated at the front should help him to hold the metre rule as he opened the compass when measuring the sides AC and BC.

The learner drew the line segment AB on the chalk board but it was not straight. Milton noticed that and he intervened. He told the learner that the only way to make a line straight was to mark with a dot at the zero mark of the ruler and another where the line ends and thereafter join the dots using the ruler. The learner erased his line and followed the Milton's instruction. Indeed he produced a straight line AB. Milton reminded him to label the line. Now when

constructing the arc above AB he placed the sharp point of the compass correctly at A, and the arm with a chalk above AB. Then the following conversation ensued.

Milton: *Why do you put it on A?*

Learner: *Because I want AC.*

Milton: *Then make an arc. Yes.*[learner drawing an arc but a short one]. *Make it long. Don't make small arcs because you may find that the other one does not cross. Yes* [learner drawing a long arc]. *Then the other one.*

The learner then attempted to draw the other arc above AB which was 70 cm from B.

Figure 5.6 Milton assisting a learner to construct arcs with an intersection

In Figure 5.6, Milton assisted the learner by holding the compass tightly on chalk board on the sharp point. Furthermore, he asked the learner some questions to try and focus his attention on why the arcs needed to be extended. After he had assisted him to draw the arcs, he told the learner to label their intersection using the letter C. Basically, Milton ensured that the learner understood all the steps of the construction. He then commented:

Milton: *Yes. That's how we locate the last corner of a triangle. That's how we find the third corner. After that you just draw the sides and label them. Write their measurements.*

The learner drew two straight lines from A and B to the intersection of the arcs to complete the triangle. He also labelled the side AC as 60 cm and BC as 70 cm. Milton then asked the class to clap hands for the learner in appreciation of what he had done. Finally the learner's constructed diagram is depicted below.

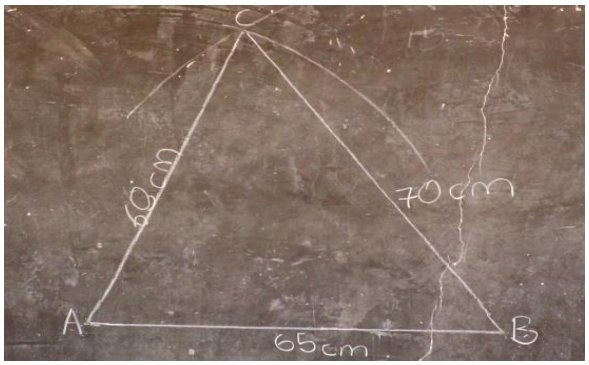


Figure 5.7 Triangle constructed by a learner with Milton's assistance

Throughout this last task exercise, Milton's focus was on that learner who volunteered to construct the triangle. He would now and again be reminding him of the next step to take. It was observed that Milton did not give the learner time to think about the next move to take when constructing the triangle. He would from time to time direct him on what to do next. The other learners were seating in their normal seating arrangement watching the lesson proceedings as it unfolded. However, those who occupied the front row would help the volunteer to hold the metre ruler horizontally on the desks when he was opening the radius of the compass to take some measurement.

Milton then gave learners a class exercise which was on page 137 in learners' Pupils' Book. Below is the exercise as it was written in the Pupils' Book.

Table 5.1 Class exercise for constructing triangles with given dimensions

Construct the following triangles:
2. Triangle ABC with AB = 8 cm, BC = 6 cm, AC = 4 cm
3. Triangle XYZ with XY = 9 cm, YZ = 9 cm, XZ = 6 cm
4. Triangle DEF with DE = 4 cm, EF = 5 cm, DF = 3 cm

At the beginning of the class exercise, all learners had a Pupils' Book. In addition to that, they also each had a full set of geometrical instruments. However, not all learners had a 30 cm ruler as a result some had to borrow it from their peers. Learners were also seating in rows facing the chalkboard.

Now the general instruction that Milton gave to his class after he had given them the exercise was that they should do it in pairs. And he made emphasis to them that they should do it in pairs.

Milton: *Do the exercise in pairs. This means you discuss it with your partner. When we say in pairs we mean you have to discuss with the person you are sitting next to* [demonstrating with his hands]. *Yes, yes, please write fast.*

However, I observed that each learner was engaged in the construction of the triangles alone although Milton asked them to do it in pairs. The picture below (Figure 5.8) shows a section of the learners engaged in the construction individually.

Figure 5.8 Learners doing an exercise individually

Milton moved around the classroom expectant of learners who had finished the first problem. He was seen holding a 30 cm ruler and a red pen in his hands ready to mark learners' work. And he told learners that everybody must be seen doing something. Furthermore, he said that if anyone had finished constructing the first triangle, s/he should raise up his/her hand so that he could check their work. After about five minutes, none of the learners had finished constructing the first triangle. So he told them that once they had constructed the triangle they should verify their measurements or check whether they constructed it

accurately or not. Perhaps he meant that they had to check the accuracy of the lengths by measuring with their rulers.

As he was moving around he told learners that he would be coming with a red pen and a ruler, and will verify their measurements first before marking. Milton encouraged learners to use a 30 cm ruler when constructing the triangles and emphasised that they should not use the 15 cm ruler which was in their geometrical sets of instruments because some of the calibrations in the 15 cm rulers were not standard. He then said the following:

Milton: *Please do not erase the arcs after you have drawn your triangles. They make your triangles to be beautiful…They show that the triangles were constructed. Who is done with the first triangle? Who are done? If you are done with the first triangle raise up your hand.*

The learners were busy with the constructions and there was no learner-learner communication about the task as expected by Milton. Milton had earlier on told learners to discuss the exercise in pairs. However, there was noise which had nothing to do with learners' meaningful interaction with one another. As Milton was moving around the class, I observed that he was expecting individual work because he was looking for any learner who had finished the first problem so that he could mark his/her work.

Milton: *Somebody is about to finish the first triangle ……once you draw a line you label it and write its measurement…..understand.*

Learner: *Yes sir.* [Learners in unison]

Milton was patiently anticipating for learners who had finished constructing the first triangle and asked them to put up their hands if they had finished. Indeed one of the learners who were sitting at the back put up his hand. He went to him, checked and marked his work. After he had marked that learner's work, he told the entire class that he was expecting them to be communicating. He then made the following remark.

Milton: *Your lines should be neat. I am expecting you to be communicating with one another guys.*

However, learners were busy doing the constructions individually. And Milton was seen attending to individual learners instead of a pair of learners as can be seen from the two pictures below.

(a)

(b)

Figure 5.9 (a) and (b): Milton attending to individual learners

Milton made a few explanations to that learner who had fished constructing the triangle and continued looking for other learners who had finished with their first construction. He would confirm the learners' constructed measurements with his ruler and would be heard praising them *[perfect; good]*. Again he emphasised to the whole class that they should not erase the arcs after constructing the triangles. He said he wanted to find arcs that learners had drawn when marking their work. Here, learners would erase the arcs because seemingly they made their constructed triangles untidy. Milton then made the following remark.

Milton: *Please don't erase the arcs. Right. I want to find them when I come to mark your work. I want to find the arcs. Somebody said the arcs make the shapes to be ugly. …No. They make the shapes to be beautiful.*

Seemingly whilst marking, he came across a learner who erased his construction arcs. In essence, the arcs show or is a justification that indeed the triangles were constructed using a pair of compasses, a ruler and a pencil. Milton continued with the marking exercise. Learners would get the constructions correct. A few of the learners would do the constructions correct but label the sides wrongly. Others would get wrong measurements because of inappropriate placement of the zero point of their rulers when drawing the lines. They would use the 1cm mark on their rulers as the starting point of the lines instead of 0 mark when

measuring hence getting wrong constructions. Each time Milton found that a learner had done something wrong, he would assist the learner first by explaining or demonstrating to him/her how to do the constructions. He would then share the same problem encountered by the learner with the whole class and explain how s/he was supposed to do it.

It took 42 minutes for learners to do the exercise. However, less than half the number of learners did not finish hence Milton requested them to finish it at home and bring their exercise books the following day. In this exercise he did try to check all of learners' constructions and assisting individual learners where he found it necessary.

5.2.4 Interview with Milton

In this section, I provide an analysis of Milton's interview transcript regarding his philosophy of teaching and his learning practices.

5.2.4.1 The philosophy of teaching

One of the questions that I paused to Milton during the interview was whether he knew about leaner-centred approaches in the teaching of Mathematics. Milton responded by saying that he learnt about learner-centred teaching and how it is used whilst he was at college in both the Education and Mathematics departments. He elaborated that:

If I can recall what I got there learners teach each other by asking each other questions they derive their own way of learning and understanding dealing with each other.

What seems to be important here is that he was talking about learners questioning each other. I then asked him what exactly learner-centred teaching was. Below is his response to my question:

Learner-centred education is whereby learners, I mean the teaching is centred on the learners. The learners are given the opportunity to go over the content and come out with their own ways of understanding. They show how they

understand and their teacher is there to monitor and guide other than just giving them all the information. The pupils have to discover the information.

Seemingly, Milton did have a firm grasp of the learner-centred approach to teaching. His definition of learner-centred teaching being centred on the learners fits well with the definition provided by Vavrus et al. (2011).

Furthermore, I asked Milton about the teaching methods that were used by his lecturers whilst he was still at college. In order for me to better understand his previous experiences with learner-centred teaching, I probed him on the kind of teaching methods he was exposed to whilst he was still at college. He responded by saying that:

They mostly lecture us. They conduct the lecture method.

His response was that the lecturers used the lecture method of teaching. However, he acknowledged that the other methods were taught to them but in practice the lecturers used the lecture method. This means that the lecturers did not model the theories they spoke about in the lecture rooms. In fact, they actually did not transfer the learner-centred approaches into practice as they lecture the students. I then asked him of the teaching method he used in his lesson that was observed by the researcher. He said that:

It was an integration of strategies of approach. It was a teacher-centred, learner-centred because that is when I started demonstrating construction and that has to be demonstrated first. Then I asked one learner to come and show the other learners that these things that he can do it.

I noticed that when Milton introduced the lesson he conducted a question-and-answer method which developed into a demonstration method. He asked learners the meaning of **construct** and the meaning of **triangle** during his introduction. He then developed the lesson by asking volunteers to do constructions on the chalk board whilst the other learners were watching. He would now and again assist and correct the learner who had volunteered to do

the construction. Milton led the class activity and his main focus was centred on volunteer learner doing the right thing as per his understanding of learner-centred teaching. He owned the information and directed the learners on what to do next. This is contrary to his submission during the interview that learners have to discover the information for themselves.

However, some aspect of his teaching was in line with his conception about learner-centred teaching. He believed that learner-centred teaching is centred on individual learner and that learners should be given an opportunity to go over the content and come out with their own ways of understanding. During his teaching he wanted learners to display individual understanding of the content.

Even though Milton mentioned that the role of the teacher in learner-centred teaching is to guide learners and encourage discussions during the interview, he never asked them questions amongst the groups such as: Did you all do this in the same way? Do you agree with this person? He missed the opportunity to allow learners to co-construct their knowledge. Learners were also not asked probing questions as a group by Milton. Instead he made explanations to individual learners among the small groups hence missing the opportunity to get them to consider answers to his questions as a group. For example, Figure5.9 showed instances where Milton was giving explanations to individual learners when in fact he was supposed to be directing them to the small groups.

An important issue that emerged during the lesson was Milton's conception of "working in pairs". In his lesson he often emphasised that leaners should work in pairs. Furthermore, he said they should discuss with the person they are sitting next to. However, throughout the lesson, learners were sitting in their normal sitting arrangement. And they were observed working as individuals (Figure 5.8), in particular when Milton engaged them into some class exercise. At some instance during the interview I asked him about the challenges of using learner-centred teaching.

Interviewer: *Do you encounter some problems when using learner-centred teaching?*

Milton: *There are because most of the time child-centred teaching, it needs you to make the groups in the class.*

From the above conversation, Milton acknowledged that during learner-centred teaching, learners should sit in small groups. But in his class learners were not working with one another. Instead Milton was seen assisting one learner whilst the whole class was watching.

Milton insisted that learners should work in pairs and told them that they should discuss with each other and communicate. What I observed was that though the learners were sitting next to each other but they were doing individual work and were not discussing or communicating with one another. Throughout the lesson, Milton took the role of telling, explaining and giving directions.

5.2.4.2 Learning practices

In his lesson, Milton started off giving an introduction to making some connection with the topic of the day, ***constructing a triangle***. He spent some time asking learners the meanings of the terms 'construct' and 'triangle'. The two terms had a bearing on learners' construction of the knowledge of 'constructing a triangle'. He then developed the lesson up to the point where a class exercise on constructing a triangle was given to learners. The learners were kept busy throughout the lesson. During the interview Milton was asked about the meaning of Meaningful learning in the teaching of Mathematics. He said that:

Meaningful learning is whereby the learners are able to take the challenge to solve problems that you have given them.

Here, Milton's explanation of meaningful learning was based on what the learners are capable of doing. According to him, if the learners can solve problems given to them, then there would be meaningful learning. His statement implies that the learners should be able to solve the problems hence Meaningful learning is guaranteed. He lamented that:

I think what made the learning meaningful was the articulation of the facts meaning it was clear to the learners that's why they were able to follow through all the steps involved in constructions.

Here, Milton means that since the learners could do all the steps that he demonstrated about constructing a triangle, then he had accomplished meaningful learning. However, in the previous extract he mentioned that meaningful learning was accomplished since learners were able to solve the problems that he had given to them. Basically, he had two conceptions about meaningful learning. They are the learners' abilities to solve problems and the learners' abilities to follow steps. Actually, it seemed Milton was not clear of the exact meaning of meaningful learning.

Milton was also asked about possible strategies he could make in his lessons so that there was meaningful learning during his lesson. He responded by saying that:

Mathematics is a technical subject. It has to do with a lot of practice. It is a lot of hands-on working. The pupils should practice it and the teacher should make it more practical and if possible concrete object can be used. Those things make the picture on how to work out problems. The picture last for a long time.

By the word, picture, Milton meant concrete objects. In my interview with him he acknowledged that he normally uses concrete objects in most of his lessons. According to him, the use of practical activities and concrete objects enable meaningful learning because they help learners work out problems and the image stays in their minds.

Interviewer: *So you were talking about concrete objects, how often do you use concrete objects when teaching Mathematics?*

Milton: *I use them a lot. As I said earlier on concrete objects make the picture in the mind of the child. The picture lasts longer than words*.

Apart from the chalkboard and a piece of chalk, Milton used only a metre ruler and a pair of compasses. He used these materials as physical tools to help learners make accurate construction of triangles. The metre rule and a pair of compasses were important resource materials used by Milton to support the construction of a triangle. Without them it would be a big challenge for him to do the construction of a triangle. Basically he did not use them to connect a representation of a mathematical idea with some concrete materials e.g. the use of Dienes Blocks to represent whole numbers when teaching addition. In other words, Milton did not use the metre rule and the pair of compasses as manipulatives to facilitate conceptual understanding. Below is an excerpt in his attempt to teach learners on how to construct a triangle using a metre rule and a pair of compasses?

Milton: *We have to open the chalk board compass and measure a radius of 50 cm on the rule. After measuring the 50 cm, we have to make what is called an arc. Because we are measuring AC, our compass by the sharper side should lie at exactly on A because we are looking for the side AC, at the beginning of the line at A.*

Milton did not use opportunities to engage in discussion with learners such as how do we know that the line from any part of the arc to A will always be 50cm? Furthermore, he did not explain to learners why at the point of intersection, we can be certain that at the point of intersection of the arcs AC will be 50 and CB will be 70 (see Figure 5.5). He just asked the class to clap hands for the learner who had constructed the triangle successfully.

However, Milton did acknowledged the value of manipulatives as an enabler of meaningful learning during my interview with him. He said that manipulatives are useful when teaching Mathematics because they make the lessons meaningful so that there is meaningful learning.

Milton was also asked to shed some light on the use of prior knowledge in the teaching of Mathematics. He seemed to articulate the significance of prior knowledge when teaching but to him, it had nothing to do with meaningful learning.

Interviewer: *Why do you use prior knowledge?*

Milton: *It is important because you have to take the known to the unknown. In fact, prior knowledge as I used it earlier on these pupils are not empty vessels they have knowledge that they have acquired. It shapes what they have to do to something. You add to what they are having.*

Milton believed that some knowledge must exist in the mind of a learner before he learns other ideas. During the introduction of the lesson he taught, he did attempt to review with the learners on what they learnt previously which had a bearing on the current topic. The lesson topic was about **constructing a triangle** hence Milton first conducted a question-and-answer session with the leaners to find out about their understanding of **constructing** and meaning of a **triangle**. According to him, the learners' knowledge of these two constructs would help them in making a drawing of a triangle. The interviewer then wanted to find out from him the frequency at which he used prior knowledge in his teaching of Mathematics.

Interviewer: *How often do you use it?*

Milton: *I use it a lot. For instance in the lesson I asked them about a triangle. They know what a triangle is. They are able to define its qualities. Others went to the extent of describing the qualities of triangles. Now what was new was how to construct it using certain measurements, a pair of compasses.*

From the above conversation, Milton seemed to know the value of prior in the teaching of Mathematics. However, one striking observation is that Milton's use of prior ideas did not seem to be associated with meaningful learning. In the lesson that I observed, Milton did use prior knowledge in his introduction.

But when I interviewed him about the use of prior knowledge he did not necessarily mention that it had anything to do with meaningful learning. To him, it was a way of facilitating conceptual understanding among the learners. Clearly, Milton's construction of meaningful learning did not correlate with the notion of linking learner's prior ideas to existing ideas.

5.3 THEMBA'S TEACHING

In this section, I make a presentation and analysis of the narrative account of Themba's video clip of his observed lesson. I also analyse Themba's interview transcript of the lesson that I observed him teaching.

5.3.1 Background

Themba is a male Primary school teacher. He is a Swazi by nationality and his first language is SiSwati. His highest school achievement is O level (Form 5). The subject combinations that he did in his exit class were Physics, Mathematics, Agriculture and Geography. After completing his O level, Themba did a computer course whilst working for a Non-Governmental Organisation which dealt with issues of HIV and AIDS. He then enrolled in a teacher training college for three years where he obtained a Primary Teachers Diploma in Education. However, teaching was not Themba's initial preferred carrier path after completing school.

Interviewer: *Now think back when you were in school, what sort of work did you think you will do after completing school?*

Themba: *I thought of being a lawyer. Teaching was a passion for me so if I fail to be a lawyer, I will come to teach so luckily for me I am now teaching and I like it.*

At college Themba specialised in Mathematics and Science. In his second and third years of study at the college, he did teaching practice for a period of six weeks each. He has been teaching at Primary School level for three years. In his current school, Themba teaches Mathematics and Science in Grade 6, and Science in Grade 5. He does not teach all the subjects which are offered at this

Grade level as per the requirement of the Ministry of Education and Training policy of Eswatini.

5.3.2 The research school

Themba teaches in a government school, which means that the government of Eswatini takes full responsibility in the school's maintenance in as far as infrastructure is concerned. However, the government does not provide funding for the learners hence the parents pay school fees for the learners. The school is located within town and is one of the best performing schools in the country at Grade 7 level external results. The medium of instruction in the school is English as per the Eswatini Education Sector Policy. The learners' first language is SiSwati.

5.3.3 Themba's lesson

I observed Themba teach a Grade 6 Mathematics mixed class made up of 27 boys and 23 girls. At the beginning of the lesson all the learners were sitting facing the chalk board. They were all quiet and waiting for Themba who was next to the chalkboard to give them directions on what to do.

Themba had prepared a seat for me at the back of the class. He let me and, showed me the chair and a desk he had prepared for me. The seat was strategically positioned such that I could see all the leaners from the back. He then introduced my camera man and myself to the class and told them that we have come to observe and video tape them whilst he was teaching as agreed earlier on in the letters of consent. He reiterated that the aim of the exercise was for research purposes only and he told learners that the researcher will observe anonymity and confidentiality after the data has been collected.

Themba's lesson topic for the day was: **The sum of the interior angles of a quadrilateral**. Its objectives as written in his lesson preparation book were:

- To identify four interior angles of a quadrilateral.
- To find the sum of the interior angles of a quadrilateral
- To use the sum of the interior angles of a quadrilateral to calculate unknown angles of a quadrilateral.

Themba started off his lesson by conducting a question-and-answer session whilst learners were sitting in their normal class positions facing towards the chalkboard. He asked them the meaning of quadrilaterals. Some of the learners raised up their hands in anticipation of being pointed by Themba.

Themba: *What do you mean by quadrilateral?*
Learner: *A shape with four sides.*

He then asked the class whether they agreed with the above definition and they said 'yes' in unison. Themba wrote the definition of a quadrilateral on chalkboard as can be seen in Figure 5.10 below.

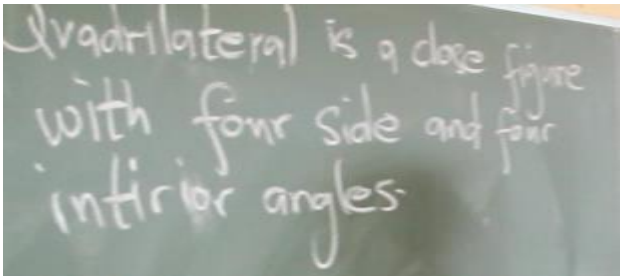


Figure 5.10 Definition of a quadrilateral

He moved on and asked them to give him examples of quadrilaterals. He pointed at individuals who had risen up their hands. And their responses were *square, rectangle, trapezium, diamond, kite, rhombus and parallelogram* of which he wrote them on chalk board. Themba eventually told learners the topic of the day.

He continued with his question-and-answer session asking learners the meaning of "sum" and "interior angles" which seemed to be key prior concepts in his lesson. He first asked learners the meaning of sum and the learners' responses were: *addition, total number of something, amount you get when you add numbers.* He then asked them the meaning of interior angle. Some learners put up their hands and he pointed at one of them.

Learner: *The interior angle is the space inside a shape.*

Themba wanted to find out from the class whether the learner's response was correct or wrong. He asked them whether they agreed with the given response.

Themba: *Do you agree with her response class?*

Learners: *No* (in unison).

Themba: *Somebody else please. What can you say about interior angle?*

One of the learners gave the meaning of interior angle and Themba seemed to be happy with her response.

Learner: *Interior angles are angles found inside a shape.*

He asked the class to clap hands in appreciation of the learner's explanation of interior angles. Themba then wrote the meaning of both *sum* and *interior angle* on the chalkboard.

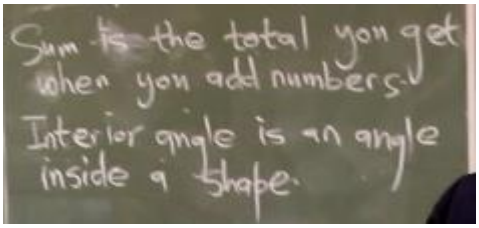


Figure 5.11 Meaning of *sum* and *interior angle*

He produced a chart with drawn quadrilaterals and pinned it on the chalkboard as shown below.

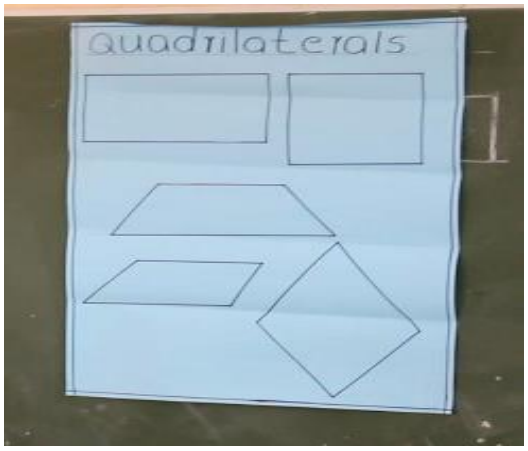


Figure 5.12 Chart with drawn quadrilaterals

He told learners that he wanted them to mark angles inside each of the shapes with an arc. Learners would put up their hands and Themba pointed at any one learner whose hand was raised. One learner came upfront to mark angles inside the rectangle on the chart after he had been pointed by Themba. However, one

of the learners was particular about the marked angles. The learner raised his hand and told Themba that in a right angle the angles are 90^0 and are supposed to be marked with a portion of a small square. Themba asked him to show the class what he was saying by marking the interior angles of a square because those of the rectangle had already been marked by one of the learners. Below are the shapes whose interior angles were marked by the two learners.

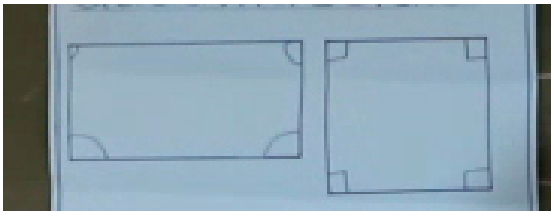


Figure 5.13 Quadrilaterals whose interior angles were marked by two different learners

He commended the learner and pointed out to the whole class that when you are marking a right angle you are supposed to mark with a small square hence the learner was supposed to mark the angles inside the rectangle with small squares. He further asked learners to mark interior angles of the other quadrilaterals. They took turns to mark the interior angles of the shapes on Themba's chart.

