Exploring Teachers' understanding of pedagogic practices in teaching Mathematical concepts in Grade 1: A Case Study in South African Primary Schools

BY

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We, the candidate's supervisor and co-supervisor agree/do not agree to the submission of this thesis.

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DEDICATION

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ABSTRACT

The study examines teachers' understanding of their learning theories on pedagogic practices in teaching mathematical concepts in Grade 1. The study emanates from the findings of the National Education Evaluation and Development Unit (NEEDU) Report and also from research which indicates that the teaching and learning of Mathematics in primary schools in South Africa are considered to be in crisis. Mathematics teachers remain critical role players in ensuring quality teaching and learning, as they are the curriculum implementers, but they seem to lack the crucial support that underpins improved learner performance. Forming a solid and a broad mathematical foundation on Mathematics concepts like numbers and operations, geometry and spatial sense, and measurement, with algebra and data analysis playing supporting roles, is one of the goals to unpack how teachers teach Mathematics to achieve their goals when teaching Mathematics. It is evident from research that learners in Grade 1 find mathematical concepts challenging and hence many perform poorly. The objective of this study was to understand pedagogic choices Mathematics teachers make to teach mathematical concepts, and to understand ways in which these pedagogical choices affect the learners' acquisition of such concepts. Theoretically, the study draws on both Constructivism and Bernstein's Pedagogic Device Theory. The study adopts a qualitative approach and uses a case study methodology. The selection of different schools in different context was not for comparison purposes but for understanding how teachers understand their pedagogic practices in teaching Mathematics in Grade 1. All ethical issues were observed to ensure trustworthiness of findings. Multiple data generation tools such as semi-structured interviews, classroom observations and documents analysis were utilised. Data was analysed through content analysis. Data were first summarised and then categorised to themes. The conclusions arrived at indicate that even though primary school teachers understand officially sanctioned pedagogical practices for Mathematics, like learner-centeredness and collaborative learning, they were faced with multiple challenges in their efforts to implement their understating of pedagogical practices as there were challenges with the shortage of resources. Therefore, it is impossible for them to implement the rationale, aims and objectives, in the content for Mathematics teaching. Vigorous innovation on teachers understanding would keep them well-informed about pedagogic theories and content knowledge to enable them to attain the required level of knowledge and understanding of their practice.

LIST OF ACRONYMS

ANA	Annual National Assessment
PIRLS	Progress in International Reading Literacy Study
DoBE	Department of Basic Education
RNCS	Revised National Curriculum Statement
CAPS	Curriculum Assessment Policy Statement
ECE	Early Childhood Education
ECD	Early Childhood Development
PCK	Pedagogic Content Knowledge
CK	Curriculum Knowledge
NAEYC	National Association for the Education of Young Children
MET	Mathematical Education of Teachers
NEIMS	National Education Infrastructure Management System
NCTM	National Council of Teachers of Mathematics
NEEDU	National Education Evaluation Development Unit
TIMSS	Trends in International Mathematics and Science Study
NCS	National Curriculum Statement
SAQME	Southern African Consortium for Monitoring Education Qualification
PGCE	Post Graduate Certificate in Education (Certificate)
B.Ed.	Bachelor of Education (Degree)

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CHAPTER ONE

CONTEXT AND BACKGROUND TO THE STUDY

1.0 Introduction to the study

In this introductory chapter, issues that relate to Mathematics teachers' understanding of teaching and learning in Grade 1 are highlighted in accordance with the aim of the study which is to examine teachers' understanding of their pedagogical practices in teaching Mathematics. The Mathematics Learning Study Committee of America (2001) indicates that effective teaching of Mathematics assumes many different shapes because it requires teaching that focuses on fostering and maintaining the development of proficiency in Mathematics over time. It is significant to understand whether Mathematics teachers understand their pedagogic practice when teaching learners to conceptualise Mathematics in the classrooms. Ngubane-Mokiwa and Khoza (2016) argue that personal vision creates an atmosphere that helps teachers and learners to construct their own unique individual identities while teachers as curriculum managers monitor the learning environment. Therefore, understanding the curriculum is dependent on three stages; self-understanding, the community understanding and the subject understanding of teachers' practices. The self-understanding of the pedagogic practices involve the profound and vital understanding of mathematics thinking which is connected to how the teacher uses his/ her skills to support learners in understanding Mathematical concepts. This is how Sadovnik (1991) explains teachers construct the knowledge in order for learners to interact with it. With the community understanding of the pedagogic practice, Ball (2008b) assert that teachers who learn from their practice to enhance their learners' understanding improve their practice. Duncan et al. (2007) argue that world-wide, it is of the utmost importance that teachers understand how to develop their learners' mathematical skills adequately. It is crucial that teachers are able to focus on developing their learners' skills rather than teaching to suit their own practices and skills in the classroom (Stuart & Thurlow, 2000). The focus of the study will shift the mindset which is shifted by natural issues that have influence during pedagogic practices, this takes place through the teaching and learning in schools and paying focus to social development of the schools.

For teachers to understand their practice, they first have to understand that the curriculum is also divided into three categories, the intended curriculum which signifies what the teacher intends to do in terms of the Learning Area/subject. The second part is the implemented curriculum where the teacher and the school plans on what is expected for the particular grade at a particular time. The last phase speaks to the intended, official, formal, planned, and prescribed curriculum that learners are expected to follow. In this case it is the prescribed curriculum for Mathematics that is planned for the Grade 1's.

Askew, Venkat, and Mathews (2012); Hoadley (2007); Taylor and Vinjevold (1999) have all noted disconcerting evidence of very poor basic mathematics content knowledge levels and insufficient pedagogical content knowledge by teachers. This signifies that teachers have to revisit their understanding and knowledge of Mathematics in order to teach successfully. Adler, Ball, Krainer, Lin, and Novotna (2005) argue that to improve learner achievements in Mathematics, it is necessary to improve the professional growth component of the teachers. The self-understanding of the pedagogic practice is what is significant as it results in learners performing well which is what the learner challenge is all about. Though this study was done abroad it is a major challenge in the South African context as well. The teacher's knowledge and understanding of Mathematics impacts on how learners learn Mathematics and has further positive bearing on how learners learn (Ball & Cohen, 1999a, Shulman 1986, and Wilson, Shulman & Richert, 1987). There is an increase in research carried out on the teaching of Mathematics in primary schools (National Council for Teachers of Mathematics, 2000, Kilpatrick, Swafford & Findell 2001; McCarthy and Oliphant (2013) as well as on how learners learn in Grade 1 (National Education Evaluation and Development Unit (NEEDU), 2013). However, evidence on whether teachers understand their practice in teaching Mathematics to younger learners, particularly in Grade 1 is limited. This paucity of research prompted the current study. Research has also shown that many learners perform poorly in Mathematics from Grade 1 to Matric, which has been cited as one reason learners are loath to study Mathematics for a professional career (Howie 2003 & Murimba, 2005).

The teaching and learning of Mathematics in primary schools has been described as being in crisis (Fleisch, 2008). Ball and Cohen (1999a) argue that teachers are rarely provided with the opportunity of being mentored in terms of mathematical teaching skills. Instead, they attend short courses or workshops that barely address the challenges in the classroom. It is for these reasons that, in addition to looking at teachers' understanding of classroom practice, the study also focused on their understanding of mathematical knowledge, as the latter is an important factor relating to learners' educational achievements in Mathematics (Hill, Rowan, & Ball, 2005). Drawing on the National Literacy and Mathematics (Numeracy) Strategy (2011), learners need to acquire high levels of literacy skills that will benefit their future achievements (Sylva, Melhuish, Sammons, Siraj-Blatchford, & Taggart, 2004). Because learners' future achievements encompass the benefits of mathematical skills, teachers' mastery and understanding of their skills is crucial in Grade 1.

Research by Fleisch (2008), National Education Evaluation Development Report (2012); Trends in International Mathematics and Science Study (2006) has proven that a raft of problems are present in Mathematics teaching and learning in schools. After an in-depth study into this phenomenon, Baker and Chick (2006) attest to the fact that teachers experience individual challenges when it comes to the content knowledge of Mathematics. Sykes and Darling-Hammond (1999) argue that teachers are faced with different types of problems and different types of learner-models in schools, which is a challenge that requires teachers to be learners too. Moreover, this study emanates from the findings of the National Education Evaluation Development Unit (NEEDU) Report (2012), which made it evident that novice teachers in the Foundation Phase seemed to be particularly vulnerable when having to teach Mathematics and, as a result, learners performed poorly in the Annual National Assessments. The report further stated that teachers' subject knowledge was poor, and that this caused the underperformance of learners. International studies like Trends in International Mathematics and Sciences (TIMSS) (2006) and the Annual National Assessment (ANA) results have subsequently revealed that the problem with Mathematics has its roots in primary schools where many learners fail to gain basic mathematical skills (McCarthy & Oliphant, 2013). The 2013 Annual National Assessment (ANA) results saw only 31% of Grade 3 learners, 39% of Grade 6 learners and 2% of Grade 9 learners scoring higher than 50% in Mathematics (Department of Basic Education, 2013).