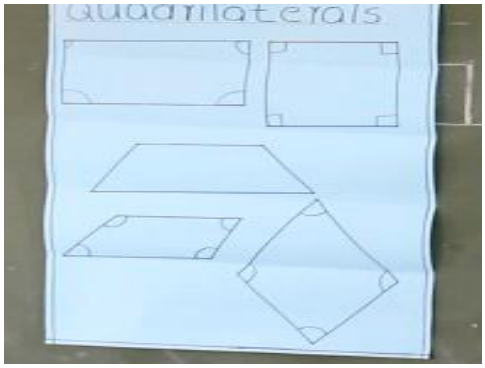


Figure 5.14 Quadrilaterals with marked interior angles

After the interior angles of four of the five quadrilaterals had been marked by the learners as can be seen in Figure 5.14, Themba said: *At least everybody understands what we mean by an interior angle.* He then asked learners to sit in their groups. Those were pre-established groups with the same members. Each

of the five groups that were formed had a total of about 10 learners (see Figure 5.15)

Figure 5.15: Learners seated in small groups

He gave each group a squared exercise book and asked them to draw any quadrilateral of their choice. Themba insisted that they should be fast because time was against them. Below is the picture of one of the groups as they engaged in his exercise.

Figure 5.16: Learners watching one learner doing an exercise

In this activity Themba did not encourage the learners to discuss and agree on the type of quadrilateral to be drawn. Hence one learner from each group was observed drawing a quadrilateral of his/her choice whilst the group members were watching (see Figure 5.16). As they were doing the activity, Themba moved from one group to another observing what they were doing without

making any utterances. He reminded them to work fast. He then asked the groups to cut their quadrilateral diagonally. Before they could even start cutting their shapes he asked them the meaning of diagonal. One of the learners he had pointed at responded by saying that diagonal means across. The same learner was asked by Themba to demonstrate a diagonal by drawing it on a quadrilateral he had drawn on the chalkboard (see Figure 5.17).

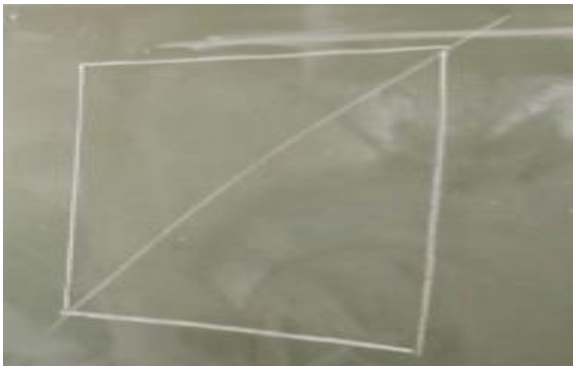


Figure 5.17: Diagonal drawn by a learner on a quadrilateral

Themba asked them whether he [learner] had drawn a diagonal and the learners said yes in chorus. The learners were not pushed to the fact that a quadrilateral has two diagonals. He then wrote the meaning of the term diagonal underneath the shape [*diagonal is sloping line connecting opposite angles of a flat shape*]. Furthermore, he drew a dotted line on the diagonal that was drawn by the learner using a metre rule and a piece of chalk somehow making an emphasis to the learners about a diagonal. After having satisfied himself that the learners know the meaning of diagonal, he asked them to cut the shape that they had drawn diagonally.

Themba: *Cut your shapes diagonally. And tell me how many shapes do you get if you cut it diagonally? You cut it diagonally* [making emphasis].

By saying cut your shapes diagonally, Themba meant drawing a diagonal line on their quadrilaterals. Hence each group representative was seen drawing a diagonal line on their quadrilateral. There was neither cutting of the shapes

using any tool nor tearing along the drawn diagonal line. The picture below shows one of the group members who was drawing a diagonal line in their shape.

Figure 5.18: Learner drawing a diagonal line through a shape

Also, what was observed in this group was that the group member attempted to draw the second diagonal of their quadrilateral but he decided to stop. That showed that he knew there were two diagonals of the shape but he decided not to draw the second one. Themba went from one group to another observing them and ascertaining whether all groups had drawn a diagonal. Whilst the learners were still sitting in their groups he asked them the number of shapes produced after the cutting.

Themba: *How many shapes do you have if you cut diagonally? How many shapes do you have now?*

Learners: *Two shapes* [in a chorus]

Themba: *What are the names of the shapes?*

Learners: *Triangles* [in chorus and Themba said excellent].

After conducting the above question-and-answer session with the learners, he confirmed the sum of the interior angles of a triangle with them.

Themba: *So yesterday we were finding the sum of interior angles of a triangle. By the way the sum of interior angles of a triangle is*

how many degrees? Of a triangle [making emphasis because of poor response from learners]. *They add up to how many degrees?*

A few learners raised their hands up in their groups and he pointed at one of them whose response was that the interior angles of a triangle add up to 180^0. He continued and the following question-and-answer ensued:

Themba: *Now we have how many triangles* [referring to their quadrilaterals]. *How many triangles do we have class?*
Learners: *Two triangles.*
Themba: *If we add the two triangles will give us how many degrees?*
Learners: 360^0 [in chorus].
Themba: *That means* $180^0 + 180^0 = 360^0$ [saying it verbally and writing the number sentence on chalkboard].

After the above conversation, Themba tried to help learners to make a conclusion about the sum of interior angles of a quadrilateral.

Themba: *Then what can you say about the interior angles of a quadrilateral?*

In the above question, Themba's intention was to ask learners about "the sum of interior angles of a quadrilateral". There was no response from them. After he realised that the learners were not responding, he decided to conduct a short discussion. His discussion focused on interior angles of a quadrilateral he had drawn on chalkboard earlier on when discussing a diagonal. He dominated this discussion expecting quick answers as he led them to label the angles inside the quadrilateral as shown below.

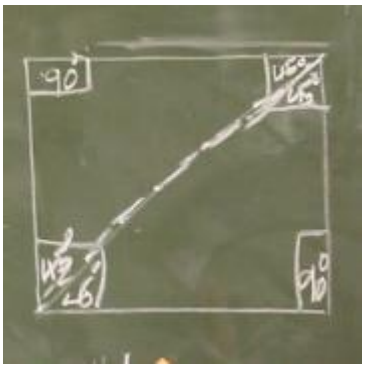


Figure 5.19: Themba demonstrating sum of interior angles in a quadrilateral

After he had labelled all the interior angles with the learners the following conversation followed.

Themba: *If you add 45^0 plus 90^0 plus 45^0 how many degrees do we get?* [Pointing at the angles of the upper half of the drawn diagonal of the above quadrilateral].

Learners: *180^0* [in chorus].

Themba: *Also if you add 45^0 plus 45^0 plus 90^0, how many degrees do you get?* [Pointing at the three angles of the triangle of the lower part of the drawn diagonal of the quadrilateral].

Learner: *180^0* [Pointing at a learner who had raised a hand].

Themba: *Now if you add all the angles, you are adding all of them now; how many degrees do you get?* [Pointing in circular motion inside the quadrilateral].

Learner: *360^0*

Themba: *Then what can you say about the sum of interior angles of a quadrilateral?*

Learner: *They add up to 360^0* [a female learner responding].

Themba: *Do you agree with her class?*

Learners: *Yes.*

Themba: *So what we can say is that all the interior angles of a quadrilateral add up to 360^0. The sum of them will give you 360^0.*

In the above conversation, Themba eventually helped learners to come to the generalization that the sum of the interior angles of a quadrilateral is 360^0 using the Figure 5.19 he had drawn on chalkboard. However, he split two opposite angles of a square into equal halves resulting to 45^0 each. I noticed that at no point did he identify his shape as a square, but by drawing in the diagonal in that way, the assumption was that the figure was a square. Hence he only considered the special case where all the angles of the triangle could be identified and it was easier to add them up. He did not refer to the case of a quadrilateral which is not a square, although the learners in their practical activity worked with quadrilaterals that were not squares. His approach may have led some learners to assume that in any quadrilateral the diagonal cuts the shape into two identical isosceles right-angled triangles since this was the example he demonstrated. Also, what I observed was that whenever Themba paused a question, learners would shout an answer but he would insist that they put up their hands. He would finally point at a learner whose hand was up.

The next activities that learners were engaged in was finding missing angles in some quadrilaterals. Themba drew a shape on grid board (see Figure 5.20) and told learners that they should work out the problem together. He then conducted a question-and-answer discussion whilst learners were seated in their groups.

Figure 5.20: Problem to be worked out by whole class

Themba asked learners the question: What should be done in the diagram in order to find angle *b*? Again learners shouted their responses but he reminded them to put up their hands. He pointed at one of the learners and she said: *You add all the numbers inside the shape*. Themba hurriedly wrote the equation $b + 110^0 + 70^0 + 70^0 = 360^0$ on grid board. He told learners that you add all the

numbers on the left and subtract the sum from 360^0. Below is his working to finding the value of *b*.

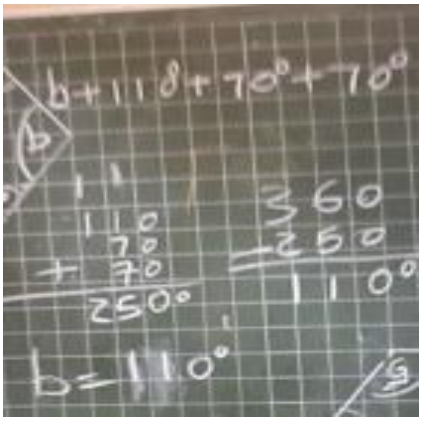


Figure 5.21: Themba explaining how to find the missing angle

As Themba was explaining what to do when finding *b*, he would translate it into writing on the grid board. On the other hand the learners were watching and giving him short responses for example when adding and subtracting.

Themba drew another diagram on the grid board with an unknown interior angle *G*. This time he asked learners to work in their small groups when finding the value of G.

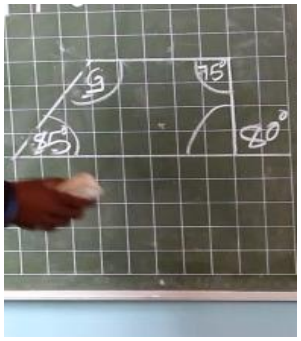


Figure 5.22: Problem to be worked out by learners in small groups

Themba walked around class from one group to another observing what learners were doing. I observed that they were discussing the problem but struggling to find its solution. Themba did not attempt to help learners, let alone asking them a few questions to guide them. Seeing that they had a problem finding angle G, he went upfront and started explaining how to go about finding G.

Themba: *Before you try to find G, what is it that you must first get?*

There was no response from learners.

Themba: *A straight angle is how many degrees?* [Pointing at the straight line with 80^0].
Learners: 180^0 [in chorus].

He then told them that they must first find the angle next to 80^0 on the straight line hence it would be easy for them to get G. After making the clarification to the whole class he went to the groups to check their work. He spotted a group that still had a problem in finding G. Themba stood next to the group. He asked them the following question.

Themba: *A straight angle is how many degrees?*

There was no response. He decided to go to the grid board and asked the group the same question pointing at the unknown interior angle of the quadrilateral (Figure 5.23), which we will call A_1, for the purpose of this discussion. We then refer to the 80° angle as A_2.

Figure 5.23: Themba explaining to a group how to find interior angle A_1

Themba: *A straight angle is how many degrees?*

A group member from one of the groups mentioned that it was 180^0.

Themba:……*and the outside angle is how many degrees?*

The same group member said that it was 80^0.

Themba:……. *So a straight angle is that angle plus 80^0. What is the inside angle? Then get the inside angle.*

He immediately left the group and proceeded to another. Again, that group was struggling to get the value of G. He checked their work and said. "This one is outside and this one inside" [Pointing at the 80^0 and the unknown angle in their diagram]. Themba went to the grid board, pointed at the 80^0.

Themba: *Hey* [mentioned student by name] *you can't put 80^0 inside because it is outside. So you have to get the inside. Sifuna* [meaning…we want... in vernacular] *interior angle.*

The student in the group was marking the interior angle (A_1) as 80°, taking it as equal to the angle it was adjacent to (A_2) and not as supplementary to A_2 . To calculate A_1, she needed to subtract A_2 (80°) from 180^0. Themba kept on asking the same student in the group. Eventually he went to another group. Again in the new group he talked about interior and outside angles of the quadrilateral he had drawn on the grid board. As he was going around he was checking for a group with a correct solution. He even asked if there is any group with a correct solution of the problem.

Themba:……..*Let me see those who have got it. Who has got it correct?*

For those groups whose solutions were wrong, he would indeed attempt to help them by giving explanations. At some point he would draw the quadrilateral and start explaining to the group how to get the unknown angle in the straight line.

Figure 5.24: Themba explaining to a group of learners how to find an unknown angle in a straight line

In this activity learners were struggling to get the unknown interior angle (A_1) in the straight line not necessarily the interior angle G, of the quadrilateral. They would take the exterior angle (A_2) as equal to A_1 which was a misconception arising from the learners' struggle to see the angle A_1 simultaneously as being part of two different figures. They found it difficult to see that A_1 formed part of the quadrilateral and at the same time A_1 and A_2 were two angles that formed the straight line. Themba tried to draw these two parts separately here. The property that the A_1 is supplementary to A_2 arises because of the straight line condition.

Themba then thanked the learners for doing the work and went straight to the chalk board and started conducting a whole class discussion. Learners remained in their groups. He drew the diagram below (Figure 5.25) on chalkboard and marked the angle 30^0 and the arc for the extended straight line. Themba seemed to have identified the underlying misconception. In trying to address this widely held misconception, he has separated out a straight line made up of two adjacent angles.

Figure 5.25 Themba addressing a misconception to the whole class

The following question- and-answer exchange ensued.

Themba: *A straight angle is how many degrees?*

Learners: *One hundred and eighty degrees.* [In chorus*]*

Themba: *What types of angles are 30^0 and the straight line? What is a straight angle?*

Learners: *A straight angle is less than a reflex angle but greater than an obtuse angle.*

Themba: *And is how many degrees?*

Learners: *One hundred and eighty degrees.*

Themba: *If here there is 30^0, how are you going to get this angle* [pointing at the exterior angle of the triangle that completes the straight line]

Learners: [Silence]

Themba then started working out the problem on chalkboard whilst learners were watching from their groups. He subtracted 30^0 from 180^0 got 150^0 and labelled it in the diagram.

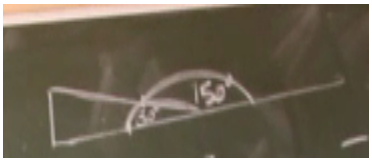


Figure 5.26: Themba working out a problem whilst learners were watching in an attempt to address a misconception

Themba quickly asked learners; "*150^0 plus 30^0 will give you how many degrees?"* He wrote the addition problem on chalkboard and worked it out.

Themba: *And is giving me how many degrees?*

Learners: *One hundred and eighty degrees* [in chorus].

Having established that you can calculate the remaining angle by subtracting the one value from 180, he then went back to the discussion of the original problem, that of calculating G (Figure 5.21).

Themba: *Then here … it comes a problem and they say find G. Wena* [you… in vernacular] *you know this angle is 85^0 and this one is 75^0 but you don't know this one* [pointing at the interior angle (not G)] *and you are given this one that it is 80^0. What am I going to do?*

There was no response from the learners. They mumbled without giving him any feedback. He then concentrated on the straight angle with the angle 80^0.

Themba: *And if you mark the whole angle what will it give you* [marking the straight angle that includes 80^0]. *What angle will be this one? What is the angle?*

Learners: *A straight angle.*

Themba: *And a straight angle is how many degrees?*

Learners: *One hundred and eighty degrees.*

Themba: *Then I must first get the inside one. I know that a straight angle is 180^0; the outside angle is 80^0, how many degrees is the inside angle?*

Learners: [Silence] ……*one hundred degrees* [few learners].

Themba wrote the 100^0 on the diagram.

Themba: *If I know this … it is 100^0, 75^0, 85^0* [pointing at the interior angles] *it should be easy for me to get G. And how many degrees is your G?*

Here, he wanted the groups to give him the value of angle G they got in the groups. Only three groups mentioned that they got 100^0 and the others did not give him their values of G. They were just quiet. And he remarked: *Let us find*

out if your G was correct. He led them to add the 100^0, 75^0, and 85^0 vertically on chalkboard to obtain 260^0.

Themba: *Then what did you do?*

Some learners raised their hands from the groups. Themba pointed to one of the learners and her response was "360^0 minus 260^0." The diagram below shows how he worked out G on the chalkboard.

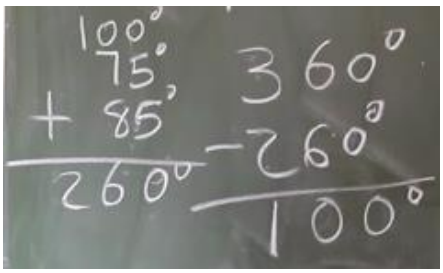


Figure 5.27: Themba demonstrating how to find interior angle G

Themba confirmed with the learners that the value of G is 100^0. He then helped them to summarise the lesson.

Themba: *So what can you say about the interior angles of quadrilaterals?*

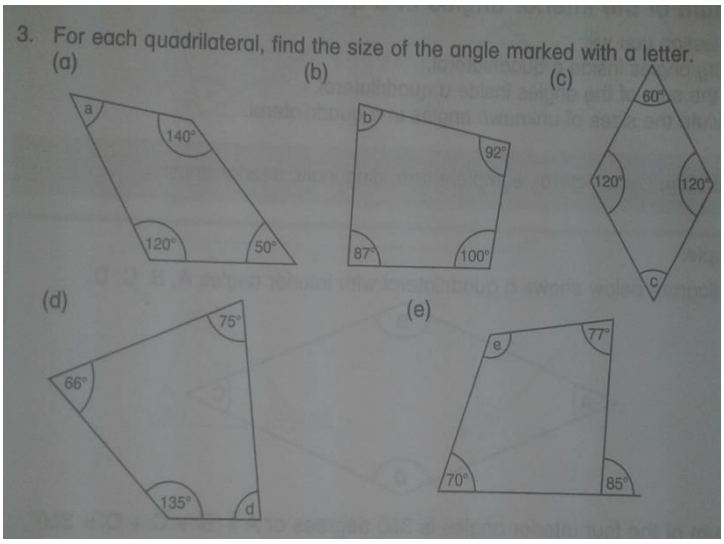
He did not wait for learners to respond and he said '*all quadrilaterals they add up to how many degrees?'*

Learners: *Three hundred and sixty degrees* [in a chorus].

Themba: *Is there anybody with a question or did anyone not understand something. You can ask me anything you want.*

There were no questions. Learners said they understood everything. He asked leave their groups and go to their normal seats.

Themba then gave learners a class exercise. He asked them to turn to page 158 in their Pupils' Book and to answer Question 3; a, b, c, d and e individually in their exercise books.



Picture 5.28: Class exercise taken from Pupils' Book

Indeed learners worked out the problems as individuals in their exercise books. Themba moved around marking each of the learners' work. He moved hurriedly from one learner to the other checking their work and marking it using a red pen. There were minimal explanations to learners who could not get the problems correctly. His explanations basically focused on the correct method of getting a correct solution of the problem if the learner did not get it right. Themba suddenly asked everyone to stop writing. He asked learners to summarise the lesson about the sum of interior angles of a quadrilateral.

Themba: *Thank you very much. Pens down please. Who can summarise for us? What can you say about the interior angles of a quadrilateral? The sum of the interior angles of a quadrilateral.*

And one learner quickly responded without being pointed by Themba to do so.

Learner: *The sum of interior angles of a quadrilateral always add up to* 360^0.

Themba reiterated the learners' response and commended him for his good summary. He then asked them to finish the rest of the classwork as homework and told them to submit it to him the following morning. When Themba's time had elapsed, learners were still attempting to answer Question 3. (a) of the class exercise. Themba's lesson lasted for about 60 minutes.

5.3.4 Interview with Themba

In this section, I offer an analysis of Themba's interview transcript about his philosophy of teaching and also his learning practices.

5.3.4.1 The philosophy of teaching

After I had observed Themba's lesson whose topic was about **the sum of the interior angles of a quadrilateral,** I interviewed him about the same lesson on the same day. My interview with him focused mainly on the constructs of learner-centred approaches and meaningful learning. In this section I will dwell on learner-centred teaching with regards to both my interview with him and the lesson that I observed him teaching.

I first wanted to find out about the methods of teaching he was taught at college. He submitted that as far as he remembered he was taught how to use the discovery and the discussion methods. However, I did not ask him about other teaching methods besides the two instead I tried to find out whether his lecturers ever taught him about learner-centred teaching. His response was that indeed they taught him learner-centred teaching at college. The following is what transpired in my conversation with him.

Themba: *Yes, especially when you are doing some topics in Math. I like it so much even here in school. Because even here at school I am still using it where it is supposed to be used.*

Interviewer: *So in other words you were taught learner-centred teaching at college.*

Themba: *Yes.*

Themba acknowledged that he learnt about learner-centred teaching at college. He seemed to like it and lamented that he normally used it in his teaching. In

his lesson, Themba had two main activities in which he engaged his learners. And in each activity he organized learners into small groups which was one of the strategies of facilitating learner-centred teaching. I observed that in the first activity one learner was actively participating whilst the others were quiet and watching him as he worked on the problem (Figure 5.16). Whilst the learners were working on the task, Themba never attempted to encourage group discussion among the groups. He moved from one group to the other telling them to work fast. Themba never pushed learners for diverse thinking. For example when he asked them to draw a diagonal on a quadrilateral, they drew only one diagonal (Figure 5.17) yet any quadrilateral had two diagonals. He seemed to be content with only one diagonal drawn by the volunteer learner. When asked to give a description of learner-centred teaching he said that:

Themba: *According to my understanding learner-centred teaching: the learners are the ones who are finding facts and the teacher is just coming with the topic and with questions just to guide them but the learners are the ones who are learning themselves the concepts in everything in Mathematics. Just guide them with the questions and assist them; then and there but they are the ones who are doing everything.*

Indeed when he introduced the lesson Themba would always ask learners questions whilst they were in normal class arrangement and even when they were sitting in groups. During the first activity he guided them to make a generalization that the sum of interior angles of a quadrilateral is 360^0. In that activity Themba dominated the discussion. Here, he was asking them questions expecting quick answers. His conception of learner-centred teaching seemed to be in line with his teaching practices. He believed that in learner-centred teaching, the teacher must lead the discussions and ask learners questions to arrive at the answer.

However, during the second activity there was discussion among learners. Here, Themba also made an attempt to give explanations to the groups that were struggling but that was minimal. In fact, he would quickly start explaining to entire class on the problem that the group was struggling with. He would

conduct a question and answer discussion with the whole class and dominating the discussion in the process.

Themba was asked on the teaching method that he used when teaching the lesson and he responded by saying that it was demonstration. Furthermore, he was asked why he used the demonstration method and whether his method had any connection with learner-centred teaching.

Themba: *I used to demonstrate some concepts. This is the way you are supposed to do it. I have to demonstrate it and then they are the ones who have to find the answers for themselves*.

Interviewer: *Does this method have any connection with learner-centred teaching?*

Themba: *It has a lot because I just think I must ask them questions and guide them then they themselves are going to find it how it is calculated.*

According to Themba, demonstration was a learner-centred teaching method because it allowed him to guide the learners as they attempt to find solutions of a problem. He believed that in learner-centred teaching, the teacher must guide learners as they work on a task. Indeed when showing them that the sum of interior angles of a quadrilateral is 360^0 as in Figure 5.19, he dominated the discussions guiding them to make a generalization. But the learners never found the answer for themselves as he pointed out in my interview with him. Again he guided learners to find the value of *b* in Figures 5.20 and 5.21 without giving them an opportunity to find the answer for themselves. Themba also mentioned that he used learner-centred teaching most of the time.

In my interview with Themba, I also asked him about the problems that he encountered when using learner-centred teaching. He pointed out that learner-centred teaching is time exhaustive because he had to go back and help learners with conceptual difficulties. Themba also mentioned that the large number of learners was a challenge to him since he had to pay attention to every learner.

From my interview with Themba I noticed that he believed in learner-centred teaching. However, his actual teaching methods did not model a learner-centred approach. In his teaching, he used the demonstration method which involved demonstrating an example while his learners watched him. According to Themba, the demonstration method is consistent with learner-centred teaching because the teacher had to guide the learners. Furthermore, his question-and-answer technique was used to get the specific answer that he was looking for. Although he made the effort to arrange his learners in groups, he did not use this arrangement to encourage learner engagements within the groups. He continued teaching to them and dominated the discussions whilst learners were in their small groups. When he asked them to work on problems in his first activity, the learners worked as individuals within their groups and did not communicate with one another in their groups. Whilst in the second activity there was discussion among learners.

5.3.4.2 Learning practices

In my interview with Themba I also wanted to find out about his conception about meaningful learning in the teaching of Mathematics. I asked him what he understood about meaningful learning. And he replied by saying that:

Themba: *It is a learning in which we come up with good sense in what you are teaching. Because in Grade 6, I think the concepts that I was teaching was in geometry, so the learners they have to know these things in real life. That's why I think it is meaningful learning.*

Themba believes that Mathematics teaching must be sense making. In short, when teaching any Mathematics topic, it must make sense to the learners. In his teaching, Themba's emphasis was explaining concepts that he thought would help learners to understand ***the sum of the interior angles of a quadrilateral*** which was the topic for the day. He made sure that his learners understood "quadrilateral, sum, interior angle" before teaching them the main topic. Though Themba did not mention any real life application of his topic but he believed that in meaningful learning Mathematics topics must be connected to

real life. I further asked him what he meant about real life and he responded by saying that:

I said geometry sir, so now we are calculating angles this thing is meaningful in real life because he does it in Primary level. When they grow up everybody is not going to be a doctor or a lawyer. So when you are dealing with angles some will be a builder or carpenter so we are dealing with angles, dealing with calculations. It is meaningful learning because we face these things in the outside world.

From the above extract, it emerged that Themba connected meaningful learning with learners' future careers. His notion about meaningful learning is that Mathematics concepts should be linked with everyday life. However, Themba never mentioned the connection between the topic and everyday life experiences in his teaching. He made explanations of some concepts and explained how to find missing interior angles of quadrilaterals (see Figures 5.21 and 5.23). Basically Themba believed that if learners could apply the concepts then there was meaningful learning.

Themba was also asked about whether he knew anything about concrete materials in the teaching of Mathematics and he responded by saying that he knew what they were. I then asked him the frequency at which he used concrete materials when teaching Mathematics.

Interviewer: *Do you actually use concrete material when you are teaching your Math lessons?*
Themba: *I use them.*
Interviewer: *How often do you use them?*
Themba: *Most of the time.*

In his lesson Themba brought a chart with pre-drawn quadrilaterals (Figure 5.14). He used it to help learners to mark interior angles of the quadrilaterals. In that way he was assisting them to connect an idea of an interior angle with interior angles of quadrilaterals. His intention of using the chart was to facilitate

conceptual understanding. I further wanted him to tell me more about concrete materials by asking him the following question.

Interviewer: *Why do you use concrete materials?*

Themba: *It brings reality to the learners. My topic was about quadrilaterals in the previous class I was also teaching them. They know what a quadrilateral is. They know a square, a parallelogram and a kite. They know and it makes sense.*

Themba seemed to have an understanding of concrete materials as he mentioned that they bring reality to learners. But in practice he believed that the shapes he had drawn on his chart were concrete materials because he had taught his learners about them the previous day hence they knew what quadrilaterals were. His theoretical understanding of concrete materials was in conflict with his practical aspect of what concrete materials were.

According to Ausubel (1962), in any educational classroom setting, meaningful learning will take place when there are connections between learner's prior knowledge and new knowledge. In my interview with Themba I asked him about his knowledge about prior knowledge.

Interviewer: *Do you know anything about prior knowledge in the teaching of Mathematics? What is prior knowledge?*

Themba: *According to my understanding it is the information they have before they get into the new concepts. The one that they have based on mapping. Information they had before I gave them the new information.*

From the above conversation with Themba it can be pointed out that Themba had a firm understanding of prior knowledge. His response about it is in line with its literature definition. Indeed in his introduction he confirmed the idea of prior knowledge with his learners. He asked them the definition of a 'quadrilateral', the meaning of 'sum', and the meaning of 'interior angles'. And all these have a fundamental bearing on learners' understanding of the new topic. Here, he was attempting to link what the learners knew which was related to the idea of "The sum of interior angles of a quadrilateral". However, during

the interview he did not mention the fact that linking learners' prior ideas and the new idea constitute meaningful learning. I also wanted to find out more about Themba's understanding of meaningful learning. Below is my conversation with him.

Interviewer: *Why do you use prior knowledge when teaching mathematics?*

Themba: *I am just stimulating their thoughts. So that they easily link the old concepts with the new concepts. It is easy for them.*

Interviewer: *How often do you incorporate prior knowledge when teaching Mathematics? Do you always use prior knowledge?*

Themba: *I used it so many times sir. I use them as my introduction most of the time so that they link and so it's easy for them. It is easy to apply to their concepts.*

The above conversation confirms his position about prior knowledge in his teaching of Mathematics. He articulated it very well and asserted that he used it often. Of course, even when learners had difficulty with a task, he would use their prior ideas that would help them solve the current problem. His teaching also demonstrated that he valued the role of prior knowledge as shown when he reminded the learners about the adjacent angles being supplementary when they formed a line as in Figure 5.25. The learners needed to apply that known result to the new situation of working with interior angles of quadrilaterals when finding the value of *G* in Figure 5.23. That in itself was prior knowledge to finding the interior angel of the quadrilateral when the other angle in the straight line was known.

Despite Themba's articulation of prior knowledge, he never related it to meaningful learning as articulated by Ausubel. In my interview with him he associated meaningful learning with connecting Mathematics to real life situations. Basically, his conceptual understanding of meaningful learning never connected with the view of linking learner's prior knowledge to existing knowledge.

5.4 SABELO'S TEACHING

In this section, I report and analyse the narrative account of Sabelo's video clip of the observed lesson. I also made an analysis of his interview transcript of the lesson that I observed him teaching.

5.4.1 Background

Sabelo was a male Primary school teacher. After completing O level (Form 5), Sabelo enrolled for a course in Information Technology but did not complete it. His highest academic qualification was a Primary Teachers Diploma. In his current school, Sabelo taught Mathematics, Science and Religious Education in Grade 6. However, he had not taught in any other school apart from his current school. Sabelo acknowledged that he never wanted to be a teacher after completing school. He said he wanted to do Chemical Engineering because he was doing Science subjects in Form 5.

For his tertiary studies, Sabelo specialised in Mathematics and Science. In his second and third years of study, he did teaching practicum for a period of six weeks each. He has been teaching at Primary School level for two years.

5.4.2 The research school

Sabelo teaches in a public school. The school is located two kilometres south of the main town, Nhlangano in the Shiselweni region of Eswatini. His school offers Grade 1 to 7 and is a feeder school for a neighbouring High school which has Grade 8 to Grade 12. The medium of instruction in Sabelo's school is English as per the Eswatini Education Sector Policy of 2011. On the other hand the learners' first language in Sabelo's school is SiSwati.

5.4.3 Sabelo's lesson

Sabelo was observed teaching a Grade 6 Mathematics class. This was a mixed class of boys and girls. There were 16 girls and 17 boys in his class making a total of 33 learners. Sabelo let me in and showed me a seat with a chair and a desk at the back of the class. The seat was strategically positioned such that I could see all the learners. He then introduced my camera man and myself to the learners and told them that we had come to observe and video tape them whilst

he was teaching as agreed earlier on in the letters of consent. He told them that the aim of the exercise was for research purposes only. Furthermore, learners were told that the researcher would observe anonymity and confidentiality after the data had been collected.

Sabelo's lesson topic was **Problem solving: Using Problem-Solving Model**. Its objective was: *To solve word problems using the problem-solving model* as he had stated it in his lesson Preparation Book. In Eswatini Primary schools, the problem-solving model is taught alongside the Mathematics content. The model consisted of the following steps:

- *Understanding the problem;*
- *Interpreting the problem;*
- *Deciding on a method, and*
- *Reflecting on the answer*

The above steps are first taught as separate lesson topics in the lower Grades (Grade 1 to 5). In Grade 6 learners start applying the model in solving Mathematics problems.

Sabelo started off his lesson by first asking his learners to sit in groups of four or five. A total of seven groups were formed by the learners. The groups were not pre-determined but learners had to choose their own group members when forming them. There was noise as the learners tried to choose their partners and rearranged themselves into small groups. Sabelo waited for them to settle down. Eventually they sat in their small groups facing each other waiting for the next instruction from him. Sabelo then started narrating a story to the learners of a certain man who was a gardener. In Table 5.2 below is Sabelo's story that he narrated to the learners.

Table 5.2 Story narrated to learners by Sabelo about a man who was a gardener

This man was a gardener taking care of his yard, home and garden. So his garden was ever green and that made him to love the garden. His yard was ever green. One day he woke up in the morning and rushed to the garden. From the house to the garden he had to pass through the yard. Whilst walking through the yard, he found a very big snake. The man asked himself, what would be his solution to get to the garden now that there was a snake? So we know that a snake is very dangerous. Then that had to be a problem.

After finishing narrating the story to the learners, Sabelo started asking learners questions about the man's predicament. He said, that man was facing a problem of getting into his garden and started asking them question as they sat in their small groups.

Sabelo: *What was the man's problem now? What was his problem class?*

Sabelo expected learners to answer his question as individuals in their groups. He looked around for learners who had raised their hands ready to respond to his question.

Sabelo: *Lift up your hands and you tell us what you think was the man's problem?*

There was silence. Learners just stared at him without any response. He asked the same question. Again none of the learners responded to the question. Sabelo told them the same story briefly for the second time then paused the same question to his learners.

Sabelo: *What is the problem then, this man is facing?* [There was silence].

Seeing that the learners had difficulty responding to his question, Sabelo decided to tell them the problem the man was facing as in the excerpt below.

Sabelo: *The problem the man is facing is the snake because we all know that a snake is dangerous. So the man is now having a problem.*

So life is full of many problems. Every problem is a thing to be solved.

In the above excerpt Sabelo was attempting to answer the question with a bit of elaboration. He told the learners that in Grades 3 and 4 they did problem-solving because every problem we face has to be solved. He said they had got to be able to solve problems in real life. Now concerning the man's problem, he told them that there could be many ways of solving the man's problem. Learners then started to raise their hands and gave him their solutions to the problem the man was facing. Sabelo listed all the learners' responses on the chalked board as shown below.

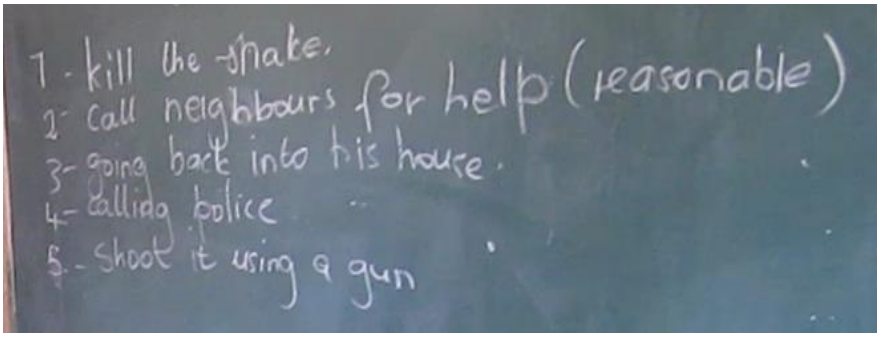


Figure 5.29: Possible solutions of solving the man's problem

Sabelo encouraged learners to justify their responses according to whether they were reasonable or not reasonable. The learners gave him four solutions to the man's problem. He then added another solution himself which was '*Shoot the snake using a gun'*. Eventually, he told learners that having looked at the man's problem; he wanted them to see how every mathematical problem written in words could be solved. He told them that:

The problem in Mathematics is recognized by a question mark at the end. The problem is just a question. You are given a story and a question. I want to give you a job to do in your groups.

Sabelo gave each group a problem to discuss and report to the whole class. Below are the problems which he verbally communicated to the learners.

- *How do you identify a problem?*
- *How do you interpret a problem?*

- *How to decide on a mathematical method of solving a particular problem? and*
- *How can we justify our answer or how can we make our answer reasonable?*

Seemingly his problems were a paraphrase of the steps of Polya's (1945) stages for solving a Mathematical problem. But here, he did not want them to apply the stages to any Mathematical problem. Instead he wanted learners to discuss each of the stages so that he would be able to find out whether they understand them (stages). Some problems were repeated among the groups because there were more than four groups. He emphasised that learners should discuss the problems in their groups and thereafter report to the rest of the class. Learners were given two minutes to do the exercise of which according to my observation that time was not enough for them to complete the given exercise. What should be noted here is that Sabelo wanted learners to understand each of Polya's stages of problem-solving without necessarily applying the stages to a task at once.

However, after Sabelo had given learners to do the tasks, he went on to explain each of stages of the problem-solving model to them without allowing them time to do the discussions. He told learners that in Mathematics a short method of solving a problem is called problem-solving model. He mentioned to them that the model includes the problems that he had given them to do. Sabelo went to the chalk board to list the stages of the problem-solving model as can be seen in Figure 5.30 below.

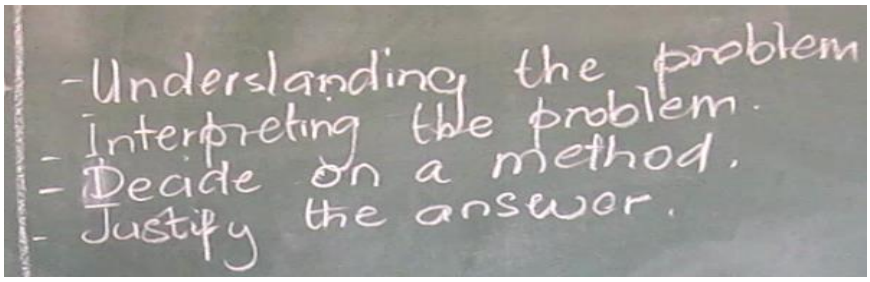


Figure 5.30: Stages of problem-solving model

He then started explaining each of the stages of the model to the learners. After giving the explanation, he requested each group to explain the problem he had given to them to discuss in their small groups.

What I noted here was that learners neither discussed the problem given to them nor reported their findings to the class. Sabelo started pointing at each of the groups in sought for an explanation and a learner from each group would respond. As the learners struggled to respond, he would say "I said discuss the problem". Sabelo would then refine learners' responses and give a further explanation. He went on to point to another group seeking for an explanation of the given problem. Seeing that learners were not giving him satisfactory responses, Sabelo decided to conduct a question and answer session that was open to the whole class rather than requesting a group or groups to respond. Learners from different groups responded after he had pointed at them. He went on to explain to the learners the stages in detail.

After he had finished discussing all the stages with the learners, Sabelo went to the chalk board and wrote the following problem.

Wamkelwe bought 25 apples at E1.20 each. He was then given a discount of E2.00. How much did he pay for the apples?

He asked learners to solve the problem as groups and gave them ten minutes to work out the problem. He told them that they should discuss it and only one person in each group should write the solution of the problem in an exercise book. He emphasised that everyone should be part of the discussion and that no one should be quiet. In one of the groups, one learner was observed solving the problem whilst the group members were watching him as can be seen in the picture below. There was no verbal communication among the group members.

Figure 5.31: A learner solving a problem whilst the other learners are watching

However, in some groups perhaps learners were seen discussing how to find the solution of the problem. Sabelo walked around watching learners as they engaged on the task in their groups. He never made any intervention. At one point he stood quietly next to a group and watched them (see Figure 5.32 below) and only one member of the group was working on the problem.

Figure 5.32: Sabelo watching the groups without making any interference

He mentioned to them that he would like to *see understanding, how you to interpret it, see even the method, how you get the answer and we would like to see how you justify the answer*. Here, he was making an attempt to emphasise to them about the stages of the problem-solving model. After the elapse of the 10 minutes, he asked each group's representative to come up front and make a presentation of his/her group's solution.

Sabelo: *Show us how you solved the problem. Choose one person. How can you solve that problem?* [pointing to the problem on chalk board].

Below (Table 5.3) is one possible way of presenting the solution to the whole class.

Table 5.3 Possible way of using the problem-solving model to solve the problem

Identifying the question and given facts
Question $\Rightarrow$ *How much did he pay?*
Facts $\Rightarrow$ *Bought 25 apples*
Each apple cost E1.20
Total amount paid was reduced by E2.00
Interpreting the problem
How much did Wamkelwe pay for 25 apples at E1.20 each with a reduction of E2.00
Deciding on a method
Find total amount paid for 25 apples at E1.20 per apple and subtract E2.00
Finding solution
Total amount = 25 x E1.20 = E30.00
Amount paid after discount = E30.00 – E2.00= E28.00
Justifying the answer
E28.00 is a reasonable answer and is a little less than E30.00 because there was discount.

Three group representatives came to the chalk board. As they attempted to write on chalk board, Sabelo stopped them. He instructed them that only one person should write on the chalk board and should talk to the whole class.

Sabelo: *You speak with us Tom.* [Referring to one of the group representatives].

However, Tom who was representing Group 2 simply wrote their findings on the chalk board without necessarily talking to the class. He wrote **25 + 1.20**

vertically and wrote the answer of E26.20. Although the sum of 25 and 1.20 is 26.20, the calculation was not related to a correct solution of the problem. Firstly, Tom wrote the answer to the sum as E26.20, which is E26.20. Tom's calculation involved adding the number of apples to the amount of Emalengeni getting an answer in terms of Emalnegeni which was not an appropriate method. Sabelo never made any feedback or intervention about their solution. The only question he asked them was whether they were done with their presentation and they responded to the affirmative. He quickly asked the next group to present their findings.

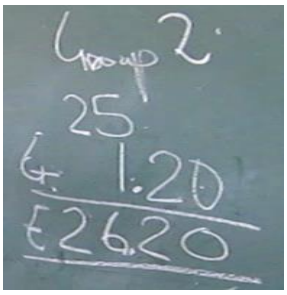


Figure 5.33: Group 2's presentation of their solution to the problem

In Figure 5.33 above is Group 2's solution which was inappropriate because they used a wrong method. Their answer was in currency form when in actual fact they added the quantity of apples to the amount of each apple which is inappropriate.

A representative, Beauty, from Group 3 came upfront to the chalk board. She wrote **1.2 x 25** vertically and started to conduct a question and answer with the whole class just like in a teacher dominated lesson. Some learners raised their hands up and she pointed at them to give responses. They helped her to arrive at the product which was E30.00. She then wrote the subtraction sentence E30.00 – E2.00 vertically and again started to conduct a question and answer. The final answer she arrived at with the assistance of her peers was E28.00 which was a correct solution to the problem. Basically she was supposed to present her group's findings to the whole class but she worked out the problem anew with the assistance of her classmates. However, Sabelo stood at the back and watched the proceedings. He never reminded her that she should be presenting her group's findings to the whole class. His only reaction was to remind her about the units of money.

The next group that made a presentation was Group 1. They were represented by Peter. Just like Group 2, Peter started off working out the multiplication sentence **2.00 x 25** without talking to anyone. Hence Sabelo reminded him to talk the class.

Sabelo: *You are speaking with us. We want to be part of what you are doing.*

Indeed the boy started involving the whole class when finding the second partial product of 200 x 25. That group's solution was 50.00 which was mathematically correct as per their computation.

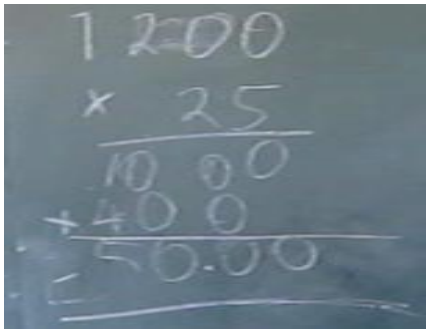


Figure 5.34: Group 1's presentation of their solution to the problem

However, the above solution was not a correct solution of the problem because the method they set out was inappropriate. The operation used in this calculation involved multiplying the number of apples by the discount that was given and not by the cost of each apple.

After Group 1 had finished with their presentation, Group 4 took over. They were represented by Busi. She wrote the multiplication sentence **1.20 x 25** vertically and started conducting a question and answer session with the whole class. Sabelo interjected and told the class that one has to lift up his/her hand in order to be pointed at. After getting E30.00 as her product, she did not ask her classmates of the next step. Instead she wrote the addition sentence 2 + 30.00 vertically. Her classmates helped her to get E32.00 but as she worked out the problem she kept on referring to her note book.

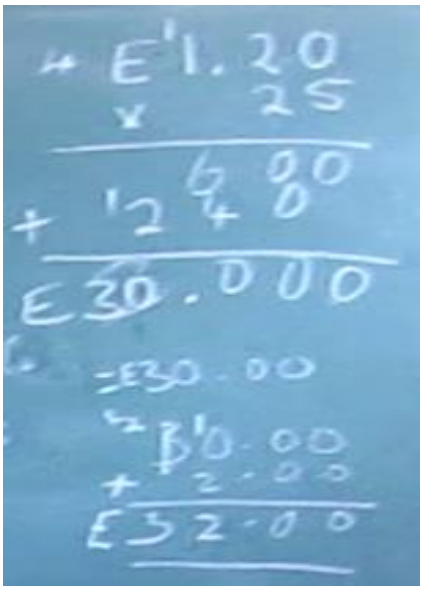


Figure 5.35: Group 4's presentation of their solution to the problem

Similarly to the cases of Tom and Peter her answer to the calculation was mathematically correct but it was not a correct solution for the problem. Her operation involved adding the total cost of apples to the discount instead of subtracting the discount from the cost.

Group 5 was next to make a presentation. A girl who represented this group started off by writing E1.20 x 25 vertically. She then conducted a question and answer arriving at E30.00. And she did mention that after getting the E30.00, you subtract the discount. She then wrote the subtraction sentence 30.00 – 2.00 vertically, carried out the subtraction with the help of the other learners and got E28.00 which was indeed a correct solution to the problem.

Group 6's representative Muzi, came to the chalk board and wrote E1.20 x 25 vertically. Just like the other groups' representatives he conducted a question and answer to arrive at E30.00. With the help of the other learners he carried out the subtraction E30.00 – 2.00 vertically to get E28.00. Group 7's presentation was the same as that of Group 6 which was presented by Betty.

What I noted here was that only three groups had incorrect solutions to the problem. After all the groups had done their presentations, Sabelo started making comments of their solutions on the chalk board. He identified learners' wrong solutions but never elaborated why the solutions were wrong. His

general remark was that the groups who got wrong answers did not interpret the problem correctly. Furthermore, he said that if the solution was wrong it was then wrong and if it was correct it was correct. He did not attempt to identify learners' difficulties or misconceptions from what they had presented, let alone making reference to the stages of the problem-solving model that learners ought to have followed when attempting to solve the problem.

Sabelo eventually asked learners to do the problem together and led them to a question and answer session whilst they were still in their working small groups. First he wrote E1.20 x 25 vertically and led the discussion to get E30.00. Without asking learners on the next step, Sabelo subtracted E2.00 from E30.00 using the vertical layout to get E28.00. It is then that he asked learners whether the answer was reasonable or not. One of the learners mentioned that it was reasonable because it was less than E30.00 and did not elaborate. I also observed that Sabelo did not make reference to all the Stages of problem-solving he had discussed with learners earlier on. He made the emphasis that learners should always check if their answers were correct.

Sabelo: *Check if your answer is correct or wrong. It may be slightly wrong but let it not be just obviously wrong. Check it* [making emphasis].

In the above extract, seemingly Sabelo was trying to point out that they should justify their answers. After explaining the solution of the problem, Sabelo asked them if they had questions. None of the learners asked him a question or even made a comment on what they had done together. He then asked them to go back to their normal seating positions. Sabelo asked learners to answer Question 2 in their exercise books (below) from the Pupils' Book on page 159.

Question 2: *80 passengers boarded a bus from Manzini to Siteki. 15 passengers got off at Matsetsa and paid E8.50 each. How much did all 80 passengers pay in total if the trip to Siteki is E10 per passenger?*

All the learners started to do the problems individually in their exercise books. Sabelo went around class looking for learners who had finished it. Indeed some learners indicated that they had finished by a show of hands. He marked their

work and gave explanations to those who had difficulties. After Sabelo had marked for two learners, he made the following remark to the entire class:

Make sure you read the question and you understand it. It's very important that you understand the story very clearly so you know what is going on. And most people fail to answer a problem not because they are not able but because they did not understand it. They just read through the problem without understanding it.

In the above extract, Sabelo was trying to emphasize that learners should read a problem with understanding. He went on to read the problem aloud for learners with some few clarifications. Before he could start marking learners' work, his time elapsed. He stopped them from going on working on the problem and told them that they should finish the problem at home. Learners were also given the rest of the exercise in their Pupil's Book as homework. The lesson took about 60 minutes duration time.

5.4.4 Interview with Sabelo

In this section, I present an analysis of Sabelo's interview transcript about his philosophy of teaching and learning practices.

5.4.4.1 The philosophy of teaching

In my attempt to elicit Sabelo's teaching philosophy I asked him about the teaching methods he encountered at college. The following conversation ensued with him:

Interviewer: *Now I would like to know about the courses on how to teach that you had at the college. What courses did you do on how to teach?*

Sabelo: *The first time I was introduced into teaching using the learner-centred approach not teacher-centred approach. I think that is the one.*

From the above conversation it emerged that Sabelo was taught learner-centred teaching whilst at college. I then asked him to give me an instance when his lecturers used the learner-centred teaching.

Interviewer: Y*ou describe an example for me when one of your lecturers at college talked about learner-centred teaching.*

Sabelo: *I will pick one I remember most of the time when a child is fed with information the teacher is responsible when feeding the child with information. The child is easy to lose the information. When the child is doing the learning on his own it is hard to forget what he has done.*

In the above conversation, Sabelo seemed to be comparing teacher-centred teaching to learner-centred teaching. He acknowledged that learners do not forget information that was taught to them using learner-centred teaching hence he seemed to have an understanding of what this approach was.

Furthermore, the researcher asked Sabelo on the teaching methods that were used by his lecturers when he was still at college. And he responded by saying that:

Most of the time the lecturers will be doing the work.

When he says the lecturers will be doing the work, it seems he was referring to the lecture method of teaching. Hence, his submission was that he was often taught using the lecture method at college.

To find out more about Sabelo's teaching philosophy, I asked him to describe for me the meaning of learner-centred teaching. And this is how he responded to my question:

I think learner-centred teaching is when the teacher is not the master of the class. But the learners are given the opportunity just to learn from themselves and one another and learning from one another and learning by doing the learning by themselves than by being fed by the teacher. And the role of the teacher in learner-centred teaching is observing the learning and helping the learners to do their learning.

From his description of learner-centred, Sabelo seemed to have a right framework of what it was. He articulated it well. During his lesson he emphasised that learners should work in groups and report their findings. Right at the beginning of his lesson he asked them to form groups and whilst teaching he insisted that they should discuss the tasks in their groups. Despite his instruction, in some groups learners never discussed the tasks in their groups (for example Figure 5.31). In that group, members were observed watching one

particular learner solving the problem. When Sabelo went passed that group he never bothered himself to ask them why they were not discussing the problem. And he never bothered to get some explanations from the group members let alone from the learner who was working out the problem. But in one of his groups, there was some discussion of the task. Basically Sabelo did not make any intervention among the groups who were either having a learner working alone whilst other members were watching or that group whose members were discussing. But when I asked him about the role of the teacher in learner-centred he gave me the following response:

The role of the teacher in learner-centred teaching is observing the learning, guiding and helping the learners to do their learning.