Reports by the Minister of Basic Education also clearly revealed that learners in the Foundation Phase were performing below par (Department of Basic Education, 2009; National Reading Strategy, 2008). Adler, et al. (2005) argue that the only way to improve achievement in Mathematics is to improve on the professional growth of the teachers. However, Gates (2001a, p. 17) asserts that "Mathematics plays an integral part in keeping the powerless in their place and the strong in positions of power". He therefore argues that, in order to avoid divisions in societies, Mathematics needs to be taught in a way that every learner is able to access it in his/her community. Samson (2007) as well as Tanner and Jones (2000) maintain that thinking mathematically is a process through which people draw their own conclusions, and therefore it is important that teachers understand their practice in order to translate their knowledge to the learners.

Teachers teach learners to make sense of the world around them, regardless of whether people are working or at play. Thus, Mathematics is a field of knowledge in which mathematicians work to discover truths about the natural world (Herzig 2004), it is universal and context-independent (Dörfler, 2003). However, despite these lofty ideals about Mathematics, teachers in urban schools revealed that even though they knew that Mathematics should be taught in the learners' Home Language, they found it difficult to teach learners in the Language of Learning and Teaching (LoLT) familiar to them, whilst also focusing on the mathematical concepts (Barton & Lee, 2002). The Curriculum and Assessment Policy Statement-Department of Basic Education, (2011a, p. 4) proposes that "Mathematics is an essential building block for young learners to make a confident start in a mathematics career". The curriculum further explains that an individual should know basic mathematical concepts in order to contribute meaningfully and effectively to the world in which they live. However, even though schools offer Mathematics as a subject, mathematicians have declined in numbers in the country. Most learners opt for Mathematical Literacy at high school level, simply because their performance in 'pure' Mathematics is poor. The Trends in International Mathematics and Science Study (TIMMS) (2011) reported that primary school learners in South Africa performed poorly in Mathematics and the later study confirmed the woeful results by South African learners in Mathematics compared to other countries. These results require learners in primary schools to undergo intensive development that is meaningful in mathematics modelling, (Carpenter and Romberg 2004; Jones, Langrall, Thornton & Nisbert 2002; and National Council of Teachers of Mathematics 2000).

The 2011 ANA results also confirmed the poor achievement by South African learners in Mathematics compared to other countries. The teaching and learning of Mathematics have moved beyond the practice of the different teaching and learning theories held by the constructivist theorists, Vygotsky or Piaget. This signifies that teachers have to revisit their understanding and knowledge of Mathematics to teach successfully. Moreover, research conducted by the Mullis (2007) states that learners in Southern Africa showed a large number of learners between the ages of 8 and 9 in South Africa were unable to read. The Foundation for Learning Campaign was meant to create a national focus on improving the reading, writing and numeracy abilities of all South African learners between 2008 and 2011. A so-called Reading Toolkit, which was meant to provide practical, back-to-basics guidelines on the planning of an effective Reading Programme in the classroom, was also introduced (Gardiner, 2008a). Such interventions by the then Department of Education (DOE) were meant to assist learners to at least understand the language used for the teaching of Mathematics. To this day, this has remained a concern for South African teachers because achievements in Mathematics are still poor. Learners who struggle to read the language used in their daily lives cannot be expected to understand the language of Mathematics in the classroom milieu. In this regard, teachers in urban schools revealed that, even though they knew that Mathematics should be taught in the learners' Home Language, they found it difficult to teach learners in the Language of Learning and Teaching (LoLT) whilst also focusing on the mathematical concepts (Barton & Lee, 2002).

The Department of Basic Education published an analysis of different school performances called Schools Performing above Demographic Expectation (SPADE) that suggested a relationship between specific pedagogic strategies and higher performance for individual learners in different schools (Hoadley, 2012). There is also a further identification of effective pedagogic strategies in higher performing schools, and this differs within the context of schools where the teaching process involves interaction with learners, this analysis measures and describes pedagogic strategies such as play-oriented learning, hands-on experience and language development (Goldenberg, Hicks and Lit, 2013).

The current study examined teachers understanding of pedagogic practices in teaching mathematical concepts in Grade 1. Ball and Cohen (1999a) assert that teachers who learn from their practice to enhance their learners' understanding will always improve their practice. It is for this reason that allowing Mathematics teachers to gain important knowledge and skills to relate to learners' educational achievement is crucial. Teachers' pedagogical and mathematical knowledge requires intertwined skills to improve learners' progress in Mathematics (Hill, Rowan & Ball, 2005). As stated earlier, the mastery of mathematical skills is a critical early skill (Duncan, et al., 2007) for learners world-wide, and it is extremely important that teachers understand how to develop these skills adequately. This ability will depend not only on their understanding of the teaching of Mathematics, but also on their understanding of how learners learn. Darling-Hammond and Richardson (2009) suggest that the Integrated Mathematics Assessment (IMA) approaches that are used by teachers in the classroom is one way of directly engaging teachers in learning Mathematics for the new curriculum, as these approaches focus on developing the pedagogical content knowledge that is necessary to teach Mathematics.

Different researchers have different views when it comes to the curriculum, for example, according to van den Akker, de Boer, Folmer, Kuiper, Letschert, Nieveen and Thijs (2009, p. 9) "curriculum is just a plan that is used for learning" and also Marsh (2009) attest that curriculum is the intended learning for which a school is accountable whereas Kelly (2006, p. 8) refers to the curriculum as "what the learner has gained knowledge throughout the learning". Kehdinga (2014) has a different view on what the curriculum is, as he states that the teachers do not own it as it is what the Government imposes on teachers as a political document that only involves teachers when they have to implement it. For teachers to comprehend their pedagogic concepts, they have to understand the curriculum used that will assist them to grasp what they are doing and why. This understanding resonates with what (Marsh, 2009) says where curriculum is referred to as what needs to the implemented in different ways that suits the learner.

Also Hoadley and Jansen (2012) view the curriculum as a political document that brings about the interests and views of the Government not of the teachers and learners. Self-understanding of the curriculum is vital as it is the teachers who have to follow it and make sense of it. This accords with what Smith (1996) says that the curriculum is a statement of what learners are expected to both know and also be able to interact with the activities that are in line with what has been learnt. This also implies how teachers will be able to assess the materials given to the learners. In terms of the community understanding curriculum, this refers to what is defined by the book prescribed for the teachers to teach from. Hoadley and Jansen (2012) point out that in Curriculum 2005, Learning Areas were integrated and content was not specified. In the statements made in the 2010 SAQMEQ Country Report, both the Minister of Education and the Director General admitted that learners were continuing to underperform at unacceptably low levels in the quality of competencies in basic literacy and numeracy skills (Department of Education, 2010). The results of both national and international studies revealed that South African schools were failing our learners as they were unable to develop the necessary skills to be able to "do mathematics" (Department of Basic Education, 2012). In light of the above, it became imperative that a study of this nature should be conducted to determine whether teachers actually understand their practices when teaching Mathematics according to the new Curriculum Assessment Policy Statement. Ornstein and Hunkins (2004) defined curriculum as the subject matter or content of subjects like mathematics, drama, history, or everything inherent in a particular subject or learning area.

The definition of teachers' understanding of their practice in terms of the community understanding resonates with what Marsh and Willis (2003) states as what is supposed to be in the books that provides definitions on how teaching and learning should take place in the classroom and as all the experiences that learners have as they progress with their schooling. Subject understanding involves the knowledge of the teacher on the subject being taught.

Koehler and Mishra (2009) define pedagogical knowledge as the knowledge teachers have with regard to the methods they use in their teaching, Teachers are expected to engage learners with the teaching strategies that will cater to learners' knowledge resulting in effective curriculum delivery in the school (van den Akker, Fasoglio & Mulder, 2010). This research looks at the teachers' understanding in teaching Mathematics concepts so will follow what van der Akker, et al. (2009) suggest as key for the teacher to ensure that the learners are learning and also that the curriculum is understood at all five levels; namely the international (supra), national (macro), institutional (meso), micro (teacher) and lastly the nano (learner). Using the curriculum correctly should allow learners to learn, and it will also talk to the teachers' belief in order to connect with the lesson taught.