In his description of learner-centred teaching, Sabelo also mentioned that the teacher was not the master of the learning process. However, he was seen dominating the class especially during his lesson introduction. That happened when groups could not give him any responses. Here, he started teaching whilst they were in their groups, giving them explanations. That was contrary to his assertion that the teacher is not the master of the teaching process in learner-centred practices.

During my interview with Sabelo, I further asked him about the teaching method he used when I observed his lesson.

Sabelo: *Mmm…. it was sort of learner-centred, I was giving the pupils some time to discuss as discussing will be helping each other. And others will see ways of solving particular problem.*

Though some aspect of his teaching was learner-centred but Sabelo would now and again use question and answer method especially when he wanted responses from the learners. Here, he wanted responses from individual learners whilst they were in their groups which were not a group effort. On another note, indeed Sabelo encouraged his learners to discuss during his lesson presentation. Furthermore, he emphasised that every learner should be part of the discussion and that no one should be quiet. Perhaps in some groups learners were not discussing the task. Sabelo seemed to acknowledge the value of learner-centred teaching but he would sometimes conduct a whole class session using a question

and answer method especially when he got inappropriate responses from the learners.

An interesting aspect of his lesson was when groups reported their solutions of the problem that he had given them. Instead of reporting what they found as a group, each group representative would write a mathematical sentence on chalkboard based on their interpretation of the problem and conducted a question and answer session using his/her peers to help him/her find the answer. The question and answer session was either on addition or subtraction or multiplication depending on how the group members interpreted the task. Sabelo supported the question and answer session that was conducted by the group's representative such that he told the other learners that they should not respond spontaneously but raise their hands. Sabelo's teaching seemed to be consisted with his belief that learners should be given some time to discuss a problem. According to him, their discussions helped each other to see how the task was solved hence he allowed them to do the discussions when they ought to be making presentations. When I asked him why he used the question and answer method in his lesson he said:

I just wanted to let them be part of speaking.

Thus, Sabelo believed that learner-centred teaching is learner-learner interaction throughout the lesson even when they had to do presentations. And during the interview he acknowledged that he normally used learner-centred teaching in most of his Mathematics lessons.

Sabelo also seemed to believe that he owned the Mathematics despite his earlier assertion during my interview with him that in learner-centred teaching the teacher was not the master of the class. After all the groups had done their presentations, he never gave learners a chance to debate the correctness of their peers' solutions. Sabelo did not moderate learners' inappropriate working and solutions by way of giving them immediate feedback. In that way the learners would be in a position to discover their mistakes and misconceptions. Instead he took control of the class, conducted a question and answer session in sought of the solution of the problem. That showed Sabelo's ownership of the content at the expense of the learners. However, dealing with learners' misconceptions

by asking them provoking questions based on their responses and giving them timeous feedback would place ownership of the content to them.

During my interview with him, I also wanted to know the challenges he encountered when using learner-centred teaching. He replied by saying that

My experience is that learner-centred approaches at times some lessons will demand materials that are sometimes then hard to get then you have to improvise at times. Most of the times it has not been that bad.

I noted that during his teaching, Sabelo never used any teaching material apart from chalk, chalk board duster and chalk board. He did not even make improvisation as he alluded above in my conversation with him.

From the foregoing, I noticed that Sabelo's understanding of learner-centred teaching is not consistent with his teaching practices. Though he seemed to articulate the philosophy well but some aspects of his teaching are not consistent with it. He believed that in learner-centred practices there had to be learner-learner interaction throughout the lesson when at some instances the teacher had to make some intervention. Also, Sabelo had some ownership of the content wherein he did not allow learners to co-construct meaning especially during the time when there were group reporting. Perhaps he was moving towards it. He had only been teaching for two years, so he has to still develop in that regard. As a young teacher he was taking steps towards transforming the class into learner-centred teaching one and he was also reflecting on where he falls short and acknowledges that he was not there yet.

5.4.4.2 Learning practices

Just like with learner-centred teaching, Sabelo was also interviewed about the concept of meaningful learning. His responses were compared with his teaching practices. So during the interview I wanted to find out about his understanding about meaningful learning.

Interviewer: *Was there any meaningful learning in your lesson?*

Sabelo: *I think there was. At times when you check you find that they are doing it. Most of the time when it comes to problem solving, learners have a challenge with the English language.*

According to Sabelo there was meaningful learning in his lesson because he saw learners solving each of the problems that he had given them. To him, when learners engaged themselves in a problem then meaningful learning was taking place. Of course in his lesson he did engage learners in some activities where they were solving a problem though they struggled to find its solution. On another note, he pointed out that normally his learners had a problem with the English Language. His observation was based on the learners' struggling to communicate using the medium of instruction (English Language) as they solved the problem. Indeed during group discussion I also observed that in some of the groups, one learner worked on a task alone without communicating with members of the group. The group members were just watching him (see Figure 5.31) as he worked on the problem. As the groups worked on the task, Sabelo walked around making some observations and never bothered himself to tell them to communicate with one another among the groups. I then asked Sabelo more about his conceptual understanding of meaningful learning. My interview with him continued as follows:

Interviewer: *What in your opinion do you understand about meaningful learning?*

Sabelo: *I think meaningful learning is when the pupils are able to express their learning and the teacher could be able to observe that learning has happened.*

It seemed Sabelo's belief about meaningful learning was consistent with his teaching practices. During the groups' presentations of the task he had given learners to work out in small groups, I observed that each group representative conducted a question and answer whilst Sabelo watched them. He never interfered with the proceedings save for encouraging learners to raise their hands when ready to respond to questions paused by their peers. Basically Sabelo believed that meaningful learning is linked to learners' expressing of their ideas and the teacher should observe that happening. With regards to his lesson, I

wanted to find out whether there was meaningful learning as he taught the learners.

Interviewer: *If I may ask you: Was there meaningful learning in your lesson?*

Sabelo: *I think there was meaningful learning just because while they were learning, the learners as they were in groups were able to express their understanding sort of.*

Again Sabelo's notion of meaningful learning was rooted on learners' expressing of their ideas during his teaching. According to him, seeing learners discussing a problem and showing their understanding was indicative of meaningful learning. Furthermore, I asked him how he could facilitate meaningful learning when teaching.

Interviewer: *Is there any way to make meaningful learning in any Mathematics lesson?*

Sabelo: *I believe there is a need. When we say there is meaningful learning, the learners will be kept busy and express understanding and its importance hence will take the learning seriously.*

Sabelo believed that there must be meaningful learning in the teaching of Mathematics. He mentioned that meaningful learning occurs when learners express understanding and the importance of mathematical ideas. Sabelo seemed to connect meaningful learning with the instance when learners express conceptual understanding.

In my interview with him, I went on to find out about the strategies that he could use to facilitate meaningful learning when teaching Mathematics.

Interviewer: *What strategies can you take to facilitate meaningful learning in any Math lesson?*

Sabelo: *I think it is giving the learners more ways of feeling part of the lesson keeping them busy. And at times as the teacher is conducting the lesson s/he can help them to see the importance of that learning.*

In his lesson, Sabelo encouraged his learners to work in their groups. He gave learners some tasks to work on. To him, meaningful learning was enabled by keeping learners work on a task and in groups. In particular he believed that when learners were busy with some work that had been given to them by the teacher and expressing their understanding, then there was meaningful learning.

During my interview with Sabelo I also wanted to find out from him whether he normally used concrete materials when teaching Mathematics. He responded in the affirmative but he said he did not use them most of the time. So I asked him why he used them and his response was as follows:
These kids love playing, when I come with something they can touch, something they can handle. You will find that during the course of the lesson they are just happy for the thing and it is hard for them to forget that lesson.

From his response, Sabelo seemed not to connect concrete materials directly with concepts in Mathematics. He associated them with play. Furthermore, he mentioned that concrete materials are for learners' enjoyment as can be noted from the excerpt below.

Concrete materials are for making the lesson enjoyable to the learners. At times it will be like a game to them. While they are learning they enjoy.

Though Sabelo approved the value of concrete materials when teaching Mathematics, I noted that he did not use any concrete materials in his lesson save for a piece of chalk and a chalk board duster. After all the nature of the topic restricted him to the use of the materials that he used during the lesson. I then wanted to find out from him whether there was a link between concrete materials and conceptual understanding.

Interviewer: *What about when it comes to the concept you are teaching. You see you are teaching the problem solving model, if you bring concrete objects what sort of link would it make.*

Sabelo: *When you come with an object, that concrete object usually as a teacher you will come with something relevant to the lesson. For example let's say we are learning on place values so for them to enjoy if you come with may be an abacus you will find that they*

will begin to play with it. 10's 1's and 1000's then it will be hard for them to forget.

Sabelo seemed to acknowledge the theoretical value of concrete materials in the teaching of Mathematics but he did not use them in his lesson. On another note, during the interview he never made any connection of concrete materials with meaningful learning.

One of the important components of my interview with Sabelo was to understand his knowledge about prior knowledge in the teaching of Mathematics. The following conversation ensued with him:

Interviewer: *What is prior knowledge in teaching of Mathematics?*
Sabelo: *It is when we are allowing the pupils to reflect what they have learnt in their previous classes or lessons.*

Sabelo's conception of prior knowledge was related to learners' understanding of lessons that they have been taught before. According to him, prior knowledge would take place if learners were permitted to reflect what they had learnt before. I continued to find reasons for using prior knowledge from him.

Interviewer: *Why do you use prior knowledge when teaching Mathematics?*
Sabelo: *Every time you look at Mathematics, Mathematics is continually from Grade to Grade and class to class. So what they have learnt previously links with what they will learn at that particular lesson.*

Sabelo's response above about prior knowledge revealed that he connected it with what learners had learnt from previous lessons. He did not mention the idea of learners linking what was new to them with what they had learnt. In his lesson introduction, Sabelo narrated a story of a big snake in a garden which was a problem to the gardener. That according to him was a problem which needed to be solved. To me, his story linked well with his current lesson. It served as prior knowledge. Indeed he took into account learners' previous knowledge which seemed to be learners' everyday experience. Here, Sabelo seemed to acknowledge the idea of the existence of prior knowledge in the teaching of Mathematics but did link it to meaningful learning. Though he

pointed out during my interview with him that he had used prior knowledge most of the time when he taught Mathematics, he never mentioned that it was connected with meaningful learning.

From Sabelo's lesson that I observed and my interview with him, it emerged that meaningful learning would occur when:

- Learners are able to express their ideas while they were working in groups.
- Learners are kept busy discussing a problem and showing their understanding.

Sabelo's understanding of meaningful learning seemed to be associated with some learning processes during the lesson and he did not link it to the aspect of cognitive development where connections are made between prior knowledge and new knowledge.

CHAPTER 6

DISCUSSION OF FINDINGS

6.1 INTRODUCTION

In the previous chapter (Chapter 5), I presented a detailed narrative account of the three teachers' lessons that were observed and analysed the data that was collected. This chapter therefore, presents a summary and discussion of the findings of this study. The literature reviewed, theoretical framework and empirical data were used to guide the discussion in this study. Its aim was to explore Mathematics teachers' constructions of learner-centred practices and the extent to which their personal enactments of "learner-centred" practices enabled meaningful learning at Grade 6 level in Eswatini. In particular, the study was guided by the following questions:

(a) What are Primary school Mathematics teachers' understandings of learner-centred teaching?
(b) How do the teachers' understandings of learner-centred teaching influence their instructional practice?
(c) To what extent do the teachers enable meaningful learning in their personal enactments of "learner-centred" practices?

In this chapter, I focus on a cross-sectional analysis of the three teachers' constructions which is used as a basis to explain key differences among the teachers with respect to their constructions of learner-centred practices and the extent to which they enabled meaningful learning in their personal enactments of "learner-centred" practices. Milton and Themba had three years of teaching experience at Primary school level, while Sabelo had two years of teaching experience at Primary school level.

In the next sections, I will discuss the findings of the study which will be stated as statements of findings with respect to the themes that emerged in the narrative account and data analysis in Chapter 5. The sections will be organized in relation to the research questions of the study. Finally, I will provide a discussion of limitations of the study, recommendations of the study and possibilities for future studies.

6.2 ANSWERS TO RESEACH QUESTION 1

This section answers the research question: **What are Primary school Mathematics teachers' understandings of learner-centred teaching?**

The literature that has been reviewed in the study indicate that for effective learning to occur, the teachers' approach to teaching Mathematics should be informed by learner-centred teaching practices. The Eswatini Ministry of Education and Training sector policy document of 2011 points out to the fact that Primary school Mathematics teachers should use learner-centred teaching approaches when teaching Mathematics. With respect to the first research question about the teachers' conceptions of learner-centred teaching, there are three themes that emerged from this study which are discussed below.

6.2.1 The teachers' perceptions of their learner-centred teaching is that the teacher takes on the role of a guide

The case studies reveal that the three teachers shared some common understandings of learner-centred teaching, that the role of the teacher is a guide. When Milton was asked about his understanding of learner-centred teaching, he responded by saying that the teacher monitors and guides learners whilst Themba said the teacher guides learners and assists them as they work out problems. Sabelo similarly submitted that the role of the teacher in learner-centred teaching is observing the learning process and helping learners as they work on a problem. In addition, Sabelo mentioned that peer learning can take place by emphasising that in learner-centred teaching the teacher is not the master of the class, rather the learners are given the opportunity to work on the given problem on their own hence they learn from one another. The teachers' perceptions are supported by literature that says during learner-centred teaching, the teacher is a manager of the learning process wherein s/he provides guidance and support to learners as they engage on a problem (Blumberg, 2008; Harden & Crosby, 2000; Sikoyo, 2010). At the core of learner-centred teaching is that the teacher guides learners as they work on a task. Hattie (2003) had pointed out that as the learners work on a task, the teacher guides them as s/he allows

class engagement such that there is learner-learner interaction. As the teacher guides learners, she observes what they are doing and helps them where necessary (Harden & Crosby, 2000; Vavrus et al., 2011; Webb et al., 2009). This belief that the teacher takes on the role of a guide when conducting learner-centred teaching was shared among the three teachers.

Both Milton and Themba mentioned that the role of the teacher in learner-centred is to guide learners whilst Sabelo said the teacher observes and helps learners during the learning process. Clearly all the three teachers articulated their understanding of learner-centred teaching as that of the teacher being guiding and helping learners during the learning process. Their responses to a larger extent rests on the learner who is doing the learning and the teacher guiding and helping learners to access and process knowledge.

In retrospect, the teacher undertakes the role of a facilitator in learner-centred teaching as mentioned by Jansen (1999b) in Outcomes-Based Education. According to Jansen (1999b), when a teacher assumes the role of a facilitator, s/he allows learners to engage with one another whilst working in small groups with the aim of guiding and helping them. In this study the three teachers believed that learner-centred teaching was about the teacher guiding and assisting learners as they engage into a task.

6.2.2 The teachers' understanding of the role of the learner in learner-centred teaching approaches

In the study, none of the teachers were able to clearly explain the role of the learner in learner-centred teaching. Whilst Milton did engage with the learners but the other two seemed to think that if they allowed the learners to their own devices, then they would automatically learn by virtue of being seated in groups. Regarding the role of the learner during the teachers' teaching practices, this is what they said during my interview with them:

Milton: *Learners have to discover the information.*

Themba: *Learners are the ones who have to do everything.*

Sabelo: *Learners have to do the learning.*

From the above responses, it can be said that, the three teachers' responses are centred on the learner accessing information, but they were silent about the specifics of the role of the learner. They were not explicit about what needed to be done so that or what conditions were necessary so that these learners could access this information. It is a short sighted view that if you leave learners to work in groups then they will automatically learn and build up the necessary knowledge. This view by teachers is not uncommon and was found to be prevalent amongst many South African teachers during the implementation of C2005 (Chisholma & Leyendeckerb, 2008; Jansen, 1999b). Learner-centred teaching, involves learners collaborating with one another (Blumberg, 2008). They need to speak and communicate about the given task so that there is learner-learner sharing of ideas. Their interrogation of ideas would in effect lead to effective leaning because they end up with shared understanding. However, some of the learners may tend to be spectators because they would feel they are not contributing meaningfully because of those dominating the discussions.

As the learners discuss the given task, they in fact actively construct knowledge in a social setting (Vygotsky, 1978). Seemingly the teachers' responses were not aligned with Vygotsky's (1978) view that during learning, learners actively construct knowledge with the assistance of the teacher. Here, learners need to be actively involved in the construction of knowledge as they socially interact with one another whilst the teacher guides and supports them (Clements & Battista, 1990; Firmender et al., 2014; Vygotsky, 1978). However, in my interview with the teachers, they did not state learners' roles in learner-centred teaching.

Milton and Sabelo did encourage learners to work with one another in their small groups, however, there was no communication among them hence no learner-learner dialogue. Both teachers made some effort to establish a constructivist classroom (Clements & Battista, 1990). The teachers knew that they had to establish a social discourse in their classes hence they asked learners to work together in small groups and hoped that they would be involved in communicating ideas with one another.

According to Clements & Battista, in a constructivist class, there must be some explanations and negotiations of mathematical ideas. But the two teachers did not satisfy Clements & Battista's criteria because there was no explanations and negotiations among their working groups. Themba's lesson on the other hand resembled a teacher dominated class. He continuously asked learners some questions whilst they were in their small groups thereby denying them an opportunity to share ideas among themselves. A limitation of the interview I had with the teachers about their meaning of learner-centred teaching was that I ought to have asked them more questions about learners' roles during learner-centred teaching in order elicit more of their ideas about it.

6.2.3 The teachers believed that group work was an important component of learner-centred teaching

The teachers in the study embraced group work as a strategy to facilitate learner-centred teaching. They believed that group work enables understanding during learner-centred teaching (Mtika & Gates, 2010; Webb et al., 2009). Ultimately group work enables learners to discuss and share ideas, thereby enhancing conceptual understanding among learners (Mtika & Gates, 2010). This is where learners discuss a task or problem by communicating with one another with an aim of finding its solution (Clements & Battista, 1990).

My analysis of the teachers' lessons during the observations indicated that they valued group work as means to facilitate learner-centred teaching. Themba and Sabelo mentioned in their lesson plans for the observed lessons that they would divide the learners into small groups during their lesson presentations. Indeed during my lesson observation both teachers asked their learners to sit and work in small groups. When Themba introduced his lesson, all learners were sitting in their normal positions and after he introduced it he asked them to sit and work in small groups. But Sabelo asked his learners to sit in small groups right at the beginning of the lesson with the intention that they would work in small groups. Both Themba and Sabelo acknowledged that having learners work in small groups is a way of facilitating learner-centred teaching which is a view shared by many researchers (Brodie, Lelliot, & Davis, 2002b; Moloi, Morobe, & Urwick, 2008; Mtika & Gates, 2010). However, although Milton never

mentioned in his lesson plan how he would arrange the learners during the lesson presentation but during his lesson he acknowledged the value of group work in his teaching practice just like Themba and Sabelo.

Milton did not ask learners to form groups but asked them to work in pairs (McDonough, 2004). Hence he did not alter the class' normal sitting arrangement. Working in pairs was the same as working in small groups. Hence Milton, just like Themba and Sabelo also believed that group work was a component of learner-centred teaching. But the teachers did not effectively utilized the notion of using group work during learner-centred teaching.

6.3 ANSWERS TO RESEARCH QUESTION 2

This section answers the research question: **How do the teachers' understanding of learner-centred teaching influence their instructional practice?**

The themes that emerged in the study which provided solutions to this question border around group work activities. During my observation of the teachers, it seemed that they associated learner-centred teaching with engaging learners into group work activity. In the next sections I discuss three themes with respect to this question.

6.3.1 The teachers' personal philosophy of learner-centred teaching did not match their actual practices

The three teachers' views about learner-centred teaching is the fact that the teacher guides learners as they access information. However, despite their articulation of learner-centred teaching, classroom observation showed that to a large extent the three teachers' personal enactment of "learner-centred" teaching did not match their descriptions. Whilst Themba's teaching practice was closely aligned to his conception of learner-centred teaching, in the case of Milton and Sabelo, there was a clear disjuncture between what they said during the interviews, and their actual classroom practices.

During his lesson, Themba constantly asked learners questions whilst they were seated in small groups. When asking them the questions, he was in fact

displaying his conception that during learner-centred teaching, the teacher guides learners by asking them questions. However, his conception of guiding by asking learners aligned to the use of probing questions during learner-centred teaching. According to Badham (1994), a teacher would ask learners probing questions in a task or problem situation when their responses are inadequate or rather say incomplete with the aim of supporting them. However, Themba used the technique of asking questions to direct his learners how to arrive at the answer he wanted, without getting ideas from learners on how to get to the answer. He did not even encourage meaningful participation among the learners.

During his lesson, Themba guided learners through a question and answer discussion to make a generalisation. For example after dividing a quadrilateral that seemed to be a square into two halves along a diagonal (as in Figure 5.19), he guided them to realise that the sum of the interior angles of the resultant two triangles is 360^0. Hence they concluded that the sum of interior angles of a quadrilateral is 360^0. This activity resonated with what he said about learner-centred teaching during my interview with him. Themba said that the teacher should guide learners by asking learners questions. Hence it may have been Themba's belief of the teacher-as-guide that translated into his practice of leading the discussions and ask learners questions to arrive at the answer. Themba's questions were phrased in such a way so as to lead the learners to the answers that he wanted. He had a clear idea of where he wanted the lesson to lead to. Hence the type of questions that Themba asked them during this activity were not just probing questions emanating from his observation of what learners were doing in their groups.

According to (Badham, 1994; Ernest, 1989; Harden & Crosby, 2000; Webb et al., 2009), probing questions are asked by a teacher after observing that learners' responses to a given task are inadequate or inappropriate. Probing questions would be wanting learners to express their ideas and say more about their ideas that they have already expressed (Badham, 1994). The main aim of asking learners probing questions is to stimulate their thinking as you guide them in the learning process. In short, probing questions would be thought provoking questions like How?, Why?, What if…?, What about…? in order to elicit

learners' ideas. However, in the case of Themba, his questions were rather from a stand view of teacher dominated question and answer session where the teacher makes some effort to guide leaners to make a generalisation. Furthermore, Themba's guiding of learners during the lesson was not done from a constructivist perspective where learners share ideas in a social setting (Clements & Battista, 1990). In a constructivist class, learners are involved in discussing, explaining and exchanging ideas whilst the teacher guides the focus of their attention as articulated by Clements and Battista. However, during Themba's lesson, learners were responding to him as individuals from their groups without engaging with one another in their small groups, leading them to the answers that he wanted.

Milton and Sabelo's interpretation of guiding was different as observed in their lessons. Classroom observation showed that Milton wanted learners to display their own individual understanding of the content, and not one that was developed by a shared understanding of the group. In his lesson, he encouraged individual learners to do some geometric constructions of a triangle whilst the other learners watched without participating. He assisted the individual learner who was doing the construction on chalkboard by holding the pair of compasses (see Figure 5.6). His focus was on an individual learner showing some understanding of ideas. Furthermore, Milton's interactions with the learners conveyed an attitude that he owned knowledge and it was his right to direct the learners on the next move during his teaching. This was an indication that he did not clearly understand his role as a teacher in a learner-centred lesson. A wider interpretation of his assertion during the interview was that the teacher guides and assists learners in learner-centred teaching may be that Milton actually meant the teacher guides and assist an individual learner. In his lesson seemingly Milton was not encouraging collaborative work among his learners which is a crucial mechanism for learning. During collaborative work, learners work together, and critique each other's solutions suggesting improvements and clarifications (Badger et al., 2012; Mtika & Gates, 2010). And the teacher encourages learners to collaborate in their learning by asking them to discuss and participate in their small groups (Brodie et al., 2002b). In addition, the teacher offers some guidance and assistance as learners collaborate with one

another. Duarte (2013) mentions that in a classroom situation, collaborative work enables learners to acknowledge that they also possess knowledge that they can share with one another to build up common understandings. Classroom observation had shown that Milton encouraged individual understanding in his lesson and did not allow understanding built from group members.

On the other hand Sabelo did not guide any of the learners as they worked in small groups on the problem that he had given them to work out. He insisted that the learners should work in groups and asked them to discuss in their groups. However, despite learners sitting in small groups, there were no discussions amongst them. Instead, similar to Milton's lesson, one learner worked on the problem whilst the other group members watched (see Figure 5.31). This resonated with Badger et al.'s (2012) observation that as learners work on a task or problem in small groups, one of the group members may be working out the problem while the others watch without participating. The teachers' inability to intervene to ensure that the groups worked together, points to the fact that the teachers were not trained about the steps they needed to take to help groups work optimally or how to recognise whether groups were working as well as they could (Theobald et al., 2017). When the teacher engages learners into a group work activity, learners' roles and responsibilities in the groups have to be explained clearly to them. In particular that every group member has to participate in the group discussions and in the process one member must write down a product of the group. This will constitute team work among the groups. In my interview with Sabelo, he mentioned that in learner-centred teaching the teacher is not the master of the class and similarly in his lesson he watched the groups working on a task as can be seen in Figure 5.32. Sabelo never bothered about whether there were discussions among the learners, let alone making some meaningful intervention among the groups. In other words, he did not interfere with the groups as they worked on the problem that he gave them yet during the interview he submitted that the role of the teacher in learner-centred teaching is that of a guide. To him, guiding learners in learner-centred teaching was observing them as they work in their groups.