Curriculum, according to van den Akker, et al. (2009, p. 9), is referred to as a "plan for learning" (referring to the curriculum document - which is the intended curriculum) and (Pinar, 2010, p. 36) defines it as a "plan of action" (referring to how teachers understand how to apply the intended curriculum) and the five levels which are listed above. Further to the identified levels, van den Akker, et al. (2009) state that a curriculum can be represented in three forms, namely, curriculum as intended, curriculum as implemented and curriculum as attained. What Mathematics teachers intend to articulate in the classroom as guided by the Curriculum Assessment Policy Statement (2011) document and what they intend to achieve at the end of the Mathematics lesson? Khoza (2014) states that "the intended curriculum consists of ideal (vision/rationale) and formal/written (intentions as specified in documents) components. The implemented curriculum consists of perceived (curriculum as interpreted by teachers) and operational (the actual process of teaching and learning or curriculum in action) components. The attained curriculum consists of experiential (learning experiences as perceived by learners) and learned (resulting learning outcomes of learners) components" (p. 27). This suggest that a curriculum should be experienced at all these levels and the three forms mentioned above. There is consistency shown by the Mathematics Curriculum Assessment Policy Statement document whereby it equips learners, irrespective of their socio-economic background, race, gender physical ability or intellectual ability, with the knowledge and skills and the values necessary for self-fulfillment and meaningful participation in society as citizens of a free country (DoE, 2011).

The understanding of the rationale is distributed or divided into three different areas being the self, community and subject understanding, (Berkvens, van den Akker, & Brugman, 2014). These researchers state that there needs to be consistency in the setting of the goals that will all connect to the concepts. The research will focus on eight learning signals according to Khoza (2015a) which are teaching content, teaching activities, teacher role, resources time, assessments, grouping and location will be discussed in this study according to how the Mathematics teachers understand them in their contexts. These concepts will be articulated in term of what the Mathematics teachers understand as their teacher role, what kind of a role a teacher plays in teaching learners Mathematics, also what the teacher understands in teaching and learning activities, that means what kinds of learning activities will be employed in the classroom whilst the teachers teaches Mathematics in Grade 1. The significance of understanding the kinds of resources to be used when teaching Mathematics would answer the question will those resources allow learners to learn? Being involved with the kinds of resources to be used for learning also refer to the kinds of assessments to be done in the classroom. Learners in the study came from different contexts (rural, township and urban) and which should help to highlight teachers' understanding of the location of the learners and their ability to use this knowledge to the learner's advantage. The last concept relates to the significant issue of content knowledge, whether the teacher has the understanding of the content to be delivered in the classroom for Grade 1.

The Curriculum Assessment Policy Statement (2011) document indicates that the curriculum principles are based on social transformation, ensuring that the educational imbalances of the past are addressed, and that equal educational opportunities are accessible to all population groups (DoBE, 2011). Curriculum knowledge is defined as the learning ideals or learning objectives that teachers are expected to meet. Teachers' pedagogic practices require curriculum knowledge which is defined as an understanding of the subject content and includes the kinds of topics that need to be articulated in the particular subject. Whereas pedagogic knowledge is defined as the relationship between the teachers' knowledge and the content knowledge that learners need to interact with, the teacher knowledge that is transformed into good classroom practices and approaches (Singh, 2002).

Pedagogic practice, however is the transmission of knowledge structures by experts in the field. Pedagogic practices are defined as encounters in formal education through which teaching and learning take place. According to Shulman (1986), teachers have a responsibility to find a tool to translate their pedagogical knowledge to their content knowledge, as the teacher with more pedagogic knowledge is the teacher with more knowledge about their subject. Bernstein and Solomon (1999) define the concept of pedagogy as the approaches and procedures used by teachers to convey knowledge to the learners. The interchangeable knowledge practices of education the manner in which teaching and learning happens in a classroom directing at developing knowledges and skills.

1.1 Background of the study

The current education system, more especially teaching approaches, theories and discourse, are based mostly on a Western perspective hence the change in curriculum from what was calling for the competence based education that focused strongly on competence and skills whether the documents on OBE and curriculum 2005 refer to learner-centred strategy for teaching Mathematics from the early grades. Due to the complex language, inadequate resources and teacher preparation, many problems had arisen in all major assessment such as complication of implementation, so outcomes-based education was reviewed (Kenton, 2002). While the OBE was implemented "some problems with the new curriculum and C2005 was reworked into the Revised National Curriculum Statement (RNCS), which was introduced into grades 1, 2 and 3 in 2004, 4, 5 and 6 in 2005, into grade 7 and 10 in 2006, 8 and 11 in 2007 and 9 and 12 in 2008" (Velupillai, Harding & Engelbrecht, 2008, p. 56). The RNCS and NCS were also reviewed due to on-going implementation problems. This kind of a curriculum focused on learners' questions and discussion, group work, and pair work teaching strategies (Hoadley & Jansen, 2012), the performance based kind of education which is Curriculum Assessment Policy Statement (CAPS) DoBE (2011). Teachers who are the curriculum implementers had challenges though out these changes. Ndlovu (2011) articulates this challenge as upsetting for South African learners' performance as compared with international learners. The curriculum was to be grounded theoretically within a social constructivist conceptual framework (Shepard, 2000). Therefore allowing the research to conceptualise the teachers understanding of their Mathematics pedagogic practices in order to know how they would be able to teach learners from the early age or Primary schools.

1.2 Problem statement

Recent research on the teaching of Mathematics has been underpinned by Shulman's (1987) seminal work on mathematics education, and which other scholars such as Adler and Reed (2000); Little (2003), Graven (2004) and Jaworski (2006) have taken further. Research on the teaching of Mathematics is growing as researchers are currently scrutinising the teaching of Mathematics in South African schools and, more particularly, how primary school Mathematics teachers learn and how their identities and practices in the Mathematics community are constructed (Fleisch, 2008). However, there is a paucity of research on how teachers conceptualise what they do in the name of teaching Mathematics, and whether or not they understand what they are doing, particularly at primary school level. Anghileri (2006) argues that South African student's performance in internationally benchmarked mathematics studies has been disappointing. Tan (2011) asserts that examining Mathematics and Science teachers' implementation of language of instruction policy in Malaysia, reveals that factors like curricular requirements, examination pressure and time constraints also shape classroom interactions, whereby teachers find themselves dominating in the lesson instead of facilitating the lesson because learners take a long time to present their sums on the chalk-board. Teaching ideally is learner-centered and the teacher's role should be that of a facilitator. Lim and Chai (2008) assert that by not being learner centered means that the cognitive dimensions of learners were neglected. Rusznyak and Walton (2011) suggest that to enhance conceptual learning, teachers should note that school knowledge and learning is complex and takes time to occur; as a result, they have to sequentially organise activities that will help learners to learn the intended subject matter. Teachers should also ensure that there is a link and progression between their lessons because that shows systematic learning which enables learners to comprehend content more easily.

Moreover, the teacher's role in the process was, in most cases, misinterpreted and misunderstood. This could have been as a result of the fact that they did not understand their practice in the curriculum changes, as all the changes centered on the tools to be used in the classroom. The danger lies in the fact that the Curriculum Assessment Policy Statement (2011) provides specifications on what teachers need to do in order to teach Mathematics and the teachers implement these stipulations practically in their classrooms to the learners.

Teachers are expected to understand their plan of action as curriculum implementers but are experiencing challenges in the Mathematics curriculum implementation process. The teaching and learning of Mathematics in South African multilingual classrooms can only be effective based on what the teachers can manage. The continuing trend of South African learners underperforming in Mathematics is posing serious threats to the curriculum. Not only do learners underperform in national assessments, they also underperform in school-based assessments, provincial assessments and international assessments such as SAQMEQ and Trends in International Mathematics and Science Study (TIMMS) (2006). In their statements in the 2010 SAQMEQ Country Report, both the Minister of Education and the Director General admitted that learners were continuing to underperform at unacceptably low levels, and that the quality of competencies in basic mathematical skills was below par (Department of Basic Education, 2010). Since 1994 there have been endless curriculum changes, starting with Curriculum 2005 and currently culminating in the Curriculum and Assessment Policy Statement. Therefore, in addition to struggling with the teaching of Mathematics in general, teachers have also been trying to cope with all these changes. Recent literature on rural education has been proactive and positive about redressing educational issues in rural areas for global change (INRULED, 2001), but these changes have not been implemented as yet. Mathematics teachers in schools in different contexts, like the rural areas are still faced with addressing the issues of dilapidated school buildings and limited resources. All of the above affect teaching and learning in Grade 1. Reflecting on the 2013 Mathematics Annual National Assessment results, a 37% achievement above 50% is not a desirable result. The Minister of Education, Angie Motshekga, commented critically on the weak 2011 Mathematics results. Also, in my experience as a lecturer in a School of Education at a tertiary institution, teachers themselves are not confident with the work they do.

The study sets out to examine teachers' understanding of their pedagogic practices in teaching mathematical concepts in Grade 1. The study emanates from the findings of the National Education Evaluation and Development Unit (NEEDU) Report and also from research which indicates that teaching and learning of Mathematics in primary schools have been described as being in crisis. It is evident that learners in Grade 1 find mathematical concepts challenging and hence many perform poorly in this discipline. The curriculum policy clearly states that learners must learn Mathematics in their Home Language.

However, some teachers resort to teaching Mathematics in English, whilst others prefer to teach in isiZulu. The majority of the teachers resort to code-switching as they view this as a resource to assist learners in engaging with and understanding mathematical concepts. The objective of the study was to understand the pedagogical choices Mathematics teachers select to teach mathematical concepts, and to understand ways in which these pedagogical practices and the choices impact on the learners' acquisition of such concepts. Theoretically, the study draws on both constructivism and Bernstein's pedagogical device. The study adopts a qualitative approach and uses a case study as the research design. Two primary schools were selected as the research sites. Three research instruments were used to generate data, these being semi-structured interviews, classroom observations and documentary evidence. This choice of instruments ensured reliability and the validity of the research findings.

1.3 Statement of the problem

There seems to be a problem with how teachers conduct their pedagogic practices in Mathematics as the subject is said to be crisis and on the other hand, learners also present challenges when they are learning Mathematics. Westwood (2011) argues that that while the use of problem solving in classroom as a core method for learning is valid and reasonable in Australia, it will be adequate once a concept has been experienced and explored fully in the teaching of Mathematics (CAPS) DoBE (2011). This has led to the call for more of learner centred approach where learners are allowed to participate in the construction of their own learning. This will make the learners to be hands on and rely on their own ability to create knowledge based on their background. After discussing the teaching strategies, it is vital to give a brief background of the curriculum.

Therefore, to achieve different instructional goals teachers should combine different management practices in their teaching and various teaching strategies teachers (Uibu & Kikas, 2014) and also employ the teaching strategies that will framed around concepts of the curricular web for the effective curriculum delivering in the school (Van den Akker, Fasoglio & Mulder, 2010).

1.4 Rationale of the study

The researcher's interest in this research began when she was still a Foundation Phase teacher teaching Mathematics in Grade 1 in 1991. The Grade 1 teachers were expected to teach all the subjects at that time and there was no specialisation in teaching subject in the Foundation Phase. The curriculum that was used in schools was Bantu Education. Therefore the topic is drawn from personal experience of teaching Mathematics in the Foundation Phase during the time when education was still divided amongst Blacks and Whites.

The education viewpoint used during the 1950's, 1960's and 1970's was that of the then National Party where the curriculum was divided, amongst the Blacks and White learners. I taught in the early years for more than 20 years. The findings of the NEEDU Report (2012) show strong evidence that learners in the Foundation Phase find Mathematics difficult, as a result they perform poorly in the Annual National Assessments. The report further stated that the teachers 'subject knowledge is very poor and continues to cause problems in learners underperformance'. The international studies and the Annual National Assessment (ANA) results indicate that the problem with mathematics has its roots in primary schools where many learners fail to gain basic mathematical skills (Meer, 2012). Jansen (2004a) points out that policy makers have the ideal educator in mind when they design policy. However, this changes when the teacher is alone in the classroom. What they actually teach (implemented curriculum) is based on how they identify themselves. The teachers then who were informed by the Bantu Education act of 1953 were also taught in that manner. What the teachers were used to was the teacher-centered approach that required teaching according to what the teachers understood. Jansen (2004a) identified teacher identities as based on a professional basis, incorporating their profession, subject matter competence, levels of training, preparation, and formal qualifications. It has been particularly evident that the curricular issue that is challenging for teachers is that of the learners' contexts. This is more so because of the curriculum used at the present moment, which is CAPS. This curriculum does not cater for different learners that are in different contexts. Rural, township and urban learners are expected to understand what is taught in the same curriculum, this should be at the forefront of curriculum planning, seems to be ignored in the new curriculum.

The challenges of learners understanding Mathematics was an issue even during the apartheid era when education was divided and learners of certain ethnic groups were disadvantaged (DoE, 2001). After the post-apartheid era the White Paper 6 that stated that all learners irrespective of the learning challenges, or race were to be accepted in all schools (DoE, 2001). The curriculum further explains that any individual must know basic mathematics in order to contribute to the world in which they live to be able to operate effectively. The major changes in the South African context and political arena transformed Black Education where the schools used different curriculums. Hoadley and Jansen (2012) point out that in Curriculum 2005, Learning Areas were integrated, and content was not specified. Teaching was learner-centred and the teacher's role was that of a facilitator.

However, the teacher's role was, in most cases, misinterpreted and misunderstood which may be as a result of the fact that they do not understand their practice as all the changes that were laid out in the new curriculum dealt with the tools to use in the classroom. The danger here, as Cooper and Robinson (2000) pointed out, is that learner centeredness meant that the knowledge base of the curriculum and social constructivism and cognitive dimensions of learners were neglected. Since 1994, there have been endless curriculum changes: Curriculum 2005, Revised National Curriculum Statement, Curriculum and Assessment Policy Statement. In addition to struggling with teaching Mathematics in general, teachers are also trying to find their way through all these curriculum changes. This study focused on understanding teachers' pedagogic practices in teaching Mathematics in Grade 1 in different contexts. Therefore looking at the disciplinary contextualisation of their understanding of the teaching of Mathematics in the Foundation Phase in South African schools.

1.5 Purpose of the study

The purpose of this study was to examine teachers' understanding of their practice in teaching Mathematics in Grade 1. The study was concerned with a critical reflections of Mathematics teachers' experiences on how mathematical concepts were acquired in an additional language. As research has proven that unqualified teachers who sometimes have no understanding of their practice in teaching Mathematics may find it difficult to teach Mathematics. I also examine the challenges of teachers who are unable to use the Curriculum Assessment Policy Statement to best advantage which has a negative effect on their teaching practice. It is envisaged that the research will inform the Mathematics community on teachers' understanding of teaching and learning issues and how this

practice can be developed to broaden the understanding of the practical knowledge of the teaching of Mathematics in Grade 1. The assumptions I had when conducting the study were that there were challenges with the teaching of Mathematics. I was drawing this assumptions from how I was taught using route learning and that was a challenge for most learners. Embarking on the study would contribute towards Education for Sustainable Development because of the lack of Doctors and Mathematicians in South Africa. Attaining Mathematics skills does not only upgrade or assist learners to pass the Subject but also have an impact on the country's development. I also envisioned that the research will inform the policies on Mathematics teaching in the primary phase.

1.6 Significance of the study

The study hopes to make a contribution to national and international debates on teaching approaches for Mathematics by providing some insights into how teachers teach Mathematics from the early grades to Matric level. Various studies have been conducted on the reasons teachers teach. Jansen (2004) argues that policy makers have the ideal teacher in mind when they design policy. However, finding, training and retaining the ideal teacher who is able to incorporate the Curriculum Assessment Policy Statement in the classroom, and dealing with learners who come from different contexts, creates challenges for the education system. Many of these problems are found in the Mathematics classroom. This does not mean that teachers cannot teach, but that what teachers actually teach is based on what is required by the curriculum, which has nothing to do with the contextual challenges they face. Mathematics teachers may identify with some of their contextual challenges, but they will have to focus on what must be taught and how they should deal with the challenges of teaching Mathematics. Jansen (2004) argues that teachers are people with identities; hence they identify with the different contextual factors found in their place of work, which is primarily the classroom. Jansen (1994) further identifies teachers' professional basis comprising the teaching profession, subject matter competence, levels of training, preparation and formal qualifications. A particularly challenging curricular issue is that the learners' contexts, which should be at the forefront of curriculum planning, appears to be ignored in the new curriculum. In addition the South African learners are rated poorly as compared to other continents.

Black and Wiliam (1998, p. 38) argue on various aspects which are related to how assessment as part of learning is handled by teachers. “This includes observing learners made by teachers during classroom deliberations and the inspection of other oral work completed by learners in the classroom environment”. This implies that after learners have been given tasks, teachers need to ensure that all learners are engaged and this is done through class observations.

1.7 Study objectives

The ultimate objectives of this study were:

1. to understand what pedagogic choices Mathematics teachers draw upon in teaching Mathematics in Grade 1 in South Africa

2. to understand how Mathematics teachers’ actual understanding of theoretical pedagogic practices effect on the teaching and learning outcomes?**.**

1.8 Critical research questions

1. What pedagogic practices do Mathematics teachers in Grade 1 draw upon to understand teaching Mathematics?
2. How do Mathematics teachers’ actual understanding of pedagogic theories effect the teaching and learning outcomes in Grade 1**?**

1.9 The scope of the study

The study examined teachers’ understanding of teaching Mathematics in Grade 1. The key concepts of teachers’ pedagogical knowledge as posited by Shulman (1987) were central to this study as they address the following: pedagogical and content knowledge and the way teachers transmit their pedagogical knowledge with the content knowledge; knowledge of representations of subject matter (content knowledge); understanding of learners’ conceptions of the subject; and the learning and teaching implications that are associated with the specific subject matter and general pedagogical knowledge (or teaching strategies).

To complete what Shulman calls the knowledge base for teaching, he includes other concepts such as: curriculum knowledge; knowledge of educational contexts; and knowledge of the purposes of education. It is evident that learners come from different contexts, and thus their understanding of mathematical content may also be different. It is for this reason that teachers should begin to teach Mathematics to cater for different contexts.