6.3.2 Teachers used 'hybrid' group work management strategies

In this section I will discuss the different ways in which the three teachers compared in their approach of using group work as a strategy to facilitate learner-centred teaching. In the context of the study, "hybrid" group work management strategies means that the teachers incorporated some features of group work management to facilitate learner-centred teaching such as moving from one group to another without communicating with the learners, watching what the groups were doing; and not making some meaningful interventions or mediation or encouraging them to participate in their groups. Of importance here is that all the three teachers acknowledged the value of group work in their personal enactments of "learner-centred" practices, as was evident in their lessons as they attempted to organize their learners to working in groups.

The role of the teacher when conducting group work during learner-centred practices is to offer some guidance and assistance. S/he has to offer timeous intervention during small group activities or during group presentations to the whole class so that learners' ideas or mistakes or misconceptions are used to improve learning. Thus in the current study, the three teachers were aware that they had to use group work as a strategy to facilitate their learner-centred practices. Their understanding of learner-centred practices was that the teacher's role is a guide and that learners must work on a given task in small groups. And the question is how they managed group work as a strategy to facilitate learner-centred teaching?

During their lessons, the teachers organized the learners to work in small groups or in pairs. Among the three teachers, Sabelo had told the learners that each group should appoint a scribe who will keep a record of the discussions and ideas. The other members of the group are expected to generate the product of the group with the scribe also making some contributions. In order to understand their group work management I asked the teachers to explain to me the role of a teacher during learner-centred teaching. Their responses to my question were as follows:

Sabelo: *The role of the teacher in learner-centred teaching is observing the learning and helping the learners to do their learning.*

Milton: *Guide the learner and give direction, and encourage discussions among groups.*

Themba: *Just guide them with the questions and assist them; then and there but they are the ones who are doing everything.*

Though the teachers' responses seemed to be on learner-centred teaching but to me, they were actually referring to the teacher's roles during their management of group work activities. The teachers had acknowledged that group work is a means to facilitating their learner-centred practices. Sabelo gave learners a contextual task and asked them to work on it in their small groups. Engaging learners to work in small groups allows them to interact with one another so that they share understanding (Brodie et al., 2002b; McDonough, 2004). He also asked the groups to report their findings to the class. However, in one of the groups, a learner was observed doing the task whilst the others remained silent and watching him. This resonated with what Badger et al. (2012) noted that during group work some learners may rely on one learner doing the activity whilst they are watching him/her. This may be caused by a situation where the dominant learner fears that their work will not be good when other learners are given opportunity to do the work or lack of the groups' training to collaborate with one another (Theobald et al., 2017). However, Sabelo did not ask them why they were not discussing the task as a group instead he moved from one group to another. Although he had the opportunity, Sabelo did not make any intervention among the groups, which would have helped them to understand how they were expected to work in groups. His actions resonated with his belief about managing group work that the teacher must watch, listen and observe them whilst they are working. Even in those groups whose members attempted to discuss the task, he stood next to the group, watched them and ultimately moved to other groups without any intervention.

During group presentations to the whole class, the group representatives either wrote the solutions to the problem on the chalk board or started working out the problem with the assistance of his peers by conducting a question and answer

session. This was where there was learner-learner interaction as the learner conducted his reporting like a teacher dominated class. However, Sabelo's intervention was minimal. He only made comments like 'make sure the units for money are correct', otherwise he stood at the back of the class watching the presentations. No interventions or assistance were made by him even when learners' solutions were incorrect. Sabelo's interactions with his learners were limited to directing them to the correct solution to the problem by conducting a question and answer session.

With regards to group work management, Sabelo was aware that learners had to actively participate during group work but he did not enforce that. He believed that watching, listening and observing learners working on a problem is a good group work management strategy. This in itself was within the confines of group work management but that was supposed to be accompanied by his intervention to elicit ideas from the learners. Brodie et al. (2002b) had pointed out that the harder part for a classroom teacher was ensuring active participation and making meaningful interventions when learners are engaged into a problem situation. Likewise Sabelo neither enforced active participation among his learners nor made meaningful intervention as they work on a problem. Instead he developed a hybrid group work management strategy of none communication with learners whilst working out a solution to a problem that he had given them.

Although Milton did not make mention of 'group work' in his lesson but when he gave them a task to work out he asked them to work in pairs and insisted that they should discuss in pairs with the person they are sitting next to. Milton believed that pair work can facilitate learner-centred teaching. Indeed Milton's learners seemed to be ready to pair up and work in pairs on the problem he had given to them.

Despite Milton's insistence that learners discuss the problem in pairs, I observed that they worked independently as individuals without communicating with each other as observed by (McDonough, 2004). The fact that the learners were sitting in pairs took the form of group work but the arrangement was not sufficient to ensure the authenticity. Milton was observed moving from one group to another marking the work of an individual from a pair who had finished

the work he had given them. His interaction with the learners was when they had gotten a wrong construction of the triangle.

He would then stop and, explain to the learner and demonstrate how to construct the triangle correctly. Though he said learners should communicate and discuss but he never encouraged them to communicate and participate. His understanding of the benefits of working in pairs was limited. McDonough (2004) had mentioned that pair work enables learners in-depth engagement with the problem because of its one-on-one interaction situation. However, Milton neither encouraged pair work participation and discussion nor made meaningful intervention. Milton seemed to be going with his notion of the role of the teacher during his learner-centred teaching where he made the submission that the teacher guides learners and gives them direction. He believed in marking learners' work. To him, group work management was about checking and marking individual learners' work and rarely, providing explanations.

After Themba had done lesson introduction with his learners, he gave them two different problems to work out one after the other. In both activities he had asked the learners to form small working groups. Just like Sabelo, he had the belief that group work was a strategy for facilitating his learner-centred practices.

During the first activity, I observed that there was no communication and discussion among learners. Only one learner was doing the activity whilst the group members watched him/her. This resonated with Badger et al.'s (2012) observation that during group work activity the group members may rely on one learner to work out the problem. The learners may be lacking self-confidence or proper training to participate during the group work activity (Theobald et al., 2017).

During this activity Themba moved from one group to another checking on what they were doing in their groups without even encouraging them to participate or discuss in their groups. After he had checked all the groups he started conducting a question and answer session to the whole class. He paused questions and learners raised their hands whilst in their groups. The researchers (Brodie et al., 2002b; Chisholma & Leyendeckerb, 2008; Jansen, 1999b; Mtika

& Gates, 2010; Umugiraneza et al., 2017) had noted that classroom teachers may revert to traditional teacher-centred practices even when using group work as a teaching strategy. Ironically Themba's belief system of managing group work as a strategy to facilitate a learner-centred lesson was being directed by a teacher-centred teaching approach.

During the second activity the learners were discussing in their groups but struggling to find a solution. Although he did try to make some explanations to a few groups that were finding it hard to do the problem, his intervention was minimal. But of note about Themba's management of group work activity is that even if he had tried to make a few explanations to some groups, he would draw the attention of the whole class and do the problem on chalk board by conducting a question and answer method of teaching. Themba would then dominate the lesson by making some clarifications without eliciting ideas from learners.

Themba had submitted during my interview with him that the teacher's role during learner-centred teaching is guiding learners with questions and assisting them. Thus his belief about group work management during his learner-centred teaching was that the teacher asks learners some questions and assist them where necessary. Hence, during his management of group work as a strategy to enable learner-centred teaching translated into a question and answer session being directed by teacher-centred practices. This could have been influenced by his previous exposure to teacher-centred practices as observed by (Brodie et al., 2002b; Chisholma & Leyendeckerb, 2008; Jansen, 1999b; Mtika & Gates, 2010).

Despite the three teachers' attempt to let learners form small groups during their lessons, it was observed that the learners were evidently not talking to one another hence no meaningful communication based on the task that they were given by their teachers. Learners' communication during group work would enable meaning making among learners (Brodie et al., 2002b; McDonough, 2004) despite challenges like language barrier or learners' lack of socialization to work in small groups. What emerged from the three cases in respect of learners' participation in group work was that they were either working as

individuals or one learner working as the others were quiet and watching him/her. There seemed to be no effective learner-learner interactions among the learners during the teachers' lessons. According to Hattie (2003) any class environment must involve learner-learner interactions in order to enable effective learning. In the study, learner-learner interaction was supposed to be encouraged by the teachers so that the learners communicate meaningfully and interrogate each other's ideas. It can be argued therefore that generally there was no sharing of ideas among the learners during the teachers' lessons.

However, in one of the lessons there was learner-learner interaction but was ineffective. Here, some of the group representatives conducted a question and answer discussion as they presented their finding to the whole group. Overall in the study, there was no meaningful social sharing of ideas among the learners because of the minimal learner-learner interactions. According to Clements and Battista (1990), sharing of knowledge in a social setting enables effective learning. And in this context, it ought to have taken place during group work activities. Quite dominant in the three cases of the study was teacher- learner interaction. The teachers would widely use the question and answer method which was not effective in managing group work activities.

In their management of group work as a strategy to facilitating learner-centred practices, the teachers would sometimes move from one group to another without encouraging discussions among the groups or learners' participation or making meaning intervention during group activities. Despite the teachers' knowledge of the value of group work as a strategy to enable learning during learner-centred practices but they could not transfer that into practice. Researchers like (Chisholma & Leyendeckerb, 2008; Mtika & Gates, 2010; Vavrus et al., 2011) had argued that classroom teachers could not appropriately implement learner-centred strategies. Hence group work is one of the strategies that teachers have to use to facilitate learner-centred teaching.

In the study teachers seemed to be aware that they had to use group work in during learner-centred teaching but they could not transfer it into practice. The teachers followed the form of group work because it was an easier thing to do (Brodie et al., 2002b). Their harder part in managing group work as a strategy

to facilitate learner-centred teaching was to ensure that the learners were communicating and interacting meaningfully with one another. Seemingly the teachers were cognisant of the importance of group work as a strategy to facilitate learner-centred teaching but instead they could not make the necessary mediation to enable learners to access knowledge among the groups. Instead they moved from one group to another without making meaningful intervention. The teachers' actions with regards to group work management as means to enable learner-centred teaching revealed their weakness in encouraging shared discussions among learners.

What emerged in the study was that the teachers developed alternatives to group work management strategies in their learner-centred practices. They tend to move between substantial criteria for authentic group work management strategies and hybrid group work management styles. This resonated with Brodie et al. (2002b) findings that during the facilitation of learner-centred teaching, a majority of teachers take up its outward strategies or *forms* neglecting its substantial criteria of their learner-centred practices.

6.3.3 The teachers' actions were modelled on how they were taught at College

The highest qualification of each of the three teachers was a Primary Teachers Diploma in Education and at the time of the study, none of them had taught for more than three years. In my interview with the teachers, I asked them about the teaching methods that were used by their lecturers during their teacher training at colleges. And their responses to my question were as follows:

Sabelo: *Most of the time the lecturers will be doing the work.*
Milton: *They mostly lecture us.*
Themba: *The lecturers would just give us everything about the topic.*

From the above excerpt, Milton's submission clearly indicates that at college the lecturers taught him using the lecture method. When Sabelo says that the lecturers were doing the work, one may assume that it was a lecture method wherein student participation is minimal. Again for Themba, the assumption

was that the lecturers used the lecture method because, according to him, the students were given everything by them during lectures.

In retrospect it is likely that the teachers in the study were taught using the lecturer method of teaching whilst they were students at their respective colleges. They never mentioned any use of learner-centred teaching by their lectures during lectures. And it seemed that the way the teachers were taught by their lecturers at college had an effect in their learner-centred practices.

It can be argued that during their observed lessons, the teachers were modelling the method of teaching that they were exposed to whilst they were at college. Another argument may be that it was an inability of their lecturers themselves to facilitate group work activities as they conduct their lectures at pre-service. Lecturers should model good teaching practices for their students so that they have good experiences of the teaching methods before they go out to start teaching. Hence Mtika and Gates (2010) made the assertion that there is a need for teacher educators to incorporate collaborative learning and cooperative learning courses at college to ensure that student teachers are able to transfer the dynamics of group work effectively during their teaching practices. This would incorporate sustentative ways of facilitating group work during learner-centred teaching.

In the light of the above, there is need for lecturers to be good role models with regards to group work dynamics so that the student teachers feel and experience them before their teaching practices. Recall that all the three teachers were relatively new in the teaching profession. Hence one would expect them to encounter difficulties with regards to using group work as a strategy to facilitating learner-centred teaching.

The Primary school Mathematics syllabus in Eswatini where the study was conducted suggests that the approach to teaching and learning should be based on learner-centred approaches. Furthermore, it states that teaching should be organized around working in groups or pairs. However, the document does not suggest how teachers should manage group work as a strategy to facilitate learner-centred teaching. Also, the Grade 6 Teachers' Guide which is a prescribed reference text book for all Grade 6 Mathematics Primary school

teachers in Eswatini suggests that teachers should divide learners into small groups of 5 to 7 and that these groups should be given simple tasks to work together. Again in this textbook there is no mentioning on how the teachers are to handle group work as a strategy during learner-centred practices. It is therefore a shortcoming on both the two materials, in particular the syllabus document with regards to group work management despite any effort that would have been made by lecturers at college to socialising the student teachers into learner-centred practices.

6.4 ANSWERS TO RESEARCH QUESTION 3

This section answers the research question: **To what extent do the teachers enable meaningful learning in their personal enactments of "learner-centred" practices?**

In this study, I found five themes that will help me answer Research Question 3. These themes emerged from the teachers' conceptions of meaningful learning and the teachers' knowledge mediation during their personal enactments of "learner-centred" practices as they conducted the observed lessons. In the study what the teachers conceived as "learner-centred" is not actually so as discussed in Research Question 1. What has emerged in the study was that the teachers' understanding of learner-centred teaching is that of a guide. To them, guiding learners was walking around class watching what they were doing as they worked on a problem in their groups without encouraging participation or without making meaningful interventions. As discussed in the literature review, Brodie et al. (2002b) stated that this a form of facilitating learner-centred teaching without attending to the fundamental substance of learner-centred practices.

The Eswatini Ministry of Educucation and Training (2011) policy document put it succinctly that Primary school teachers should teach Mathematics within the framework of learner-centred philosophy. And the learner-centred philosophy puts emphasis on the learner who is engaged in learning and the teacher facilitating the learning process (Di Napoli, 2004; Sikoyo, 2010; Vavrus et al., 2011). In the study, the teachers acknowledged the value of using group work to facilitate learner-centred teaching of Mathematics. In the literature review

chapter, it emerged that learner-centred practices are the context within which meaningful learning occurs. This therefore implies that meaningful learning is an outcome of teaching within learner-centred practices. In order to provide answers regarding this question, I will discuss the teachers' conceptions of meaningful learning in the first section and in the other sections, I will provide a discussion of the extent at which the teachers enabled meaningful learning in their "learner-centred" practices.

6.4.1 The teachers displayed narrow conceptions of meaningful learning which they tried to implement

The teachers had acknowledged the value of using learner-centred teaching in the teaching of Mathematics. Hence, they conducted the observed lessons within their personal enactment of "learner-centred" practices of which it emerged that they believed that the role of the teacher was that of a guide. In the study, the literature review has revealed that learner-centred practices have a strong link with meaningful learning because that is where the latter occurs. This would imply that the teachers' conceptions of meaningful learning basically inform the way they enable effective learning in their "learner-centred" practices. And in the literature review chapter, I have established that the constructs meaningful learning and effective learning mean the same thing. In this section, therefore, I will provide a discussion of the teachers' conceptions of meaningful in their personal enactments of "learner-centred" practices.

In education literature, meaningful learning can be viewed as learners' experiences that have particular meaning to them (Kostiainen et al., 2018; Wong, 2015) e.g. the teacher links theory and practice, or learners' engagement in a task situation, or learners' success in solving a mathematical problem, or learners working collaboratively. Whilst in cognitive development meaningful learning is viewed as a situation where learners make connections between new ideas and their own existing related ideas (Ausubel et al., 1978). In the study, the teachers differed in the way they viewed meaningful learning in their "learner-centred" practices.

Milton held two contrasting views about meaningful learning. On one hand, he believed that meaningful learning was the learner's ability to solve a given

problem and on the other hand he believed it was the learner's ability to follow steps as they attempted to work on a problem. Apparently Milton based his first description of the meaning of meaningful learning on learners being able to solve a problem (Kostiainen et al., 2018). Despite some of his learners not getting the task that he had given them to do on constructing a triangle correct, Milton believed that meaningful learning took place because learners attempted the problem.

On the second account, Milton's conception of meaningful learning seems to be associating it with the application of mathematical procedures to problems with no concern about concepts connections which resonates with Skemp's (1976) construct of instrumental understanding and Star and Stylianides' (2013) notion of procedural knowledge. In my literature review chapter, I have pointed out that instrumental understanding and procedural knowledge do not lead to meaningful learning because, here, the learners do not make some effort to link some mathematical ideas. However, there is need for learners to make conceptual connections in order to enable effective learning among them.

In constructing the triangle, the learners were in fact trying to follow steps that Milton had demonstrated to them. It is important to note that during his demonstration, Milton did not explain his steps to the learners. It was possible that they got the construction wrong because the sharp point of the compass was not placed at the zero mark on the ruler as the start off point of the radii of the arcs. As such his learners did not make a connection between radii of their arcs and the zero mark of the ruler as used in the measurement of line segments. Hence, they seemed not to make meaning of the steps he used during his demonstration.

Milton's demonstration of constructing a triangle did not enable effective learning. Without being able to follow the steps, there was no basis for them to make sense of the actual construction procedure. Furthermore, without understanding the steps they would not be able to reflect about how and why the construction procedure resulted in the triangle with the required dimensions. Neither would they be able to make connections between the steps and the concepts. Learners need to understand the reasons for doing things and to make

connections between the concepts just like in Skemp's (1976) construct of relational understanding and Star & Stylianides' (2013) notion of conceptual knowledge.

Themba's conception of meaningful learning was based on connecting Mathematics to real life situations (Wong, 2015), for example linking meaningful learning to future carriers. Themba believed that meaningful learning is achieved if learners can associate mathematical concepts with future carriers. He maintained that if learners could apply the concepts that they learnt in class to everyday life then there was meaningful learning. To him, meaningful learning is informed by learners' application of scientific concepts to real life.

Themba explained in his interview that if you teach learners Geometry, then there will be meaningful learning because some of them will end up being carpenters or builders. This view of the importance of linking mathematics concepts to real life applications is supported in the literature, however at no point in Milton's lesson did he pointed out the links or make the links explicit. He seems to believe doing such mathematics concepts was his task and that it was up to his learners to recognise or make up the connections to real life.

Just like Milton, Sabelo held two conceptions about meaningful learning. His first conception is that it occurs when learners can express their ideas while they are working in groups. Sabelo believed that group work enables effective learning because in their groups learners discuss and share mathematical ideas which is shared by the researchers (Mtika & Gates, 2010; Webb et al., 2009; Wong, 2015). As the learners discuss in their groups learning opportunities are generated because they would be bringing in various experiences to the discussions. However, Sabelo could not utilize group work effectively to enable meaningful learning.

Sabelo's second conception about meaningful learning was that learners should be kept busy by the teacher discussing a problem and showing their understanding. This belief he held about meaningful learning resonates with Kostiainen et al.'s (2018) assertion that learners should be seen engaged in a

task situation that they have been given by the teacher so that there is effective learning.

Indeed, after Sabelo had given his learners a task to work in small groups, he went around observing what learners were doing in their groups without any interference with what they were doing in their groups. He made sure that learners were seated in groups and seemed to be working on something. His interventions fell short of ensuring that the learners were working together meaningfully while being engaged in the task. All he did was check if the answers were correct and provided the correct answers when necessary.

In the study, the teachers displayed narrow conceptions of meaningful learning in their personal enactments of "learner-centred" practices. Their conceptions of meaningful learning were rooted on what the learners were capable of doing in a classroom environment. Despite the teachers' emphasis on the role of prior knowledge in their observed lessons, they did not associate it with it view in cognitive development. In cognitive development, meaningful learning is viewed in terms of learners' association of new knowledge with what they already know.

6.4.2 The teachers tried to emphasize the role of prior knowledge in their teaching

In the study, the teachers seemed to have a common understanding of prior knowledge in their learner-centred practices. They said that prior knowledge is knowledge that the learners already know. When they were asked about its significance, the teachers submitted that it links what the learners already know to new knowledge (Ausubel et al., 1978). They seemed to believe that during learner-centred teaching, learners must connect new ideas to ideas that have been learnt already. Indeed, in their lesson introductions that I observed, they attempted to confirm learners' prior knowledge. The table 6.1 below shows the teachers' lesson introductions that they used during their respective lessons.

Table 6.1: The three teachers' lesson topics and their respective introductions

Name of teacher	Lesson topic	Lesson introduction
Milton	Constructing a Triangle	Milton asked learners to give a definition of a triangle.
Themba	The sum of the interior angles of a quadrilateral	Themba asked learners the meaning of a quadrilateral and to give examples of quadrilaterals.
Sabelo	Using problem-solving model	Sabelo narrated a story to the learners about a gardener who found a big snake in his garden. He asked learners to state the problem the man was facing and decide on possible ways of solving it.

In the above table, Milton and Themba asked learners questions that elicit their information related to the new topic. According to them, asking learners questions about concepts that are related to the new topic would enable meaningful learning of the new topic. Sabelo on the other hand seemed to be using a context that was familiar to his learners (Dickinson et al., 2010; Freudenthal, 1977). Sabelo believed that the story will assist learners to associate it with the new topic hence would ultimately enable meaningful learning. Just like Milton and Themba, he asked learners some questions in order to help learners relate their previous knowledge to his new topic about problem-solving.

In essence, classroom teachers would ask learners questions to find out what they already know and to assist them make links to what they know (Ausubel et al., 1978; Badham, 1994). They do this to make sure that learners' prior knowledge is confirmed. Hattie and Timperley (2007) emphasize that leaners should be asked questions in order to elicit feedback information that bridges the gap between the new topic and what the learner already knows.

What was common among the teachers' introductory lessons in the study was that they kept on asking learners some questions. According to Woloshyn,

Pressley, and Schneider (1992), the reason for a teacher to ask learners some questions when introducing a topic is to confirm their prior knowledge and hence facilitate learners' association of the new knowledge and existing knowledge. While Ausubel (1962) had argued that for meaningful learning to take place, the teacher should ensure that the learner already owns appropriate knowledge in his/her cognitive structure that s/he can assimilate the new knowledge. Hence the teachers in the study wanted to confirm ownership of relevant previous knowledge by learners that would eventually enable meaningful learning. The teachers in the study seemed to believe that learner-centred teaching is about confirming learners' prior knowledge and asking them questions during their lesson introductions. They thought that their way of introducing the new topic, as they did, will enable meaningful learning.

In the study, the teachers had acknowledged the use of prior knowledge in their learner-centred practices during my interview with them. In order to get an in depth understanding of their use of prior knowledge, I then asked them to provide me with reasons for using it. The table below shows their reasons for using prior knowledge in their lessons that I observed them teaching.

Table 6.2 The teachers' reasons for using prior knowledge

Name of teacher	The teacher's reason for using prior knowledge
Milton	To take the known to the unknown hence adding knew knowledge to knowledge that already exist.
Themba	To stimulate their thoughts hence linking old concepts with new concepts.
Sabelo	To link what they have learnt previously with what they will learn during the lesson hence helping learners to build on what they know and learnt before.

From the above table, it seemed that the teachers value the significance of using prior knowledge in their "learner-centred" practices. They shared the same view that prior knowledge provides a link between what the learners have learnt previously and new knowledge. The teachers' views about the prior knowledge resonated with Stephen & Simon's (1999) argument that prior knowledge has

to be confirmed by teachers when introducing a new topic in order to enable effective learning among learners. In the study, the teachers attempted to help learners to associate their previous knowledge with the current topic, however, it was done superficially and their lessons were not planned to take the prior knowledge into account.

In my interview with the teachers it also emerged that they tried to use prior knowledge regularly when teaching Mathematics. Their references to the use of prior knowledge during their lessons implies that they associated it with learner-centred teaching. Hence the teachers believed that using prior knowledge in their "learner-centred" practices basically enables meaningful learning.

The teachers' use of prior knowledge implies that they were in fact enabling meaningful learning. Though the teachers did not associate prior knowledge with meaningful learning during my interview with them but clearly as they introduced their lessons, it can be assumed that learners assimilated new knowledge to concepts that they have learnt already know(Ausubel et al., 1978; Harel, 2013; Piaget, 1970). This is because learners' learning of new knowledge relies on what the learners already knows (Ausubel et al., 1978).

In sum, the teachers acknowledged the value of using prior knowledge in the teaching of Mathematics as they showed evidence of using it during their lesson introductions. They emphasised the role of using prior knowledge in their personal enactments of "learner-centred" practices that would ultimately enable meaningful learning.

6.4.3 The teachers emphasised the use of group work in their teaching

In the study, the teachers believed in group work in their personal enactments of "learner-centred" practices. They believed that group work is a strategy that is useful in enabling effective learning among learners as observed by the researchers (Brodie et al., 2002b; McDonough, 2004; Moloi et al., 2008; Mtika & Gates, 2010; Webb et al., 2009). However, the teachers did not attend to the substance of group work in their teaching practices. Achieving the fundamental substance of group work in order to enable meaningful learning would require

them to ask learners probing questions and giving corrective feedback, making meaningful interventions and encouraging learners to participate as they are engaged into group work activities.

During their observed lessons, the teachers asked learners to work in small groups. Sabelo told his learners to sit in groups before he even started making his lesson introduction. After Themba had introduced his lesson, he told his learners to sit in their normal groups. Seemingly Themba's group arrangement were those old groups with the same group members. As for Milton, though he did not say that they should form groups but after he had made his lesson introduction, he asked learners to do a class exercise in pairs. By asking them to do a class exercise in pairs, he was referring to the persons that each of the learners was sitting next to. Milton even emphasised to the learners that they should work with a partner.