As this study examined the pedagogical practices of Mathematics teachers teaching in Grade 1, it was vital to consider what is expected of teachers of Mathematics in Grade 1. The following are deemed significant characteristics of such teachers. Van den Akker, et al. (2009) state that learners learn through their everyday knowledge where thoughts and discussions are overhead from media, peers and parents. Though van der Akker attests that the ten concepts are significant for learners to learn they do not provide for learning outcomes which are very important in terms of determining teachers understanding of their practice. To ensure teachers' understanding of the curriculum concepts, the following ideas were clarified focusing on Khoza's (2014) curriculum concepts.

- preparedness to teach Mathematics;
- pedagogical knowledge of teaching Mathematics in Grade1;
- conceptual and professional knowledge;
- effective pedagogical practice;
- mathematical knowledge that teachers have in teaching Mathematics in Grade 1.

Mathematics teaching especially in the Foundation Phase requires the teacher to accommodate different types of learners in different contexts, such as learners in rural, township and urban areas. Van den Akker, et al. (2009) does not consider learning outcomes which in a South African setting are very important in terms of measuring learners' performance. These are highlighted by Khoza (2015b) and in the Mathematics the Curriculum Assessment Policy Statement (2011) document as specific skills. As indicated earlier in the introduction other concepts introduced by Berkvens et al. (2014) do cater for this limitation found that teachers did have difficulty in understanding the proper content knowledge in order to deliberate on the suitable goals, teaching and learning assessment resources. These are important issues to determine the relevant teachers' strategies which will be

explored for this study on teaching Grade 1 Mathematics using the Curriculum Assessment Policy Statement document (2011).

1.10 Clarification of terms

1. According to the Oxford Advanced Learners Dictionary (1995) the word understanding is a noun meaning to grasp information or evidence through the power thought and intellect or people's perceptions about a specific situation. The word understanding as explained by the Flip Dictionary (2000) means awareness or belief.
2. Self-understanding means relating to what the teachers understands in that particular subject. The self-understanding in pedagogic practices involves the profound and vital understanding of a subject.
3. Community understanding refers to people's opinions about the particular issue.
4. Subject understanding means the critical skills teachers have to understand the particular subject.

1.11 The study outline

Chapter one contains the outline of the study and the background of context is provided. Chapter two relates to the literature reviewed from different research done on the phenomenon. It comprises a review of studies that have been done, how they were done, and the findings of these studies. It concludes by reflecting on how this study will fill the gap left by prior studies. Chapter three discusses social constructivism and Bernstein's pedagogic device as the two theories which frame the study. The former is discussed within Vygotsky's (1978) understanding, and the latter from the Bernsteinian perspective. Slavin (1997, p. 269) argues that constructivism is "learning [about] the understanding and the application of knowledge".

The pedagogic device theory by Bernstein (1996) which deals with the translation of knowledge in the world of pedagogic communications, is also closely referred to revealing the significance of understanding content knowledge for teachers in order to deal with reflective teaching.

These two theories constitute the lenses through which data is generated, interpreted and analysed in this study. Chapter Four details the research methodologies that were implemented. The focus is on the choices that were made regarding the research strategies that had to be employed to generate data within the context of the research questions posed in this study. It also discusses in detail how these methodologies were implemented to suit the study. The rationale for each choice is clearly specified. Lastly, the identification of the research site and the rationale for selecting the research participants in the two different schools comprising two different contexts is explained. Chapter Five presents the data that were obtained by means of semi-structured interviews. Semi-structured interviews were conducted with the research participants in order to understand teachers' practices in teaching Mathematics in Grade 1. This process engaged with research question 1: **What pedagogic practices do teachers in Grade 1 draw upon to understand teaching Mathematics in Grade 1.** Chapter Six presents an evaluation of the data pertaining to research question 2: **How do Mathematics teachers' actual understanding of pedagogic theories effect the teaching and learning outcomes in Grade 1.**

The data addressing this research question were obtained during classroom observations. These observations were structured into two categories, namely (1) pre-observations and (2) main classroom observations. The purpose of the initial observations was to establish which approaches the teachers used, what resources they employed, and what preparation they had done for each lesson presentation in the classroom when teaching Mathematics. The pre-observation was a semi-structured observation in order to understand how teachers prepared for a Mathematics lesson. The second stage was a semi-structured classroom observations of the actual lessons to determine how the teachers understood their pedagogic practice in Mathematics teaching.

The rationale behind conducting a two-phase semi-structured observation process was that observing teachers in the preparation stage of their teaching allowed the reasoning of the curriculum concepts as well as their preparations. The second part of the semi-structured observations allowed the researcher to observe the actual curriculum unfolding in the Mathematics lessons. Chapter seven presents summary, recommendations and conclusions pertaining to the teachers understanding of their Mathematical practices in this study and a theorised understanding of teachers' conceptualisation of their understanding of the pedagogic practices in Grade 1.

CHAPTER TWO

STUDIES ON TEACHERS' UNDERSTANDING OF PEDAGOGICAL PRACTICES OF THE PHENOMENON

2.0 Introduction

The previous chapter presented an overview and introduction to teachers' understanding of Mathematical concepts. This chapter presents the literature review, which is defined by Vithal and Jansen (2012, p. 16) as "the overview of current and previous relevant research and appropriate research articles on the topic under study". Chapter two therefore focuses on pertinent literature, both books and journal articles that report on studies concerned with teachers' understanding of their pedagogical practices with particular reference to the teaching of Mathematics in the early phase of schooling. Murray and Male (2005) argue that teachers' understanding of their practice is an area that has received minimal attention, and they have identified new areas of research to be explored by scholars. Also this research will attempt to understand some of the teachers' practices though it is in Mathematics but it might assist teachers with the other Learning Areas. Various scholars deliberated on different curriculum concepts that examined teachers' understandings in this chapter. These diverse curriculum concepts were explored by van den Akker, et al. (2009), Khoza (2015a & 2015b), Kehdinga (2014) and Shulman (1987) who supplied insights into the key concepts of pedagogic, content knowledge, and the concepts teachers use in teaching. These studies tried to look into what the teachers do in the classroom and found different challenges. Some of the challenges could be behind the reasons on the challenges in Mathematics teaching.

Furthermore, this chapter looked into the teachers' understandings of effective classrooms in different contexts, like rural, township and urban areas. Thereby articulating what Khoza (2016) refers to as curriculum or teaching visions that allow teachers to teach with goals for achievement that will assist in an improvement in their practice. The teachers' understanding serves as the significant measures in the quality of their teaching. Researching different schools in different contexts was done not for comparing the schools but for understanding how teachers teach with understanding in these different contexts.

The historical background in the South African context in terms of the curriculum allowed diverse understandings that took into consideration the various key concepts of pedagogical, and content knowledge as proposed by Shulman (1987). These were identified as teaching and learning signals by Khoza (2015a & 2015b) for understanding of how teaching took place in the classrooms. Furthermore the chapter looked at the concepts framed around the curricular spider web by Van den Akker et al. (2009) in order to detect relevant teaching strategies for these concepts. Berkvens et al. (2014) discussed the study undertaken by the Netherland Institute for Curriculum Development to interpret the needs and wishes arising from post-2015 education agenda. As the study examined teachers' understanding of their pedagogical practices in their teaching of Mathematics in Grade 1, teacher education in pedagogical practices became highly significant as a factor that impacts how learners learn Mathematics. Teaching and learning of Mathematics is a crucial subject in the South African curriculum, yet it is a known fact that South Africa has a critical shortage of skilled professionals in this field, (Breier & Erasmus, 2009) Researchers further stated that the Curriculum and Assessment Policy Statement (CAPS) (2011) and the apartheid curriculum (Christian National Education – CNE) are driven by the traditional teaching approaches/strategies which preferred the content-centered and teacher-centered approaches respectively (Khoza, 2015a). However there were concepts that influenced the curriculum in both positive and negative ways that led to teachers having a different understanding of their pedagogic approaches to teaching, especially Mathematics. These concepts are framed around the curricular spider web in order to detect the relevant teaching strategies one has to use in order to deal with these concepts called components according to Van den Akker et al. (2009). These concepts are referred to as teaching/learning signals by Khoza (2015b). On the basis of these assumptions, the chapter will look at various understandings of the curriculum and how they impact on the teaching pedagogical knowledge or strategies used in teaching Mathematics in Grade 1.