Clearly, the teachers in the study believed that engaging learners into group work will enable meaningful learning. Basically classroom teachers need to engage learners in a task situation in small groups in order to achieve a shared understanding (Brodie et al., 2002b; Webb et al., 2009; Wong, 2015). It is assumed that in their groups, learners will come with a variety of rich experiences either from their everyday life, or from other subject disciplines apart from Mathematics, or from knowledge of concepts within Mathematics. They will then share these experiences as they discuss the given task in pursuit of a common understanding. According to Vygotsky (1978), learners construct meaning individually or socially whilst the teacher mediates the learning process. In the study, the teachers gave learners an exercise or a problem to work out in small groups. The teachers seemed to believe that group work enables meaningful learning because they were expecting learners to discuss the given problem in their small groups.

What I observed during the teachers' lessons was that they could not ensure that the main substantive goals of group work in enabling meaningful learning are enforced. But what they did was to watch the groups as they worked on an exercise or problem. What is worth pointing out here is that Themba did engage with some of the learners in one of the two activities that he gave them, however,

Sabelo and Milton seemed to think that if they left the learners to their own plans, then they would automatically learn by virtue of being seated in groups.

Thus, in the study, it has emerged that the teachers tried to use a form of group work in their attempt to enable meaningful learning, but did not attend to the substance underlying group work to enable meaningful learning. Seemingly, the teachers were not empowered to put group work into practice in order to enable meaningful learning during their observed lessons.

6.4.4 The teachers instinctively used principles of RME in their teaching

In the study the teachers facilitated their learner-centred teaching by trying to engage learners into small group work activities. Their philosophy of learner-centred teaching was that of a guide. During their observed lessons the teachers implicitly used Treffers' (1987) notions of horizontal and vertical mathematization which are within the principles of the Dutch's RME tradition.

In his introduction, Sabelo narrated a story to the learners and started asking learners questions about the story. He used a contextual problem in his introduction in an attempt to link it to Polya's approach of problem solving. Dickinson et al. (2010) had noted that Mathematics teachers must start with a meaningful context which will serve as a basis for the learning process. However, during Sabelo's introduction, none of his learners was able to respond to the questions he had asked them about the story. They could not see the links probably because it was farfetched. Sabelo's context could have been out of the learners' experiences (Bansilal, 2009) as such they could not make meaning to it. His intention was that the context was the learners' experiences. It was also possible that they struggled to answer his questions because the story was narrated to them in English hence the context ended up being an English barrier. In my interview with Sabelo he did acknowledge his learners have a problem with English Language when solving Mathematics problems. Sabelo eventually solved the problem himself when he wanted it to be solved by the learners.

In his main lesson, Sabelo gave his learners a contextual problem on commercial arithmetic to work on which I believe was within the notion of horizontal mathematization. Below is the problem that he gave to the learners:

Wamkelwe bought 25 apples at E1.20 each. He was then given a discount of E2.00. How much did he pay for the apples?

The problem seemed to be familiar to the learners and was activity based. Of note about Sabelo's problem was that it was located in a real-life situation (Treffers, 1987) and learners were expected to use their mathematical tools to solve it. The problem was in fact within the idea of horizontal mathematization wherein, according to Treffers, learners mathematize a problem from real life situation.

Out of Sabelo's seven groups who were working on the problem, only three got a correct solution to it. Recall that during Sabelo's lesson some groups did discuss the given problem whilst in other groups there was one learner doing the problem. Possibly during Sabelo's lesson either one learner had difficulty in solving the given problem or all members of a group had a difficulty working it out. Or rather it could have happened that the design of the task and/or the context being biased, made it difficult for the learners to get a correct solution (Bansilal, 2009). In other words, learners can get confused by a contextualised problem if it is not actually their context. This issue would have been averted had Sabelo made some meaningful interventions during the group activities.

Whilst Sabelo used a contextual problem in his lesson, Themba and Milton used problems where learners were supposed to use aspects of mathematical content within the mathematical system itself (Treffers, 1987). Treffers referred to such use of mathematical problems as vertical mathematization because with this notion of mathematization concepts are used within mathematics to build on others. Themba gave his learners a problem where he asked them to calculate one of the missing interior angles in a quadrilateral. Clearly learners had to use their relevant prior mathematical ideas to work out the solution of the problem.

As for Milton, he wanted his learners to do a geometrical construction of a triangle where all its dimensions were given. Similarly, his problem was located within the RME's vertical mathematization as pointed out by Treffers because it required learners to navigate within the system of Mathematics.

Both Themba and Milton seemed to be introducing their lessons by attempting to use aspects of mathematical content that the learners have learnt whilst Sabelo

made use of a real-life situation. Thus, it is encouraging to note that these novice teachers are actively finding ways to try to put the RME ideas into their teaching practices implicitly. My argument is that they used the principles of RME in their lessons instinctively in order to enable meaningful learning.

6.4.5 The teachers made their own personal enactment of learner-centred lessons in the absence of direction from the department

Both the curriculum and subject syllabus documents of Eswatini Ministry of Education and Training advocate for learner-centred teaching methods when teaching Mathematics at Primary school level in Eswatini. However, none of the two documents unpack approaches on how the Primary school teachers should teach Mathematics within the learner-centred framework. Furthermore, the two documents do not provide any explanation or clarification of the meaning of learner-centred practices. When I quizzed the teachers on the type of teaching method that was used by their lecturers at college, they responded by saying that it was the lecture method. Hence the teachers seemed not to be empowered with some of the skills to attend to the fundamentals of facilitating learner-centred practices in their teaching of Mathematics. This is simply because their lecturers at college did not model the substantive elements of learner-centred practices during lectures.

The teachers in the study were left to decide on their own on how they could personally enact this notion of learner-centred lessons, based on their own incomplete understandings. Furthermore, the education department did not provide any curriculum workshops about how these ideas could be put into practice. It would be expected that curriculum workshops would empower teachers with some elements of learner-centred teaching such as group work as a strategy to enable learner participation and engagement (Brodie et al., 2002b) in order to facilitate meaningful learning. Umugiraneza et al. (2017) have pointed out that classroom teachers need some professional support in trying to move to more modern teaching such as group work as a teaching strategy to enable effective learning. Through professional development support, teachers may be given practical advice on how to attend to the substance of learner-

centred practices on how to facilitate the progressive group work strategies in order to enable meaningful learning.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 INTRODUCTION

This chapter presents the researcher's conclusions and recommendations from this empirical study. The aim was to explore teachers' constructions and enactments of learner-centred practices, focusing on three urban schools in the Shiselweni region of Eswatini. The findings, conclusions and recommendations of this study were based on data gathered from two data collection instruments; semi-structured interviews with three Grade Six teachers and classroom observations of these three teachers during their Mathematics lessons.

7.2 SUMMARY OF FINDINGS

Based on these research questions the study yielded the following findings:

Research Question 1: What are Primary school Mathematics teachers' understandings of learner-centred teaching?

- The teachers' perceptions of their learner-centred teaching is that the teacher takes on the role of a guide.
- The teachers' understanding of the role of the learner in learner-centred teaching approaches.
- The teachers believed that group work was an important component of learner-centred teaching.

Research Question 2: How do the teachers' understandings of learner-centred teaching influence their instructional practice?

- The teachers' personal philosophy of learner-centred teaching did not match their actual practices.
- Teachers used 'hybrid' group work management strategies.
- The teachers' actions were modelled on how they were taught at college.

Research Question 3: To what extent do the teachers enable meaningful learning in their personal enactments of "learner-centred" practices?

- The teachers displayed narrow conceptions of meaningful learning which they tried to implement.
- The teachers tried to emphasize the role of prior knowledge in their teaching.
- The teachers emphasised the use of group work in their teaching.
- The teachers instinctively used principles of RME in their teaching.
- The teachers made their own personal enactment of learner-centred lessons in the absence of direction from the department.

7.3 CONCLUSION FROM THE EMPIRICAL STUDY

In this chapter, I have provided conclusions and recommendations drawn from the findings of the present study that sought to explore Mathematics teachers' constructions of learner-centred practices and the extent to which their personal enactments of "learner-centred" practices enabled meaningful learning at Grade 6 level in Eswatini. I have also discussed the limitations of the study, the recommendations for action and further research which I noted as I conducted this study. There were two key findings in the study on which I drew my conclusion.

The study showed that teachers' understandings of their learner-centred teaching are that the teacher takes on the role of a guide without clearly demonstrating the extent to which they offered the guidance to the learners. The teachers in the study shared some common understanding on this concept. I concluded that teachers have a vague knowledge of the concept of learner-centred teaching. Their construction just sees the role of the teacher as a guide and lacked explicit understanding of the theories and approaches that are involved in learner-centred teaching.

The teachers believed that learner-centred teaching was about the teacher guiding learners as they engage into a task. They engaged the learners into some small group work activity. To the teachers, guiding learners basically involved walking around class and watching the groups working on a problem or a task without making some meaningful interventions and encouraging them to participate.

Another conclusion drawn, was that the teachers' enactment of what they considered as "learner centred practices" prioritised the outward forms and avoided the main function of learner-centred practices which is to enable meaningful learning. An example of this was that the teachers stressed the importance of group work in their personal enactments of "learner-centred" practices. Their belief was that engaging learners into group work would enable meaningful learning in their learner-centred teaching. Hence, they organised their learners to sit in small groups during their observed lessons. However, they used a form of group work without attending to the substance underlying it.

7.4 THE ORIGINAL CONTRIBUTION OF THIS STUDY

The study has contributed new knowledge in the field of Mathematics education at primary school level in the context of Eswatini by showing that teachers' constructions of learner-centred education influences their classroom practices.

7.5 LIMITATIONS OF THE STUDY

Generally, any research could be affected by a number of factors. This current study is no exception as it has some limitations that emerged. Since by design, this is a qualitative case study, it would be difficult to state the extent at which the findings of this study would be generalizable. The observations and interviews were administered to only three Grade 6 Mathematics teachers from three different Primary schools in one of four regions in Eswatini. I wish the study had incorporated six or more Grade 6 Mathematics teachers from all the regions in the country. The study is therefore of limited scope hence the findings cannot be generalizable to all Grade 6 Mathematics teachers in Eswatini or across to other contexts. Nonetheless, the study will give an indication of constructions and enactments learner-centred practices by Mathematics teachers and where possible serve as a pilot study to further investigation for a larger scale study.

On the other hand, my inexperience in interviewing provided a serious limitation. This is because when I looked at the interview transcripts, I realized that some questions needed more probing in order to elicit more information from the research teachers. But I did not realize this at the time of data collection

whilst engaging the three teachers in the interview. For example, during my interview with the three teachers, I missed asking them about the role of the teacher in learner-centred teaching as a follow-up question after they had given me their meaning of learner-centred teaching. Here, their responses would have shed some light on facilitation as a key aspect of the role of the teacher in learner-centred practices. In essence, one of the teacher's role in learner-centred practices is to facilitate the learning processes as alluded earlier on in this chapter. The study has as well highlighted important implications for my own practice, the implementation of group work dynamics in learner-centred practices.

7.6 RECOMMENDATIONS

My focus in this study was to explore Mathematics teachers' constructions of learner-centred practices and the extent to which their personal enactments of "learner-centred" practices enabled meaningful learning. Data was drawn mainly from lesson observations and interviews with Grade 6 Mathematics teachers in Eswatini. Despite the teachers having a shared understanding of learner-centred teaching but they seemed to be struggling with the dynamics of group work in their classrooms facilitating group work as a teaching strategy to enable meaningful learning. This point to the fact that Primary school Mathematics teacher professional development programmes in Eswatini need to ensure that teachers are given opportunities to engage with and understand what the important ideas are that underpin a "learner centred" teaching approaches.

From the discussion of the findings of the study, it is evident that the three teachers were unable to employ the substantive form of group work as a strategy to facilitating learner-centred teaching. During group work activities, the teachers would simply watch what the groups were doing and moved from one group to another without encouraging learners to participate, or asking learners probing questions, or making some meaningful interventions.

That said, there is need for teacher professional development programmes that will ensure that teachers are given opportunities to engage with, and understand what the important ideas are that underpin a "learner-centred" teaching approach. There is also need for curriculum designers to seriously consider the

support structures they put in place to ensure that Grade 6 Mathematics teachers should facilitate group work in the classrooms. This may include, but is not limited to teachers' interventions during group work activities, asking learners some probing questions and encouraging participation among learners.

There is also need for pre-service providers to include courses that incorporate collaborative learning in their curriculum. This would help student teachers to master the appropriate Mathematics instructional skills group work dynamics hence enabling meaningful learning in learner-centred practices. Furthermore, the lecturers at pre-service need to model learner-centred practices as they conduct their lectures in order to empower their students' teachers with the necessary skills of implementing learner-centred approaches in their teaching of Mathematics.

7.7 RECOMMENDATIONS FOR FUTURE STUDIES

Below are suggestions for future studies:

- Studies which can explore the kinds of professional development programmes in place to support teachers implementing the curriculum.
- Studies which focus on the nature of Mathematics education instructional practices at the colleges of education
- Future studies should focus on all the four regions of the country and include rural schools to allow for a sound comparison of the Grade 6 Mathematics teachers' constructions and enactments of learner-centred practices. In the current study, data was collected from only one region and in urban schools in Eswatini.

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APPENDICES

APPENDIX A
REQUEST FOR PERMISSION TO CONDUCT RESEARCH

Ngwane Teachers college

P. O. Box 474

Nhlangano

29th June 2015

The Director Education

Ministry of Education and Training

P. Box 39

Mbabane

Dear Madam

Re: Permission to conduct educational research in the Shiselweni region

I am Henry C. M. Ndlovu (Student Number: 213573738). I am a PhD student under the supervision of Professors Michael de Villiers and Sarah Bansilal in the School of Education, Edgewood Campus University of KwaZulu-Natal. The area of my study is in Mathematics Education. The study is entitled: **"Learner-Centred Pedagogies: Meaningful Learning Constructions of Mathematics teachers".** It aims to describe and explain meaningful learning constructions in learner-centred practices of Mathematics teachers at Grade 6 level in Swaziland. I am asking for permission to conduct the above study in three schools in the Shiselweni region of the country.

Affiliation and contact details of the researcher with qualifications

Occupation: Lecturer – Mathematics Education at Ngwane Teachers College – Swaziland

Qualifications: BSc (Maths & Chemistry), Concurrent Diploma in Education (CDE), Bed Hons, MSc (course work).

Current Doctor of Philosophy study is being undertaken at the University of KwaZulu-Natal, School of Education, and College of Humanities.

Below are my contact details:

Email: henryndlv@gmail.com

Address: Ngwane Teachers College
P.O. Box 474
Nhlangano
Swaziland

Cell: (+268) 76143366

Work: (+268) 22078466/7

My supervisors' contact details are as follows: Professor Michael de Villiers (027-(0)31-2607252(w), +27 836561396(cell), e-mail: profmd1@mweb.co.za) and Professor Sarah Bansilal (cell: +27 832795916, e-mail: bansilalS@ukzn.ac.za).

You may also contact the Research Office through:

Phumelele Ximba

University of KwaZulu-Natal

Research Ethics office: HSSREC

Private Bag X 54001

Durban, 4000

Telephone: +2731 260 3587

Email: ximbap@ukzn.ac.za

Thank you for your contribution to this study.

Yours faithfully

Henry C. M. Ndlovu

(Student number: 213573738)

APPENDIX B

PERMISSION TO CONDUCT RESEARCH BY MINISTRY OF EDUCATION AND TRAINING

The Government of the Kingdom of Swaziland

Ministry of Education & Training

Tel: (+268) 2 4042491/5
Fax: (+268) 2 404 3880

P. O. Box 39
Mbabane, SWAZILAND

3rd July, 2015

Attention:
Head Teachers:
Evelyn Baring High School Ngwane Practising Primary School Nyamane Primary School

THROUGH
Shiselweni Regional Education Officer

Dear Colleague,

RE: REQUEST FOR PERMISSION TO COLLECT DATA FOR UNIVERSITY OF KWAZULU-NATAL STUDENT – MR. HENRY C. M. NDLOVU

1. Reference is made to the above mentioned subjects.
2. The Ministry of Education and Training has received a request from Mr. Henry C. M. Ndlovu, a student at the University of KwaZulu-Natal, that in order for him to fulfill his academic requirements at the University of KwaZulu-Natal, he has to collect data (conduct research) and his study or research topic is: *Learner-Centred Pedagogies: Meaningful Learning Constructions of Mathematics Teachers.* The population for his study comprises of three (3) qualified experienced mathematics teachers from the above mentioned schools. All details concerning the study are stated in the participants' consent form which will have to be signed by all participants before Mr. Ndlovu begins his data collection. Please note that parents will have to consent for all the participants below the age of 18 years participating in this study.
3. The Ministry of Education and Training requests your office to assist Mr. Ndlovu by allowing him to use above mentioned schools in the Shiselweni region as his research sites as well as facilitate him by giving him all the support he needs in his data collection process. Data collection period is one month.

Yours Faithfully,

DR. SIBONGILE M. MTSHALI-DLAMINI
DIRECTOR OF EDUCATION AND TRAINING

MINISTRY OF EDUCATION TRAINING 2015 -07- 03 BOX 39 MBABANE SWAZILAND

cc: Regional Education Officer – Shiselweni
Chief Inspector – Primary
3 Head Teachers of the above mentioned schools
Prof. Michael de Villiers

Page 1

APPENDIX C

REQUEST TO CONDUCT RESEARCH IN SCHOOL A

Ngwane Teachers college

P. O. Box 474

Nhlangano

24th June 2015

The Head teacher

Primary School A

Nhlangano

S400

Dear Sir/Madam

Re: Permission to conduct an educational research in your school

My name is Henry C. M. Ndlovu, student number: 213573738. I am a Doctor of Philosophy (PhD) student under the supervision of Professors Michael de Villiers and Sarah Bansilal in the School of Education, Edgewood Campus University of KwaZulu-Natal. The area of my study is in Mathematics Education. The study is entitled: **"Learner-Centred Pedagogies: Meaningful Learning Constructions of Mathematics teachers".** It aims to describe and explain meaningful learning constructions in learner-centred practices of Mathematics teachers at Grade 6 level in Swaziland. I am asking for permission to conduct the above study in your school.

Affiliation and contact details of the researcher with qualifications

Occupation: Lecturer – Mathematics Education at Ngwane Teachers College – Swaziland

Qualifications: BSc (Maths & Chemistry), Concurrent Diploma in Education (CDE), Bed Hons, MSc (course work).

Current PhD study is being undertaken at the University of KwaZulu-Natal, School of Education, and College of Humanities.

My contact details are as follows:

Email: henryndlv@gmail.com

Address: Ngwane Teachers College
P.O. Box 474
Nhlangano
Swaziland

Cell: (+268) 76143366

Work: (+268) 22078466/7

My supervisors' contact details are as follows: Professor Michael de Villiers (027-(0)31-2607252(w), +27 836561396(cell), e-mail: profmd1@mweb.co.za) and Professor Sarah Bansilal (cell: +27 832795916, e-mail: bansilalS@ukzn.ac.za).

You may also contact the Research Office through:

Phumelele Ximba

University of KwaZulu-Natal

Research Ethics office: HSSREC

Private Bag X 54001

Durban, 4000

Telephone: +2731 260 3587

Email: ximbap@ukzn.ac.za

Thank you for your contribution to this research.

Yours faithfully

Henry C. M. Ndlovu

(Student number: 213573738)

If you understand the contents of the letter and grant permission, I am kindly asking you to sign this declaration form.

Declaration Form

I.....(full name of Head Teacher) hereby confirm that I have read and understood the contents of this letter and the nature of the research project and I give consent to the researcher to conduct her study at the school.

APPENDIX D

REQUEST TO CONDUCT RESEARCH FROM SCHOOL B

Ngwane Teachers college

P. O. Box 474

Nhlangano

24th June 2015

The Head teacher

Primary School B

Nhlangano

S400

Dear Madam

Re: Permission to conduct an educational research in your school

My name is Henry C. M. Ndlovu, student number: 213573738. I am a PhD student under the supervision of Professors Michael de Villiers and Sarah Bansilal in the School of Education, Edgewood Campus University of KwaZulu-Natal. The area of my study is in Mathematics Education. The study is entitled: **"Learner-Centred Pedagogies: Meaningful Learning Constructions of Mathematics teachers".** It aims to describe and explain meaningful learning constructions in learner-centred practices of Mathematics teachers at Grade 6 level in Swaziland. I am asking for permission to conduct the above study in your school.

Affiliation and contact details of the researcher with qualifications

Occupation: Lecturer – Mathematics Education at Ngwane Teachers College – Swaziland

Qualifications: BSc (Maths & Chemistry, Concurrent Diploma in Education, Bed Hons, MSc (course work)

Current PhD study is being undertaken at the University of KwaZulu-Natal, Faculty of Education

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Nhlangano
Swaziland

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University of KwaZulu-Natal

Research Ethics office: HSSREC

Private Bag X 54001

Durban, 4000

Telephone: +2731 260 3587

Email: ximbap@ukzn.ac.za

Thank you for your contribution to this research.

Yours faithfully

Henry C. M. Ndlovu

(Student number: 213573738)

If you understand the contents of the letter and grant permission, I am kindly asking you to sign this declaration form.

Declaration Form

I.....(full name of Head Teacher) hereby confirm that I have read and understood the contents of this letter and the nature of the research project and I give consent to the researcher to conduct her study at the school.

APPENDIX E

REQUEST TO CONDUCT RESEARCH FROM SCHOOL C

Ngwane Teachers college

P. O. Box 474

Nhlangano

24th June 2015

The Head teacher

Primary School C

Nhlangano

S400

Dear Madam

Re: Permission to conduct an educational research in your school

My name is Henry C. M. Ndlovu, student number: 213573738. I am a PhD student under the supervision of Professors Michael de Villiers and Sarah Bansilal in the School of Education, Edgewood Campus University of KwaZulu-Natal. The area of my study is in Mathematics Education. The study is entitled: **"Learner-Centred Pedagogies: Meaningful Learning Constructions of Mathematics teachers".** It aims to describe and explain meaningful learning constructions in learner-centred practices of Mathematics teachers at Grade 6 level in Swaziland. I am asking for permission to conduct the above study in your school.

Affiliation and contact details of the researcher with qualifications

Occupation: Lecturer – Mathematics Education at Ngwane Teachers College – Swaziland

Qualifications: BSc (Maths & Chemistry), Concurrent Diploma in Education (CDE), Bed Hons, MSc (course work).

Current PhD study is being undertaken at the University of KwaZulu-Natal, Faculty of Education

My contact details are as follows:

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Address: Ngwane Teachers College
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Cell: (+268) 76143366
Work: (+268) 2078466/ 7

My supervisors' contact details are as follows: Professor Michael de Villiers (027-(0)31-2607252(w), +27 836561396(cell), e-mail: profmd1@mweb.co.za) and Professor Sarah Bansilal (cell: +27 832795916, e-mail: bansilalS@ukzn.ac.za).

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University of KwaZulu-Natal
Research Ethics office: HSSREC
Private Bag X 54001
Durban, 4000
Telephone: +2731 260 3587
Email: ximbap@ukzn.ac.za

Thank you for your contribution to this research.

Yours faithfully

Henry C. M. Ndlovu
(Student number: 213573738)

If you understand the contents of the letter and grant permission, I am kindly asking you to sign this declaration form.

Declaration Form

I.....(full name of Head Teacher) hereby confirm that I have read and understood the contents of this letter and the nature of the research project and I give consent to the researcher to conduct her study at the school.

APPENDIX F

LETTER OF INFORMED CONSENT FOR PARTICIPANTS

Ngwane Teachers college

P. O. Box 474

Nhlangano

3rd August 2015

Informed consent letter

Dear Participant

My name is Henry C. M. Ndlovu, student number: 213573738. I am a PhD student under the supervision of Professor Michael de Villiers and Professor Sarah Bansilal in the School of Education, Edgewood Campus University of KwaZulu-Natal. The area of my study is in Mathematics Education. Its title is: **"Learner-Centred Pedagogies: Meaningful Learning Constructions of Mathematics teachers".** The study aims to describe meaningful learning constructions in learner-centred practices of Mathematics teachers at Grade 6 level in Swaziland and explain how the teachers' constructions about meaningful learning influence their instructional behaviour.

Your school is one of the three schools where I will be conducting my research. In order to gather information for the research, you will be observed teaching a Mathematics lesson to a Grade 6 class and thereafter interviewed about the same lesson. The class has been chosen because it is an upper grade and is not a completing class.

The information obtained from this study will be made available to you through a copy that will be given to the school administration and may be kept in the school library to be accessed by anyone who has an interest in the teaching and learning of Mathematics. The value of this research exclusively depends on your contribution as your perceptions and experiences of the teaching and learning of Mathematics form an integral part of this study.

Please note that:

- Your confidentiality is guaranteed as your inputs will not be attributed to you in person, but reported only as a population member opinion.
- The interview may last for about 60 minutes.
- Any information given by you cannot be used against you, and the collected data will be used for purposes of this study only.
- Data gathered through the observational notes, transcripts, one-to-one interviews notes will be shredded and disposed to Town Council waste centre, and audio tapes and flash drives will be incinerated after submission of the thesis.
- You have a choice to participate, not participate or stop participating in the research. You will not be penalized for taking such an action.
- The research aims at helping the Swazi learners in improving their learning of Mathematics.
- Your involvement is purely for academic purposes only, and you will not be paid for participating in the study.
- If you are willing to be observed and interviewed, please indicate (by ticking as applicable) whether you are willing to allow the observation and interview to be recorded by the following equipment:

	Willing	**Not Willing**
Video recording		
Tape recording		

Name, affiliation and contact details of the researcher with qualifications:

Name of the researcher: Henry C. M. Ndlovu (213573738)

Occupation: Lecturer – Mathematics Education at Ngwane Teachers College – Swaziland

Qualifications: BSc (Maths & Chemistry), Concurrent Diploma in Education (CDE), Bed Hons, MSc (course work).