It is also important that this study provides a brief discussion of how the South African curriculum moved from the competence based curriculum that was based on the skills people acquired to the performance based curriculum that allowed people to assess qualifications on their performance. The performance based curriculum refers to the professional understanding (facts) that are based on people's mastering specific content whereas the competence based curriculum is based on the achievement outcomes/competences (from people's opinions). The South African curriculum moved from the Outcome Based Education and Curriculum 2005 that focused strongly on competences and skills and all the documents on OBE and Curriculum 2005 refer to a learner-centered strategy for teaching Mathematics in Grade 1, where the focus was on teachers' teaching strategies, learners' questions and discussion, group work, and pair work and peer work (Hoadley & Jansen, 2012). However there were many challenges that due to the complex language usage, the inadequate resources that were not context based and the preparation of teachers which was really not adequate. Therefore it was clear that numerous challenges would emerge especially when it came to teachers understanding the assessment of the learners as there were complications in the implementation of the curriculum. As a result of these problems, Outcomes Based Education (OBE) was revised (Kenton, 2002) and the Department of Basic Education implemented/enacted the new C2005 that was later reworked into the Revised National Curriculum Statement (RNCS), which was introduced to the Grades R, 1, 2 & 3 in 2004, 4, 5 & 6 in 2005, into Grade 7 & 10 in 2006, 8 & 11 in 2007, 9 & 12 in 2008 (Velupillai, Harding & Engelbrecht, 2008, p. 56). The RNCS and NCS were also reviewed due to on-going implementation problems. As a study by Ramatlapana and Makonye (2012) state that there was too much independence with the teachers' understanding of their practice as they were using the Revised National Curriculum Statement and National Curriculum Statement. This suggests that understanding is an important phenomenon that may help teachers to deal with their curriculum such as Mathematics pedagogics. As a result, the next section unpacks understanding as a phenomenon.

2.1 Understanding as the phenomenon

Understanding is divided into self-understanding, community understanding and subject understanding. The understanding of the self in pedagogic practices involves the profound and vital understanding of mathematics thinking which is connected to how a teacher uses his/ her skills to support learners in understanding Mathematical concepts. This is how Sadovnik (1991) explains how teachers construct the knowledge in order for learners to interact with it. Regarding the community understanding of the pedagogic practice, Ball and Cohen (1999a) assert that teachers who learn from their practice to enhance their learners' understanding will always improve their practice. Duncan et al. (2007) argue that, world-wide, it is of the utmost importance that teachers understand how to develop their learners' mathematical skills adequately. It has become crucial that teachers are able to focus on developing their learners' skills rather than on making decisions that merely suit their own practices and skills in the classroom (Stuart & Thurlow, 2000). For teachers to understand their practice, they first have to understand that the curriculum to be used is also divided into three categories, the intended curriculum which signifies what the teacher intends to do in terms of the Learning Area/Subject. The second one is the implemented/enacted curriculum (community understanding) curriculum where the teacher and the school plan the programme and the last phase speaks to the assessed or sometimes called the attained/achieved (self-understanding) that the learners are expected to follow. In this case it is the prescribed curriculum for Mathematics that is planned for the Grade 1's. Understanding the skills required for learners to be competent in Mathematics specifies that scholars focus on the community understanding which is called the competence or horizontal curriculum (Bernstein 1999) which will assist learners to understand Mathematics and the requisite skills.

As a result Shulman (1987) defines teachers' knowledge and understanding as broad principles and strategies of classroom management and organisation that apply to the subject to be taught. Teachers should enrich learners' natural interest in mathematics as well as create a favourable classroom environment that helps learners to develop characteristics like curiosity, imagination, persistence and flexibility.

This would take into consideration both understanding the self-environment where teachers can relate to the learners as well as the subject understanding of the pedagogic knowledge that requires the Mathematics teacher to be a researcher and learn the facts about Mathematics teaching. Khoza (2016) took the curriculum discussion further by articulating that the understanding of the teaching visions and goals was key in teachers' understanding of their practice. Such articulation made it clear that teachers do allow their self-understanding of the curriculum to impact on how they teach. With Shulman (1987) the understanding took a different turn as he felt the subject understanding of the curriculum was a priority and this became significant in his discussion when he spoke about the teaching and learning principles of understanding the subject.

2.2 Understanding the curriculum

It is important for teachers to understand and be knowledgeable about mathematical topics that are stipulated in the curriculum which is referred to as subject understanding. This knowledge may help them to plan logical and appropriate lesson plans that will expose learners to mathematical concepts in all major content areas of mathematics, thus taking the discussion towards the vertical curriculum (B. Bernstein, 1999). Also teachers are expected to understand the facts to allow learners to perform for progress in their grades. Curriculum, according to van den Akker, et al. (2009, p. 9), is a "plan for learning" (referring to the curriculum document - which is the intended). However Pinar (2010, p. 36) defines it as "plan of learning" (referring to the attained/achieved/assessed curriculum curriculum) or "plan of action" (referring to teachers' experiences - implemented of attained curriculum). They identified five levels which the curriculum is divided into. These levels are the international (supra), national (macro), institutional (meso), micro (teacher) and lastly the nano (student). Further to the identified levels, van den Akker, et al (2009) state that curriculum can be represented in three forms, namely, curriculum as intended, curriculum as implemented and curriculum as attained. Khoza (2015a) states,

> The intended curriculum consists of ideal (vision/rationale) and formal/written (intentions as specified in documents) components. The implemented curriculum consists of perceived (curriculum as interpreted by teachers) and operational (the actual process of teaching and learning or curriculum in action) components. The attained curriculum consists of experiential (learning experiences as perceived by students) and learned (resulting learning outcomes of students) components. (p. 27)

It is arguable that the teachers' understanding must include personal, social and professional understanding (Khoza, 2015b). Stenhouse (1975) focuses on a process of teaching that leads to achieving outcomes through understanding content. This clearly assumes that teachers require content knowledge, which is enabled by a clear understanding of the subject or discipline. According to Stenhouse (1975), the curriculum needs to be an attempt to communicate the essential principles and features of an educational proposal that is open to be critiqued for it to work in different practices. Stenhouse (1975) thus allows that the curriculum may be driven by what can be critiqued during the process of teaching, but that will nevertheless result in achieving outcomes through understanding the content.

Some curriculum researchers still rate Tyler's (1949) model of the curriculum as the strongest, because it caters for both the learners' societal and subject needs. It recommends that all four principles (goals, content, organization and evaluation) must be incorporated in such a way that each one of them addresses learners' social and subject needs. This is seen as teachers' understanding of the pedagogic practices in teaching Mathematics that indicates the teacher's achievement of aims/objectives. In terms of the teachers pedagogic knowledge, the self-understanding relates to what the teachers understands in terms of mathematics teaching refers to what teachers know and have been believing.

Shulman (1986, p. 9) defined this as pedagogical and content knowledge, "which goes beyond knowledge of subject matter per se to the dimension of subject matter knowledge for teaching". When teachers start learning and become researchers in their classrooms (Keyes, 1999) they happen to understand their practice and what learners are supposed to do in the classroom. In other words, teachers should be able to move from self-understanding, to society or community understanding and to subject understandings in order to develop learners' talents (self-understanding, meaning instilling good habits, or career direction required by society (community understanding, that is based on everyday knowledge, and subject understanding (subject advancement that is fact based).

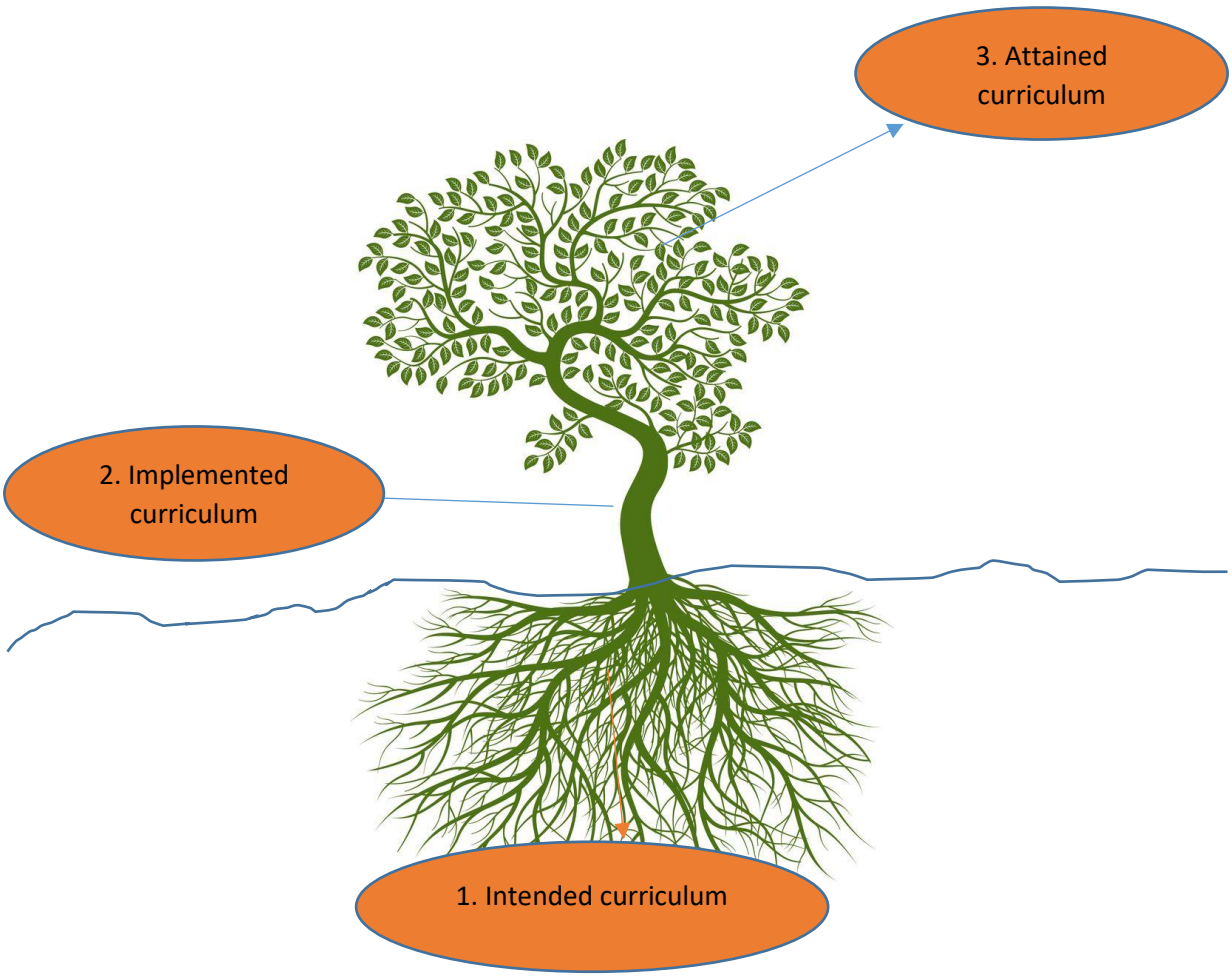
Tyler (2013) looked at the significance of a rationale and goal-directed teaching strategy and refers to the four guiding questions to be answered by teachers to understand their practice. What educational purpose should the school seek to accomplish, the educational purpose to be provided, and how the educational experiences can be effective for the teaching and lastly what tool could be used for the determination of the purposes of teaching using the curriculum. Van den Akker, et al. (2009) states that a curriculum should give teachers clear guideline that have been decided on and thoroughly research about what teachers need to teach and further states that the best way to do that is by providing a clear set of objectives, in other words, a plan for learning". Kelly (2006, p. 8) believes that "curriculum is the totality of experiences the learner has as a result of the provision made". According to Hoadley and Jansen (2012) curriculum can be called curriculum-as-plan, the prescribed curriculum or the intended curriculum, since the view of the curriculum concentrates on the official curriculum. According to Kehdinga (2014) the curriculum is political and that teachers become role players in what has been discussed and carries the principles of the ruling government. Curriculum progression has to address the needs of the learners to ensure the learners' performance. Khoza's (2015b) research on the curriculum concepts referred to them as learning signals. He clearly specifies that teachers need to understand their teaching through these learning signals in order for them to understand their teaching outcomes. Khoza's (2015a) identification of learning signals further states that teachers have to think more about what triggers their teaching and this is aligned to self-understanding of the curriculum. This would allow the teachers' understanding/visions to play a significant role in their teaching.

Furthermore, Berkvens, et al. (2014) argue for the needs and wishes arising from the post-2015 education agenda where a need arose for the introduction of another concept called accessibility in 2014, which replaced 'grouping' in the curricular spider web. The study will also examine the recent studies on the pedagogic and curriculum concepts as defined by van den Akker, et al. (2009) where he emphasised the significance of the learners, society and the subject as the most noteworthy concepts in curriculum formation. For this study, accessibility had to play a significant role as some of the teachers were from rural areas where research has proven that schools in these areas still suffer in terms of resources (Gardiner, 2008a). Khoza (2015a) brought a different dimension to the idea of a curriculum when he stated clearly that the goals and vision becomes significant in curriculum concepts with the understanding that visions and goals might assist teachers to focus on what they need to do in teaching. The key concepts set out by Shulman (1987) were consulted to illuminate teachers' pedagogical and content knowledge.

Furthermore the teachers' understanding of their practice was explained using the diagram (Figure 2.1) below which explains what van den Akker (2009) explains as the different levels in the curriculum making a clear distinction between intended, implemented, and attained curricula specifying the subject as the most noteworthy concepts in curriculum formation. Van den Akker (2003) conceptualises curriculum as a plan for learning is that of curriculum components and can further be divided into ten components that address specific elements of the learning process in teaching and learning. Understanding teachers practice begins from what is specified as 1 the teachers' vision that translate to 2 what the teachers implement in order to achieve the 3 learning outcomes that are seen from the learners.

The three representations of the curriculum as represented in the diagram below, the intended curriculum represent what is called the subject understanding of the curriculum. What I grew up believing as the teachers knowledge on how learners need to be supported in order to grow the knowledge of understanding Mathematical concepts. The second representation is the implemented curriculum that relates to the community understanding, which the people understanding that significantly depends on teachers (Chisholm & Wildeman, 2013).

Hoadley and Jansen (2012) argue that the intended curriculum guides teachers towards curriculum implementation. Teachers become specialists as they work with both the intended curriculum and the enacted curriculum when implementing teaching strategies during teaching and learning (Hoadley & Jansen, 2012). The third representation is the subject understanding that comprises of facts, that is requires the assessed curriculum which is the learning experiences perceived by learners as measured through their achievement of learning outcomes. Ramatlapana and Makonye (2012) state that this is a performance curriculum where there is a representation of facts on how learners need to perform for them to progress in different phases whilst understanding the different Mathematical concepts.



1.Intended	What is written?	The philosophy underlying the curriculum
2. Implemented	What is operational?	What teachers implement
3. Attained	What is learned?	Learning outcomes by learners

Figure 2.2.1 The three representations of the curriculum

Curriculum concepts, or pedagogic knowledge highlights the significance of the relationship between the teachers' knowledge and the content knowledge that learners need to interact with. Ramatlapana and Makonye (2012) state that teachers are aware of the different learners' needs, interests and talents and also make decisions in response to the different characteristics of their learners but lack the capacity to effect a change. Though the learners needs play a significant role in their learning, taking into consideration what the Mathematics content is about (the number operations and relationships, patterns, functions and algebra, space and shapes, measurements and data analysis) could be catered for in terms of what learners understand and relate to. Zimmerman and Schunk (2008) identify four epistemological assumptions that are at the heart of constructivist learning, that is the setting of the objectives, making sure that the strategies used are working and self- monitoring on the performance outcomes. (In a learning space that is social/societal, the teacher has a responsibility to take the learners' needs into account through the learner-centred approaches). As physical knowledge is constructed in the classroom, learners need to be involved in active learning where the teacher will use symbols to construct learning that will suit learners in their context. Moreover, learners need to be assisted by teachers to make their own judgments, using what the teacher has designed as resources for better understanding. Schunk (2008b) further notes that a Mathematics teacher needs self-confidence because this, in turn, boosts learners' self-confidence. According to Khoza (2016), learners' self-confident is boosted if the teachers' talents, skills and the pedagogical content knowledge are taken in considerations. Also the teachers' subject knowledge and understanding of the content taught allows learners to develop in the learning process.

To interact with the phenomenon that relates to teachers' understanding of their pedagogic practices in Mathematics teaching, it is significant to look at the phenomenon in three categories, that is the self-understanding, community understanding and subject understanding. As curriculum may be represented by three main layers which translate to the self-understanding of the pedagogic practices and involve the profound and vital understanding of mathematics thinking which is connected to how the teacher uses his/her skills to support learners in understanding Mathematical concepts. For teachers to understand their practice, it is also significant that they understand that the curriculum to be used is also divided into three categories, the intended curriculum which signifies what the teacher intends to do in terms of the Learning Area/subject (subject understanding or development). Explaining the teachers' construction of the knowledge in order for learners to interact with it

(Sadovnik, 1991). The community understanding of the pedagogic practice. Ball and Cohen (1999a) assert that teachers who learn from their practice to enhance their learners' understanding will always improve their practice (community/societal understanding/development).

Cockburn and Nardi (2003) argue that teachers use the teaching resources to connect the concrete experiences, pictures and symbols as these allow learners to create images of the mathematical concepts. As the study looked at examining teachers' pedagogic practices in teaching Mathematics, the concrete experiences would allow teachers to see the progress in learners' learning. Furthermore the study by Cockburn and Nardi (2003) also advocated for the development of the learners and this is understanding the communities or the societal or sometimes called community understanding through learners career developments.

The Curriculum and Assessment Policy Statement (CAPS) requires teachers to use resources as they play an important role in learners' understanding and remembering concepts. CAPS pushes for content-centred approach which is the subject development or content knowledge. That is different from Outcome Based Education which was too complex in terms of language terms for teachers. It also pushed for a learner-centred approach sometimes called the competence based curriculum or societal or community development. As the resources were inadequate teachers spent most of their time preparing for the lessons. There were many problems that arose in the OBE approach resulting in problems with assessment and complication of implementation, and so Outcomes Based Education was reviewed (Kenton, 2002).