Current PhD study is being undertaken at the University of KwaZulu-Natal, School of Education, and College of Humanities.

Contact details:
Email: henryndlv@gmail.com
Address - Ngwane Teachers College
P.O. Box 474
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My supervisors' contact details are as follows: Professor Michael de Villiers (027-(0)31-2607252(w), $^{+}$27 836561396(cell), e-mail: profmd1@mweb.co.za) and Professor Sarah Bansilal (cell: $^{+}$27 832795916, e-mail: bansilalS@ukzn.ac.za).

You may also contact the Research Office through:

Phumelele Ximba
University of KwaZulu-Natal
Research Ethics office: HSSREC
Private Bag X 54001
Durban, 4000
Telephone: + 2731 260 3587
Email: ximbap@ukzn.ac.za

Thank you for your contribution to this research.

Yours faithfully

Henry C. M. Ndlovu

APPENDIX G

DECLARATION BY PARTICIPANTS

Ngwane Teachers college

P. O. Box 474

Nhlangano

3rd August 2015

Declaration by participants

I…… (full name(s) & surname of teacher) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

I understand that participation is voluntary and I am at liberty to withdraw from the research project at any time, should I desire and this decision will not affect me negatively. I understand that every effort will be made to keep my personal information confidential. I also understand that efforts will be made to provide me with feedback of the results of the completed research project.

.....

Signature of participant Date: .....

<u>Additional consent to audio recording:</u>

In addition to the above, I hereby agree to the video and audio recordings of the lesson and interview respectively for the purposes of data collection. I understand that no personal identifying information will be released in any form. I also understand that all recordings and manuscripts will be kept securely and be destroyed after all data capturing and analysis are completed.

.....

Signature of participant Date: .....

APPENDIX H

ETHICAL CLEARANCE CERTIFICATE

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

4 September 2015

Mr Henry Cedric Mfanuzile 213573738
School of Education
Edgewood Campus

Dear Mr Mfanuzile

Protocol reference number: HSS/0619/015D
Project title: Learner-Centred Pedagogies: Meaningful Learning Constructions of Mathamatics teachers

Full Approval – Expedited Application

In response to your application received on 1 June 2015, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol have been granted **FULL APPROVAL.**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

.....

Prof Urmilla Bob
University Dean of Research
On behalf of Dr Shenuka Singh (Chair)

/pm

Cc Supervisor: Prof M de Villiers & Prof S Bansilal
Cc Academic Leader Research: Professor P Morojele
Cc School Administrator: Ms T Khumalo

Humanities & Social Sciences Research Ethics Committee
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APPENDIX I

LESSON PLAN FOR MILTON

Date : 21 October 2015
Time : 0720hrs to 1030hrs
Class : Grade 6 A+B+C
Subject : Mathematics
Topic : Constructing a Triangle.
Objectives: By the end of the lesson pupils should be able to

(a) use a compass and ruler to construct triangles given the lengths of the three sides of the triangles.

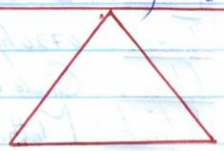
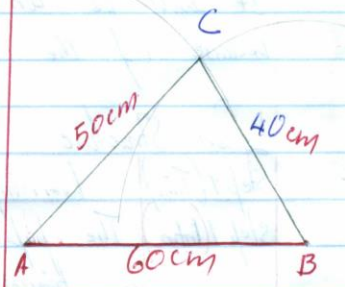
Teaching/learning Material
Grade 6 Mathematics Teacher's Guide
Grade 6 Mathematics Pupil's Book.
Ruler, Pencil, eraser, pair of compasses, grid papers.

Vocabulary.
Intersect, arc, radius pair of compasses, protractor, extended line, construct a circle and interior.

Teaching/learning strategies:
It will be an intergration of all the approaches because of the nature of the topic.

Lesson Structure

Step 1 (Time)	Learning/Teaching Activity	Learning Point
Step 1 (Intro)	The pupils will define a triangle	As a flat shape with three angles and sides.

Step (Time)	Learning/Teaching Activities	Learning Point
Step 2	The pupils will draw a triangle on the chalkboard without specific dimensions.	
Step 3	The pupils draw a line with a measurement on the chalkboard e.g a 60cm line. The ends of the line should be labelled with letter	scale: 1cm = 10cm 
Step 4	The pupils will locate the third corner of a triangle by making two arcs. Where the two arcs meet, marks the position or point of the corner or angle. e.g AC = 50cm and BC = 40cm	1cm = 10cm. 
Step 5	The pupils will then draw the complete triangle, with specified dimensions. -	Scale 1cm = 10cm 

Evaluation

The pupils will answer the exercise questions which are in their books in pairs.

Comment.

APPENDIX J

LESSON PLAN FOR THEMBA

Grade 6 Maths lesson plan

Date : Grade 6
Time : 10:45 – 11:45
Subject : Mathematics
Class : Grade 6
Number of Pupils : 50
Topic : The sum of the interior angles of a quadrilateral.

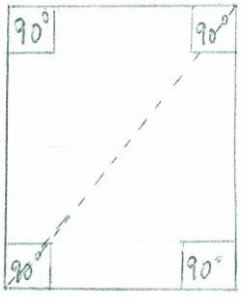
Rationale : Knowing angles is part of the 6th grade section. This lesson is about identifying and finding the sum of interior angles of quadrilaterals. This content is taught so that it fulfill the objectives needed in this 6th grade geometry.

Objectives : At the end of the lesson, the pupil should be able to:
- identify the four interior angles of a quadrilateral
- find the sum of the interior angles of a quadrilateral
- use the sum of the interior angles of a quadrilateral to calculate unknown angles in a given quadrilateral.

Prerequisite knowledge : Addition and subtraction skills.

Materials : Chart paper, grade paper, glue stick, scissors, grid paper.

Vocabulary : Interior angles, sum, quadrilateral, diagonals

Stage / Time	Teaching / Learning Activities	Learning Points
Introduction 5 Minutes	The teacher will ask pupils, "what a quadrilateral is?" Then he/she will ask them to give example of quadrilaterals they learnt about. Then says, "Today, we will learn how to find the sum of the interior angles of a quadrilateral.	Quadrilaterals is a closed figure with four sides and four interior angles. Ex Rectangles, squares, Kite, trapezium, Parallelogram, Rhombus
Presentation Step 1	The teacher will ask them "what does the word interior angles mean". Also ask them the meaning of the word "sum". Then the teacher will pin a chart on the chalk board with quadrilaterals. Pupils will mark the four interior angles of each quadrilateral and name it.	An interior angles is an angle inside a shape. Is the total or answer you get when adding numbers. 
Step 2	Pupils in their groups will draw any quadrilateral they like. Pupil and teacher define "diagonal". Then they will draw a diagonal line on their quadrilateral. They will have two triangles. Since we know the sum of the interior angles of each triangles is 180°. So for 2 triangles, the total sum of interior angles will be 180° + 180° = 360°	Sloping line that connect opposite angles of a flat shape. 

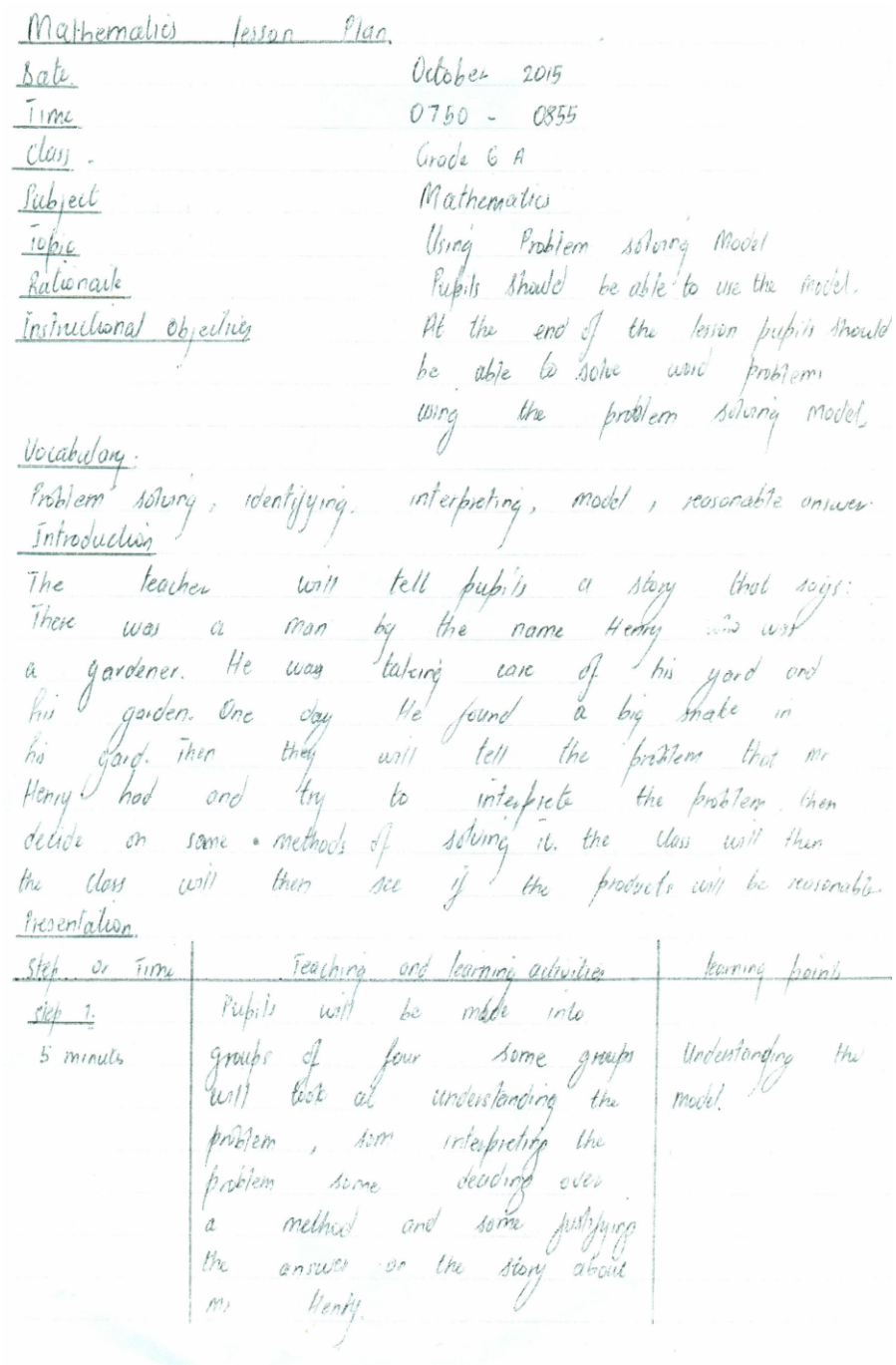
Step 3	Pupils form the quadrilateral they drew above. They will tear out the angles and paste them together. Then the teacher will ask them "What is it that they notices?"	The angles make a complete turn (add up to 360°)
Step 4	He/she will draw quadrilaterals on the chalkboard, pupils will find the size of the angled marked with a letter.	a)  b) 
Conclusion	The teacher will emphasize that all the sum of angles of any quadrilateral is 360°.	

Evaluation: Pupils will do the exercise on their pupils book page 158 individually.

Teacher's evaluation:

APPENDIX K

LESSON FOR SABELO



Mathematics lesson Plan.

Date: October 2015

Time: 0750 - 0855

Class: Grade 6 A

Subject: Mathematics

Topic: Using Problem solving Model

Rationale: Pupils should be able to use the model.

Instructional objectives: At the end of the lesson pupils should be able to solve word problems using the problem solving model

Vocabulary:

Problem solving, identifying, interpreting, model, reasonable answer.

Introduction

The teacher will tell pupils a story that says: There was a man by the name Henry who was a gardener. He was taking care of his yard and his garden. One day he found a big snake in his yard. Then they will tell the problems that Mr Henry had and try to interprete the problem then decide on some methods of solving it. the class will then the class will then see if the products will be reasonable.

Presentation

Step or Time	Teaching and learning activities	learning points
Step 1: 5 minutes	Pupils will be made into groups of four some groups will look at understanding the problem, som interpreting the problem some deciding over a method and some justifying the answer on the story about Mr Henry.	Understanding the model.

Step 2 10 minutes	The teacher will write the following problem on the board. Womkelwe bought 25 apples at E 1.20 each. She was given a discount of E 2.00 How much did she paid for the apples Pupils will work the problem in their groups	
Step 3 10 minutes	The problem will be worked as a whole class group. 1. identifying the question and giving facts: 25 apples Each cost E1.20 ammount paid is reduced by E 2.00 2. Interpreting the problem How much did Womkelwe paid for 25 apples at E1.20 with little reduction 3. Deciding on a method find the total amount then subtract E 2.00 E 1.20 x 25 = E 30.00 E 30 - E2.00 = E 28.00 4. Justifying the answer E 28.00 is a reasonable answer each apples cost a little more than E 1.00	Solving the problem

Evaluation

Pupils will do question to question four in page 154 of the pupils book.

APPENDIX L

CLASSROOM OBSERVATION SCHEDULE FOR THE GRADE 6 TEACHERS

Name of school: ……

Name of observer: …….

Date of observation: ……..

Name of observed teacher: ……

Grade observed: …….

Total number of learners: Female: ……..

Male: …….

Number of learners present: Female: ……..

Male: ……..

Lesson topic: ……..

Time of lesson: ……...

Length of lesson: ……

Video recording: Y/N ……

Focus observational items:

- Does the teacher use prior knowledge during his lesson introduction?
- Are learners actively involved in the formulation of the problem?
- What teaching method(s) is the teacher using in his/her teaching?
- Does the teacher encourage learners to participate during his lesson?
- Does his/her teaching promote learners' involvement in decision making process in the class?
- Are learners working in pairs, groups of threes, fours?
- What is the role of the teacher during the lesson?

APPENDIX M

INTERVIEW SCHEDULE FOR THE GRADE 6 TEACHERS

1. What was the highest form you completed at school?

2. What subject combination did you do in your highest form?

3. Do you hold a diploma or degree?

4. What college or university did you attend?
    a. How many years did you attend the college/university?
    b. What was your area of specialization?

5. In addition to secondary/high school and college/university, have you had any other formal education?
    a. If yes, ask the interviewee to tell you the name of the school/college, the subject(s) studied, and number of years attended.

6. How many years have you been teaching at Primary school level?
    a. How many years have you been a teacher at the current school?
    b. If 6 & 6a are different, ask the interviewee to list the other schools and number of years s/he taught at each school.

7. What subjects do you teach (currently)?
    a. How many learners are in each class?

8. How many hours, in total, do you teach per week?

9. In addition to teaching, what other responsibilities do you have at the school?

10. If you think back to when you were a student at school, what did you hope to do upon completion of your school education?

11. I would like to know about the courses on **how to teach** that you had at college. What courses on **how to teach** did you have in college?

12. If you compared the courses you took on how to teach your courses in your area of specialization at college, how were they similar/different?

13. In general, what teaching methods did your lecturers at college/university use?

14. Describe for me an example of when one of your lecturers at college talked about learner-centred teaching.

15. Could you tell me about the best example you recall from college in which one of your lecturers demonstrated or used learner-centred teaching.

16. Now I would like to know about your experiences as a student teacher.
    a. How many times during your college did you do teaching practicum?
    b. During which year(s) in your program did you do teaching practicum?
    c. How many weeks was your teaching practicum?
    d. How often were you observed by a lecturer from your college?
    e. Describe for me how you received feedback from this lecturer about the observation.
    f. I would like you to describe your experience the first time you did teaching practicum.

17. The Swaziland government is now requiring teachers to use learner-centred approaches to teaching Mathematics at Primary school level. How would you describe learner-centred teaching?

18. In your opinion, why does the Swaziland government now require Primary school Mathematics teachers to use learner-centred teaching?

19. Now I would like you to reflect on your lesson that I observed you teaching.
    a. What teaching strategy did you use?

b. Why did you use the strategy you mentioned in a. above?
c. How often do you use learner-centred teaching in your Mathematics lesson?
d. What do you think are the benefits of using learner-centred approaches to teaching Mathematics both to you as a teacher and to the learner?
e. What can you say about your experiences of using learner-centred teaching when teaching Mathematics?
f. Do you encounter challenges/problems when using learner-centred teaching? [Probe to find out more about challenges/problems]

20. Now I want us to focus on meaningful learning on your lesson that I observed you teaching.
    a. Was there meaningful learning in your lesson?
    b. What in your opinion is meaningful learning?
    c. What aspects of your lesson do you think made it meaningful?
    d. Give me possible strategies to make the learning of mathematics more meaningful and exciting for the learners.
    e. How often do you use concrete objects in your teaching of mathematics?
    f. Explain to me why you use concrete objects when teaching mathematics. Give reasons.
    g. What is prior knowledge in the teaching of mathematics?
    h. Why do you use prior knowledge when teaching mathematics?
    i. How often do you incorporate prior knowledge when teaching mathematics?
    j. Do you emphasize on the connection between mathematics and learners' everyday experiences/reality/previously learnt concepts? Elaborate.

APPENDIX N

INTERVIEW TRANSCRIPT FOR MILTON

	Transcription
Interviewer	Good Morning
Milton	Good Morning Sir
Interviewer	I have an interview for you, the interview is based on the lesson you have just taught so there is no wrong or right answer. This is only for research purposes. I will ask you some questions which are in 3 parts. There is this part on information about you then about learner cantered teaching. The last one is about meaningful learning.
Milton	Ok
Interviewer	What is your highest Form you completed here?
Milton	In Swaziland?
Interviewer	Yes
Milton	It is the diploma in teaching.
Interviewer	Form 5
Milton	Yes
Interviewer	What was your subject combination in your highest form?
Milton	It was Math, Science, Commerce, Accounts, SiSwati and English what else Physics and Chemistry, Biology and Agriculture.
Interviewer	Are you having a degree or diploma?
Milton	A diploma in Math and Science.
Interviewer	That is your area of specialization?
Milton	Yes
Interviewer	What college did you attend?
Milton	I trained at Ngwane College.
Interviewer	Ngwane Teachers College. How many years did you attend the college?
Milton	I took 3 years.
Interviewer	Your area of specialization?
Milton	Pure Mathematics and Science.

Interviewer	In addition to Secondary or high school or college, did you have any other formal education apart from what you did at Ngwane?
Milton	No, I did not have.
Interviewer	How many years have you been teaching here?
Milton	This is the 3rd year.
Interviewer	How was your teaching experience?
Milton	I enjoy teaching especially Math and Science in all I was teaching I taught Math and Science only. I enjoy it a lot. What makes me to feel happy is that most of the time pupils who are taught by me Math and Science they really compete and do well.
Interviewer	So, in this particular school.
Milton	Yes, I did.
Interviewer	Have you taught elsewhere?
Milton	Yes, in Nhlangano Central Primary.
Interviewer	For how long?
Milton	One year.
Interviewer	Okay the only schools where you have taught is at ----- Nhlangano Central Primary and this school.
Milton	Yes, as a qualified teacher
Interviewer	Yes
Milton	I do have an experience of teaching before I became a qualified teacher as a temporary teacher.
Interviewer	How long did you teach
Milton	I taught for about three years from 2005 to 2008.
Interviewer	So, what subjects do you teach?
Milton	Math and Science.
Interviewer	So, 3 classes. How many learners in each class?
Milton	Roughly 40.
Interviewer	There are 3 classes one is 39, one is 40 and the other one is about 39. In total how many hours do you teach per week?

Milton	For Math it is 10 per class. Each period is 30 minutes which means how many hours per week is 50 hours per class per week.
Interviewer	Besides teaching what other responsibilities do you have at the school?
Milton	We call it sports master. That's the responsibility.
Interviewer	If you think back to when you were a student in school what did you hope to do after completing your school education?
Milton	My desire it was being an engineer.
Interviewer	I want to know about the courses on how to teach that you had at college. What courses did you do at college on how to teach?
Milton	On how to teach, there was Professional Studies which is education, they taught us on how to teach and how to interact with the pupils. Even in Mathematics they do have methods of teaching. They taught us how to teach especially in Mathematics.
Interviewer	How were these courses similar?
Milton	Yes, they are similar because both of them they talk about the young ones that when you we come out from training you must be with them. They were addressing the same challenges that we are going to face.
Interviewer	What teaching methods did the lecturers at college use, the lecturers themselves?
Milton	They mostly lecture us.
Interviewer	So, describe for me an example of when one of your lecturers at college talked about learner-centred teaching. Just one example. Lecturer was talking about learner-centred teaching.
Milton	Yes, that's good. I do have one. In professional studies they taught us about child-centred learning in education and they taught us about how it is done and in mathematics

Milton	If I can recall what I got their learners teach each other by asking each other questions they derive their own way of learning and understanding dealing with each other.
Interviewer	I would like to talk about your experience as a student teacher. How many times during you teaching practice?
Milton	I did it twice.
Interviewer	During which years did you do teaching practice?
Milton	It was year two and three.
Interviewer	How many weeks was your teaching practice?
Milton	Six weeks, six per year.
Interviewer	How often were you observed?
Milton	I was observed several, many times. If I can recall when I was doing the last year, I was visited six times. Lecturers from the college, inspectors and the university people
Interviewer	How did you receive a feedback from these people who were observing you and how were you given some feedback?
Milton	They were having a copy of their comments. Yes, they used to give me the copy of their comments. Most of the time I used to ask them why, how, where I should improve. I always wanted to have some good points.
Interviewer	Your first-time experience in your teaching practice what was your first time of teaching practice?
Milton	It was not easy the first time you see pupils for the first time that you don't know and they also don't know you so you think how they are going to understand me. Would I be able to come to their level?
Interviewer	Okay now I want to focus on learner-centred approaches. Now the Swazi Government is advocating for learner-centred approaches to teaching mathematics. What is learner-centred teaching?
Milton	Learner-centred education is whereby learners, I mean the teaching is centred around the learners. The learners are given the opportunity to go over the content and come out

	with their own ways of understanding. They show how they understand and their teacher is there to monitor and guide other than just giving them all the information. The pupils have to discover the information.
Interviewer	In other words, you are saying that the role of the teacher is to.....
Milton	Guide the learner and give direction, and encourage discussions among groups.
Interviewer	Why does the Swazi government require mathematics to be taught using the learner-centred teaching?
Milton	I think the government people they have discovered that they are these pupils are not just empty vessels. They do have information. So, if they are allowed to express themselves, they will learn better than just being taught things as it used to be. I think somebody has discovered that these pupils are talented, they have skills in learning. If they want to share this they are allowed to, they can help each other.
Interviewer	Ok nice. Now lets us focus on the lesson that you were teaching. What was the teaching strategy that you used?
Milton	It was an integration of strategies of approach it was a teacher, learner-centred because that is when I started demonstrating construction and that has to be demonstrated first. Then I asked one learner to come and show the other learners that these things that he can do it.
Interviewer	You are saying it was an integration. Why?
Milton	The nature of the topic.
Interviewer	How often do you use these learner-centred teaching?
Milton	I use it a lot especially here in Grade 6. The syllabus is aiding the topic they have learnt earlier on. Especially here, some of the topics are building on information which they learnt in the first term. Also, on information they have learnt in previous grades.
Interviewer	Now do you always use this most of the time.

Milton	Yes
Interviewer	What are the benefits of learner-centred approaches to teaching?
Milton	There are. One of them is that as we know pupils, they teach each other better than us for e.g. if they are learning together, they are discussing there could be things that I could not impart to them that they will be able to get from their peers. Secondly it also helps me as a teacher to identify their challenges because they will show me where they are. The information they have about a topic and show me exactly where they are to the point, I would like them to be.
Interviewer	Are there benefits to you as teacher?
Milton	To the learner.
Interviewer	What can you say about your experience of using learner-centred teaching when teaching mathematics?
Milton	Ya it is good. It is a style that should be adopted. It helps us both of us, the pupil and the teacher.
Interviewer	Do you encounter some problems? What are the challengers that you face?
Milton	There are because most of time child-centred learning, it needs you to make the groups in the class. Others they rely on the peers working out those questions by themselves.
Interviewer	You think about the facilities do you have problems with the resources, the teaching materials
Milton	Ja sometimes we might be managed to be cornered by the teaching facilities to make those groups in this school. Sometimes we can make them. Teaching facilities we do have them in this school.
Interviewer	What about the cooperation from the learners because you are talking about groups? Are they used to this grouping them?
Milton	Yes, there are some challenges there. My learners especially in Math and Science they are competing even if you put them

	in groups the person will want to do their own thing. They will want to be the first one to present to the teacher. It makes the group not be effective.
Interviewer	This is the last section and it is talking about meaningful learning. Now in a lesson you have got one hour and 10 minutes. Was there any meaningful learning in your lesson?
Milton	I think so.
Interviewer	In your understanding what does it mean to be meaningful?
Milton	According to my own understanding it is a meaningful lesson..
Interviewer	In your understanding what is meaningful learning?
Milton	Meaningful learning is whereby the learners are able to take the challenge to solve problems that you have given them.
Interviewer	If you come back to the lesson now the aspects of this lesson do you think that made it meaningful? What are the aspects that made it meaningful?
Milton	The aspects of this lesson. I think what made it meaningful was the articulation of the facts meaning it was clear to the learners that's why they were able to follow through all the steps involved in constructions.
Interviewer	Okay can you give me some possible strategies to make learning mathematics more meaningful and exciting for learners? Possible strategies that will make it more meaningful. Make the lessons more meaningful.
Milton	Mathematics is a technical subject. It has to do with a lot of practice. It is a lot of hands on working. The pupils should practice it and the teacher should make it more practical and if possible, concrete object can be used. Those things make the picture on how to work out problems. The picture last for a long time.
Interviewer	So, there is a way to make the lesson more meaningful.
Milton	Yes

Interviewer	So, you were talking about concrete objects, how often do use concrete objects in when teaching mathematics?
Milton	I use them a lot. As I said earlier on concrete objects make the picture in the mind of the child. The picture lasts longer than words.
Interviewer	In other words, they are useful they are there to make some lessons meaningful so that there is meaningful learning.
Milton	Yes
Interviewer	Do you know anything about prior knowledge?
Milton	Yes
Interviewer	What is prior knowledge?
Milton	It is knowledge that has been acquired.
Interviewer	Why do you use prior knowledge?
Milton	It is important because you have to take the known to the unknown. In fact, prior knowledge as I used it earlier on these pupils are not empty vessels, they have knowledge that they have acquired. It shapes what they have to something. You add to what they are having.
Interviewer	How often do you use it?
Milton	I use it a lot. For instance, in the lesson I asked them about a triangle. They know what a triangle is. Are able to define it its qualities. Others went to the extent of describing the qualities of triangles. Now what was new was how to construct it using certain measurements, a pair of compasses.
Interviewer	There is this thing of everyday experience that is the connection between mathematics and learners' everyday experiences. Do you incorporate that into your teaching?
Milton	I do a lot because those experiences they help the pupils to understand the lesson.
Interviewer	How?
Milton	I am a Math and Science person if we talk about everyday experience for example there are some toys that are triangular formed. If you are teaching about triangles come

	with that toy. They will be excited. They will be excited to follow what you are going to present. Then you will trigger the desire to follow what you will present.
Interviewer	In this lesson did you talk about their everyday experience constructing a triangle?
Milton	No, I did not.
Milton	Here I used the information that is already inside them. That's why I asked them to come and draw the triangle at the beginning of the lesson because that is something that they know. They are happy when they can prove to their teacher that we know something about.
Interviewer	Do you emphasize on the use of it in your lessons?
Milton	Yes, I do.
Interviewer	This is the end of the interview. Thank you very much for contributing to my study.

APPENDIX O

INTERVIEW TRANSCRIPT FOR THEMBA

	Transcription
Interviewer	Ok. Good morning. How are you?
Themba	I am fine.
Interviewer	Okay what I have here it's an interview. The interview is based on the class you have just taught. There are several questions I am going to ask you. Somehow it is divided into 3 sections. There is some personal information about you. There is also learner-centred teaching or approaches and then there is meaningful learning. So, I will just ask you the questions and you will respond. This is for research purposes. Actually, there is no wrong or right response. And I will make sure everything that all your responses are confidential. Okay let us then start.
Interviewer	What was the highest form you completed in school?
Themba	O level.... Form 5
Interviewer	What subject combination were you doing in Form 5?
Themba	Physics, Maths, Agriculture and Geography.
Interviewer	Do you hold a diploma or a degree?
Themba	A diploma.
Interviewer	At what college? Where did you get it?
Themba	Ngwane Teachers College.
Interviewer	How many years did you attend there?
Themba	Three years sir.
Interviewer	Did you have a specialization in that college?
Themba	It was Maths and Science.
Interviewer	Now in addition to your secondary schooling, have you had any other formal education? Apart from high school, any other formal education.
Themba	After I finished school, I went to do a course on computers. (A lot of background noise, can't hear the words properly).

	A computer course I worked for the NGO which is NURTURE about HIV and AIDS.
Interviewer	How many years have you been teaching at Primary School level?
Themba	Almost 3 years but it is 2 full years.
Interviewer	And in this particular school?
Themba	Two years.
Interviewer	Any other school you have taught?
Themba	No, I teach Math and Science at Grade 6 and Grade 5. That means Grade 6 I am taking Mathematics and Science and Grade 5 I am only taking only science.
Interviewer	How many learners are in each class?
Themba	The one I teach in Grade 6, there are 50 learners and in Grade 5 there are 45.
Interviewer	If you think about the hours that you have per week
Themba	We try by all means to accommodate all the subjects. For Math it is 6 hours and that is 1 hour, 1 hour, 1 hour. That is 4 hours because Monday, Tuesday and Thursday and I give it 2 period, 2 period it is 30, 30, 30. The total is 4 hours.
Interviewer	Now in addition to teaching do you have any other responsibilities besides teaching?
Themba	Besides teaching we have committees for example, I am a chairman of this ICT. So, we have to go to donors when the governments fund is not enough, we just go outside and see donors who can assist us giving us all the things we need in the laboratory. I am just the head of that committee.
Interviewer	That's the responsibility of the community.
Themba	Find donors for the computers and how to maintain the equipment we have to keep it in good shape so we are trying to make sure everything is in order.
Interviewer	Now think back when you were in school what sort of work did you think you will be doing after completing school.

Themba	I thought of being a lawyer. Teaching was a passion to me so I said if I fail to be, I will come to teach so luckily for me I am now teaching. I don't care about it, I like it.
Interviewer	You were aspiring to be a lawyer, now I am glad to hear about the courses you had at the college. Were you taught some courses on how to teach?
Themba	Yes, we were taught on how to teach especially we were taught on the approaches how to teach in the Primary
Interviewer	Now if you compared the courses you took on how to teaching courses in your area of specialization college how were they similar there were some courses that you took on how to teach in your area of specialization any maybe in education you called it professional studies or so how was that similar or different the courses were they similar of different
Themba	Almost the same because when you talk about teaching a child, they give you these are the things you are going to approach I was surprised when I was on the field the majority of the things, they were teaching us we find the things are there/exist.
Interviewer	Let us talk about the teaching methods you were taught at college those you can remember.
Themba	The discovery method and the discussion method
Interviewer	Now you describe for me briefly an example of when one of your lecturers at college talked about learner-centred teaching whilst you are in college. Could you tell me about the best example you recall from college when one of your lecturers demonstrated / used learner-centred teaching
Themba	Yes, especially when you are doing some topics in Math. The teacher would just give us everything about the topic and then he gives us some topic and its us who is going to give him everything on the topic he is presenting. I like it so much

	even here in school. Because even here at school I am still using it where it is supposed to be used.
Interviewer	So, in other words you were taught learner-centred teaching at college.
Themba	Yes
Interviewer	So, you learnt about it. Now let me talk about your experience as a student teacher. Did you go for teaching practice?
Themba	Yes
Interviewer	How many times did you do teaching practice?
Themba	2 times
Themba	2 times, 2nd and 3rd year.
Interviewer	How long was your teaching practice?
Themba	6 weeks
Interviewer	6 weeks per year?
Themba	Yes
Interviewer	How often were you observed by a lecturer from your college?
Themba	They check me at least five times.
Interviewer	How did you receive feedback from the lecturers?
Themba	After I have taught I was doing teaching practice after that the lecturer would come in the class he would take a seat at the back them he would observe as I am teaching then after he/she observes s/he would call me after the lesson and give me the feedback that is where you are powerful, and that is your weakness point so try to improve in that. Then when they come the following day, he would take it from there where he said I should improve. Then he would see whether I was able to work on that.
Interviewer	What was your experience the first time you went for teaching practice?
Themba	It was tense and I don't want to lie because my problem was that when I was doing the writing on the chalk board. That

	was my weak point because I was afraid that every time I go and write on the board. Then I improved as time goes on.
Interviewer	Now let us focus on learner-centred teaching. In Swaziland for instance the government is now requiring teachers to use learner-centred approaches to teaching mathematics at primary school level. How would you describe learner-centred teaching? What is it?
Themba	According to my understanding learner-centred teaching: the learners are the ones who are finding facts and the teacher is just coming with the topic and with questions just to guide them but the learners are the ones who are learning themselves the concepts in everything in mathematics. Just guide them with the questions and assist them then and there but they are the ones who are doing everything.
Interviewer	That is your description. Now in your opinion then why does the Swaziland government require mathematic teachers to use learner-centred teaching? Why does the Swaziland government require them to use that approach?
Themba	I think the government is aware that they need people at the end who will come out and face or deal with the situation across as the world is developing. So, they are trying by all means so that children are critical thinkers themselves and they can be able to face problems and come up with solutions.
Interviewer	Now let us reflect on your lesson that I observed. It was about quadrilaterals. Finding the angle sum of a quadrilateral. What teaching method did you use?
Themba	I just used the demonstration.
Interviewer	The topic is the sum of interior angles of quadrilaterals. You used the demonstration strategy. Why did you use this method?

Themba	I used to demonstrate some concepts. This is the way you are supposed to do it. I have to demonstrate it and then they are the ones who have to find the answers for themselves.
Interviewer	Does it have any connection with learner-centred teaching?
Themba	It has a lot because I just think I must guide them then they themselves are going to find it how it is calculated.
Interviewer	How often do you use learner-centred teaching in your math lessons?
Themba	Most of the time. I try to.
Interviewer	What are the benefits of learner-centred teaching? Maybe if you can divide them into two categories. The benefit to the teacher and the benefit to the learner.
Themba	I think the benefits to the teacher because once we have presented and the people have grasped the information, they won't forget it because we won't go back to it. It is good for the learners because it will help them not to forget the concept they were taught about. They don't easily forget them.
Interviewer	What are the challengers about learner-centred teaching? What challengers do you face? Just talk about the experiences that you have.
Themba	The challenge I have with it is that it exhausts a lot of time and because it exhausts all the time that's why. Another thing once I exhaust the time another thing the challengers, we had been the number of children is big, a lot of time is wasted because we have to go back and assist the learners.
Interviewer	This comes again to the challengers. Are those the only challengers you encountered?
Themba	The big numbers and the time we have is not enough because we have an hour. So, it's not enough.
Interviewer	Let's move onto to the so-called meaningful learning. In this particular class you are in and taught was there any meaningful learning

Themba	There was.
Interviewer	In your opinion what is meaningful learning?
Themba	It is a learning in which we come up with good sense in what you are teaching. Because in grade 6, I think the concepts that I was teaching was in geometry so the children they have to know these things in real life. That's why I think it is meaningful.
Interviewer	Okay so in real life how can you put it?
Themba	I said geometry sir, so now we are calculating angles this thing is meaningful in real life because he does in primary level. When they grow up everybody is not going to be a doctor or a lawyer. So, when you are dealing with angles some will be a builder or carpenter so we are dealing with angles, dealing with calculations. It is meaningful learning because we face these things in the outside world.
Interviewer	It's only the geometry that you are talking about. Give me possible strategies that will make the learning of mathematics more meaningful. How can you enable meaningful learning in your teaching?
Themba	I don't know how I can answer this question. I think what you are talking about is somehow the application when you push further you see that the in meaningful learning learners will be able to do this in the end.
Interviewer	Do you know concrete objects in teaching?
Themba	I don't know.
Interviewer	It is sort of the teaching aids. We refer to them as concrete aids. Some lecturers are teachers may emphasize not just talking. Do you actually use concrete material when you are teaching your math lessons?
Themba	I use them.
Interviewer	How often do you use them?
Themba	Most of the time.
Interviewer	Why do you use them?

Themba	It brings reality to the children. My topic was about quadrilaterals in the previous class I was also teaching them. They know what a quadrilateral is. They know a square, a parallelogram and a kite. They know and it makes sense.
Interviewer	In other words, in your lesson you used concrete material.
Themba	Yes
Interviewer	Do you know anything about prior knowledge in the teaching of Mathematics? What is prior knowledge in the teaching of Mathematics?
Themba	According to my understanding it is the information they have before they get into the new concepts. The one that they have based on mapping. Information they had before I gave them the new information.
Interviewer	Why do you use prior knowledge when teaching Mathematics?
Themba	I am just stimulating their thoughts. So that they easily link the old concepts with the new concepts. It is easy for them.
Interviewer	Is it useful?
Themba	Yes
Interviewer	How often do you incorporate prior knowledge when teaching Mathematics? Do you always use the prior knowledge?
Themba	I used it so many times sir. I use them as my introduction most of the time so that they link and so it's easy for them. It is easy to apply to their concepts.
Interviewer	Now let us look at everyday experiences. Do you emphasize on the connection between mathematics and learner everyday experiences? Do you normally emphasize on that?
Themba	Not most of the time. But now I think you have just made my mind up to think about it and use it most of the time. When I am doing the lesson, I will try by all means to link them with a situation outside with the Mathematics.

Interviewer	This brings us to the end of our interview. Thank You very much. Thank you for your co-operation and contributing something to my study.
Themba	Thank You

APPENDIX P

INTERVIEW TRANSCRIPT FOR SABELO

	Transcription
Interviewer	Good Morning, I have an interview for you. The interview is based on the lesson you taught. The purpose of the interview is for research purposes. I am not trying to find out whether you were teaching right or wrong or there were things that you did not do well and whatever. It is for research purposes. There are no correct or wrong responses. And of course, I am going to keep everything confidential as per research ethics. Now my interview is divided into 3 categories. There is some information about you. There is some interview about learner centred teaching and the last one is about meaningful learning. The last two are based on the lesson you taught. My first question is what is the highest form you completed in school?
Sabelo	At School.
Interviewer	Yes, at school in your formal education. At school not college.
Sabelo	Form 5.
Interviewer	What subject combination did you do in your highest form?
Sabelo	I was doing Mathematics, Physical Science, Geography, SiSwati, English, Biology, the last one was Agriculture.
Interviewer	Do you hold a diploma or degree?
Sabelo	I hold a diploma.
Interviewer	Diploma in what
Sabelo	In Education.
Interviewer	Education, what college or university did you attend?
Sabelo	I attended Ngwane Teachers Training college.
Interviewer	How many years did you attend the college?
Sabelo	3 Years.
Interviewer	What was your area of specialization?

Sabelo	It was Math and Science.
Interviewer	In addition to Secondary education and College, have you had any other formal education?
Sabelo	I had but not completed IT.
Interviewer	IT, where.
Sabelo	Oxford
Interviewer	Is it a college?
Sabelo	Yes, a college in Manzini.
Interviewer	What is IT by the way?
Sabelo	Its Information Technology.
Interviewer	How many years have you been teaching?
Sabelo	Here at this school?
Interviewer	Yes
Sabelo	Its 2 years.
Interviewer	Have you taught in any other school?
Sabelo	No
Interviewer	So, after completing your diploma you came down here.
Sabelo	Yes, I came here
Interviewer	What subject do you teach currently?
Sabelo	Mathematics, Science and Religious Education.
Interviewer	How many learners are in each class?
Sabelo	35 and 38
Interviewer	What subject is that?
Sabelo	I am teaching 2 classes the other class has got 35 and the other one has got 38.
Interviewer	So how many hours in total do you teach per week?
Sabelo	Its 44 hours.
Interviewer	44 hours per week?
Sabelo	It means I got 44 periods. Because one period is one hour.
Sabelo	I am mistaken I got 22 because I got 44 periods.
Interviewer	22 hours per week. What other responsibilities do you have at school here?

Sabelo	I am doing career guidance.
Interviewer	Is that all.
Sabelo	Ja
Interviewer	If you think back when you were a student at school what did you hope to do after the completion of your schools' education
Sabelo	In fact, teaching was not my first choice. I wanted to do chemical engineering.
Interviewer	By the way you were doing science subjects at school.
Sabelo	Yes
Interviewer	Now I would like to know about the courses on how to teach that you had at the college. What courses did you do on how to teach?
Sabelo	The first time I was introduced into teaching using the learner-centred approach not teacher-centred I think that is the one.
Interviewer	Is that the only one?
Sabelo	Yes.
Interviewer	It was an approach to teaching a course purse say you just compared in education and in your area of specialization, where the courses are different? The courses on how to teach where they are different? Those that they taught you in education
Sabelo	They are mostly alike. Not that different. Most of the time you would find that what you are doing in education is the same as in our area of specialization.
Interviewer	In general, what teaching methods did your lecturers at college use?
Sabelo	Most of the time the lecturers will be doing the work. I think at college we were doing the work.
Interviewer	You describe an example for me when one of your lecturers at college talked about learner-centred teaching.

Sabelo	I will pick one I remember most of the time when a child is fed with information the teacher is responsible when feeding the child with information. The child is easy to lose the information. When the child is doing the learning on his own it is hard to forget what he has done.
Interviewer	Did the lecturers ever demonstrate the learner-centred teaching for you?
Sabelo	They did demonstrate it. But not all the time. They were using learner-centred teaching. They will just come and pose to us than give us to go and details a particular subject and then summarize it together.
Interviewer	Give me your experience as a student teacher. How many times during your college did you do teaching practice?
Sabelo	I think 2 times. During which year?
Interviewer	During which year did you do it.?
Sabelo	It was year 2012 and year 2013.
Interviewer	Okay you stayed there for 3 years. During which year did you do your teaching?
Sabelo	I did it year 2 and year 3.
Interviewer	How many weeks was your teaching practice?
Sabelo	Each year 6 weeks. It took 6 weeks each.
Interviewer	How often were you observed by a lecturer from your college? Let say per teaching practice. In year 2 or 3 how often did they visit you?
Sabelo	Year 2 I was observed four times. In year three it was about six times.
Interviewer	Describe to me how you received feedback from the lecturers about the observation. How were you given the feedback?
Sabelo	At times they will write because there is this form that they have to complete. They will give us the form and what they will do is give the strong points and weak points

	encouraging me on how to work on the weak points to do better in my teaching.
Interviewer	Was it immediate after you have taught the class or wait maybe until the end of the teaching practice?
Sabelo	Every day they visited me just one day after finishing it they will call me and I will go
Interviewer	I would like you to describe your experience say the 1st time you went for teaching practice. What was your experience?
Sabelo	The main problem with that is that you fear when you coming to a place for the first time. So, the first time when you were there, I look at the pupils I was like or will they listen to me? Will they work together with me? Only to find out that when we begin to work, they were so good then I had a good experience my first time.
Interviewer	Now learner-centred teaching that is the 2nd part of our interview. The Swazi government requires teachers to use learner-centred approaches to teaching mathematics at Primary school level. How would you describe learner-centred teaching?
Sabelo	I think learner-centred teaching is when the teacher is not the master of the class. But the learners are given the opportunity just to learn from themselves and one another and learning from one another and learning by doing the learning by themselves than by being fed by the teacher.
Interviewer	What is the role of the teacher when teaching?
Sabelo	The role of the teacher in learner-centred teaching is guiding, observing the learning and helping the learners to do their learning.
Interviewer	My next question is in your opinion why do you think the Swazi government is advocating for learner-centred teaching. Why do they want Primary school mathematics teachers to use learner-centred teaching?

Sabelo	My belief is that most of the time people fail to have responsibilities when they are grown-ups. Our government has made a point that let the people be able to take responsibility at their tender age. Learning to do work for themselves.
Interviewer	Now I would like you to reflect on your lesson which I also observed. What teaching strategy did you use?
Sabelo	Mmm it was sort of learner-centred, I was giving the pupils some time to discuss as discussing will be helping each other. And others will see way of solving particular problem.
Interviewer	Ok the topic was what?
Sabelo	The topic was problem solving. Specifically using problem-solving model.
Interviewer	What I am trying to get is the method you were using to teach the problem-solving model.
Sabelo	The method I was using was questioning and answering. I will give the people the problem and they will ask.
Interviewer	Why did you use this strategy, this method you were using?
Sabelo	I just observed that for our schools those not able to and children fail problem solving because they did not have time of understanding the problem. They are not good in English so and I was trying to encourage them make sure you are able to speak and you are just able to answer to see how you can respond if you are questioned.
Interviewer	The 1st part is like you were using the question and answer, why did you decide to use the question and answer?
Sabelo	I just wanted to let them be part of speaking.
Interviewer	How often do you use learner-centred teaching in your mathematics class?
Sabelo	Most of the time I will try to use it but not all the time.
Interviewer	What are the benefits of using learner-centred teaching?

Sabelo	What I have noted is that when they are part of the learning every time, they will be speaking about what they learned when it is break time and it helped me to see that the learner-centred teaching, it makes them enjoy the learning. That is the benefit.
Interviewer	What about you, do you benefit from using the learner-centred approach?
Sabelo	I have learnt that sometimes you might teach they say even this one can help us? So, it gives more options.
Interviewer	Now let's look at your experiences about learner centred-teaching. What can you say about using learner-centred teaching when teaching mathematics? The challenge that you get when you use learner-centred teaching.
Sabelo	My experience is that learner-centred approach at times some lessons will demand materials that are sometimes then hard to get then you have to improvise on times. Most of the times it has not been that bad.
Interviewer	Do you ever have a challenge on the time when using this approach?
Sabelo	Almost every time. I have a plan when they are doing their activities, they will take almost most of their time. I will be spending more time unable to finish the lesson at an appropriate time.
Interviewer	Ok let's talk about the number of learners you made them seat in certain group and they were doing something in groups. What about the number? Is it not challenging? Is it not giving you some tough time - the big number of students you have in your class?
Sabelo	At times they give a challenge. As a teacher you have got to attend to every learner. Making sure that he/she is part of it.
Interviewer	Do you encounter some challenges when using learner-centre teaching? Do you ever have some problems and if you

	do have what problems do you have when using learner-centred approach?
Sabelo	Most of the time these people are able to help each other because they are the one conducting the lesson by themselves.
Interviewer	Somehow in their lesson they were a bit quiet in their groups. At times there will be minimal talking. Why?
Sabelo	I think most of the time as I have mentioned before our people they have got a challenge of speaking in English so they feel like I cannot speak. Maybe if I speak then they are not going to understand me. Some people they don't have that braveness to state their opinions.
Interviewer	Were they doing some discussions, were they really talking in their groups?
Sabelo	Actually they were talking but like whispering.
Interviewer	Let's move on to the last part of my interview here which is about meaningful learning.
Interviewer	Again this is based on the lesson you taught. Was there any meaningful learning in your lesson?
Sabelo	I think there was. At times when you check you find that they are doing it. Most of the time when it comes to problem solving learners have a challenge with the English language.
Interviewer	What in your opinion do you understand about meaningful learning?
Sabelo	I think meaningful learning is when learners are able to express their learning and the teacher could be able to observe that learning has happened.
Interviewer	If I may ask you: was there meaningful learning in your lesson?
Sabelo	I think there was meaningful learning just because while they were learning, the learners as they were in groups were able to express their understanding sort of.

Interviewer	Is there any way to make meaningful learning in any Mathematics lesson?
Sabelo	I believe there is a need. When we say there is meaningful learning, the learners will express understanding and its importance hence will take the learning seriously.
Interviewer	What are the benefits of meaningful learning?
Sabelo	When they are making it meaningful on their side they are able to take the learning serious. So taking their learning serious they are able to learn and they can take their time during the course of the learning.
Interviewer	What strategies can you take to facilitate meaningful learning in any Math lesson?
Sabelo	I think it is giving the learners more ways of feeling part of the lesson keeping them busy. And at times as the teacher is conducting the lesson s/he can help them to see the importance of that learning. Usually Mathematics is based on daily life.
Interviewer	Let's talk about concrete objects. Do you know anything about concrete objects?
Sabelo	It's tangible.
Interviewer	Like what? For example.
Sabelo	Something that you can touch example like a duster, like chart, a stone. Something you can touch.
Interviewer	How often do you use concrete objects in you teaching of Mathematics?
Sabelo	I use them but not always.
Interviewer	So normally you use them.
Sabelo	Normally I use them.
Interviewer	Why do you use them?
Sabelo	These kids love playing, when I come with something they can touch, something they can handle. You will find that during the course of the lesson they are just happy for the thing and it is hard for them to forget that lesson.

Interviewer	If you can think of some reasons for using concrete objects. What will be the reasons?
Sabelo	For making the lesson enjoyable to the learners. At times it will be like a game to them. While they are learning they enjoy.
Interviewer	What about when it comes to the concept you are teaching. You see you are teaching the problem-solving mode, if you bring concrete objects what sort of link would it make. Is it justifiable to use concrete objects.
Sabelo	When you come with an object, that concrete object usually as a teacher you will come with something relevant to the lesson. For example let's say we are learning on place values so for them to enjoy if you come with may be an abacus you will find they will begin to play with it. 10's 1's and 1000's then it will be hard for them to forget.
Interviewer	Is it about playing or understanding?
Sabelo	It is about understanding. But a child most of the time learns better by touching. When touching, s/he will take it as a game yet there is learning in it.
Interviewer	Did you use teaching objects in your class
Sabelo	This lesson?
Interviewer	Yes
Sabelo	This lesson I did not use it.
Interviewer	Why?
Sabelo	I just wanted them to work in their groups. Just doing the model together.
Interviewer	What is prior knowledge in teaching of Mathematics?
Sabelo	It is when we are allowing the pupils to reflect what they have learnt in their previous classes or lessons.
Interviewer	Why do you use prior knowledge when teaching Mathematics?
Sabelo	Every time you look at Mathematics, Mathematics is continually from Grade to Grade and class to class. So what

	they have learnt previously links with what they will learn at that particular lesson.
Interviewer	That is the reason for using prior knowledge?
Sabelo	Yes
Interviewer	How often do you use prior knowledge?
Sabelo	I try to use it almost all the time in Mathematics.

APPENDIX Q

LANGUAGE EDITING CERTIFICATE

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APPENDIX R

TURNITIN REPORT

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