Hollins (2011, p. 395) explains that teaching "is a complex and multidimensional process that requires deep knowledge and understanding in a wide range of ideas and the ability to synthesize, the integration and application of knowledge in different situations, under varying conditions and with a wide diversity of groups and individuals". This definition looks closely at the Mathematics education context because teachers need to possess adequate knowledge of mathematics (self, societal/community and subject) in order to demonstrate their competences in facilitating learning, employing effective teaching strategies and methods that help learners to positively learn mathematics.

In teaching Mathematics, subject understanding that requires the understanding of the facts is crucial. Sarama and Clements (2009) argue that how learners learn Mathematics seems to have captured global attention. Learners will only understand Mathematics if they are taught correctly and in a way that is conducive to the acquisition of mathematical skills. In addition, Hoadley and Jansen (2012) argue that the National Curriculum Statement is a mixed model of curriculum that retains many aspects of the competence model of curriculum such as a learner-centred teaching strategy. Therefore teachers must ensure that learner-centred teaching strategies dominate in the teaching and learning situation for the curriculum to be effective. As a result the Revised National Curriculum Statement and National Curriculum Statement was revised to the Curriculum and Assessment Policy Statement (2011).

The Curriculum and Assessment Policy Statement indicates the importance of teacher development in terms of content knowledge and how the teacher can put the curriculum into practice where in-service training is inadequate. The Mathematics curriculum and assessment policy statement (2011) document puts a strong emphasis on content knowledge as "the general focus of the content area and the specific focus of the content area for each Grade. It also indicates the specification of the content which shows progression in terms of concepts and skills as well as the clarification of the content which provides guidelines on how progression should be addressed" (DoBE, 2011, p. 9). The Curriculum Assessment Policy Statement also provides the curriculum implementers with teaching guidelines (DoBE, 2011). It becomes imperative for teachers to use effective teaching strategies in order to have effective teaching therefore understanding and becoming aware of all the components of the curricular spider web and how these concepts are connected to each other to provide consistency and coherence in the content knowledge of understanding the teaching pedagogy (Van den Akker, et al., 2009). Therefore, it is imperative for teachers to use the teaching strategies that are intended for teaching Mathematics for effective teaching and understanding to take place. That relates to teachers using effective strategies and the understanding the learners' location is not that significant when you deal with subject development (content-centred like CAPS), because the target is to make sure that the subject always meets international standards. Learners must either fit within the subject frames or standards or they fail.

Therefore allowing Tyler's (2013) model that recognises the significance of a rationale and goal-directed teaching strategy which recognises the four questions that relate to what educational purposes the school should seek to attain, what educational experiences can be provided that are likely to attain these purposes, how these educational experiences can be effectively organised and how can we determine whether these purposes are being attained. Teachers are only involved in the implementation of the curriculum at the micro level as they are excluded from the designing stages. This can make them passive implementers of the curriculum. Teachers have no idea of how the curriculum is developed therefore a vital body of knowledge is missing. This process of merely allowing teachers to implement the curriculum can lead to teachers centralising teaching which may permit them to choose teacher-centred approaches or direct instruction as their comfort zones.

Van den Akker, et al. (2009) suggest that everyday knowledge is learnt randomly from everyday discussions and Khoza (2015b) argues that the learning signals in teaching and learning are significant especially when teaching Mathematics focusing on the Curriculum and Assessment Policy Statement (CAPS). Mathematics teachers have a responsibility to think about the reasons for teaching Mathematics, that translate these to the teaching/curriculum/pedagogical concepts (aims, objectives and learning outcomes they are teaching, content and learning outcomes they are teaching, teacher role, resource used in teaching, grouping in teaching, location of teaching, time of teaching and assessment) with the purpose of improving the teaching strategies of the intended curriculum.

2.3 Understanding the international curriculum context

The international curriculum focused more on the "evidence based policy agenda" during the 1980s and the global landscape of education looked different from its current state. The standardised teaching and curriculum set a clear, highly prescribed performance standard for all schools, for teachers and learners to improve the quality and equity of outcomes in order to have logical and common criteria for measurements and information (Sahlberg, 2011). The international curriculum was more evidence based and required teachers to produce what they were able to work with the learners. Khoza (2015a) attests that because learners are expected to achieve according to the international standards or levels the curriculum is more content-centred. How learners perform is

paramount and their knowledge evaluated horizontally. This concerns learner-centred or societal or community understanding.

There are curriculum reforms all over the world that are designed to suit the current educational trends. Sahlberg (2011) on describing the beginning of the present global education reform movement discussed some of the key characteristics and implementation in practice. It reveals that other countries like Germany and the Netherland have adopted an "evidence based policy agenda" in their educational reforms. This clearly shows that curriculum is being developed all over the world. This movement changes the nature of teaching from open-ended, non-linear mutual inquiry and exploration to a linear process with causal outcomes (Sahlberg, 2011). There is clear evidence that curriculum reform is continuous process of upgrading in other countries. Therefore the next subsection describes how the South African curriculum has evolved.

2.4 Understanding the historical effects of the South African curriculum

The present South African curriculum (CAPS, 2011) has taken the form of a performance based curriculum. Since 1994 the curriculum in South Africa has gone through many curriculum changes. It is a country that has emerged from the apartheid regime and is trying to get its act together in the education sector. Hoadley and Jansen (2012) argue that Curriculum 2005 was intended to be the reverse of Bantu Education which was based on the outcomes of how learners performed. This according to Bernstein (1999) is a horizontal curriculum. Community understanding prevailed in this curriculum as it was based on learners' competence. Kehdinga (2014) states that each new Minister of Education in South Africa introduced a new curriculum. The National Curriculum Statement was introduced in 2009. These two curricula were combined to produce one which comprised a single Grade R-12 National Curriculum Statement which subsequently became a single Curriculum and Assessment Policy Statement (CAPS) curriculum assessment policy statement in 2011. CAPS (2011) intended to build on the previous curriculum but also to update it from the competence based curriculum that was referred to as Outcome Based Education and therefore aimed at providing a clearer specification performance based education to be taught and learned where the performance is vertically aligned as follows: Curriculum and Assessment Policy Statement (2011) for all approved school subjects listed in the documents, the National Policy document, National policy pertaining to

the programme and promotion requirements of the National Curriculum Statement Grades R-12 (2011) and National Protocol for Assessment Grades R-12 (DoBE, 2011).

Hoadley and Jansen (2012) argue that the CAPS document does not give teachers guidance on how to teach, the teachers have to figure this out this by themselves (p. 188). A performance curriculum lists the content to be mastered (vertically from facts or school knowledge) and competence based gives competences or outcomes to be achieved (horizontally from opinions or everyday knowledge).

After 1994 the education system changed to the principles of Outcome Based Education (Killen, 2000). Noting that this OBE was just an approach to curriculum but curricula in South Africa from 1994 to 2012 were Christian National Education (CNE), Curriculum 2005 (C2005), Revised National Curriculum Statement, National Curriculum Statement and Curriculum Assessment Policy Statement. The Department of Education introduced the National Curriculum as an attempt to transform the curriculum inherited by apartheid (DoE, 2011). In 1997 Outcomes Based Education which was an approach used by teachers was horizontal which is driven by everyday knowledge aligned as a means of competence as introduced to overcome the curricular divisions of the past. Velupillai, Harding and Engelbrecht (2008) researching for General Education and Training in Mpumalanga investigated how to go about teaching problem solving in South Africa, indicated that Outcome Based Education (OBE) was implemented. In the light of the above, Hoadley and Jansen (2012) argue that the Curriculum 2005 was intended to be the reversed of the then Bantu education.

This freedom in curriculum implementation was also a challenge as it did not produce the results that were expected or desired as learners continued to perform very poorly especially in Mathematics. C2005 as the competence based curriculum was not supposed to be judged according to international standards because it was created as a horizontal curriculum to accommodate local everyday knowledge, the information learners would be able to access from home, as well as in conversations. The only curriculum that was to be judged according to international standards was CAPS because it prescribes the vertically international recognised content. The schools had their assessments where the Department of Basic Education used the international comparison achievement tests, like the Annual National Assessments (ANAs) which were also performed poorly by learners.

Furthermore Bantwini's (2010) study revealed that teachers were still using teacher-centred strategies during the Revised National Curriculum Statement and this went continued in the National Curriculum Statement (2015). This is significant as teachers rely on the independence and freedom that is needed to teach using this curriculum. For example the self-understanding required where the teachers had to rely on what they knew and have been taught for them to be able to teach. Schiro (2013) refers to this self-understanding as personal understanding that is uniquely owned and the community understanding which refers to the teachers' opinions about the curriculum. Mncube and Harber (2010) researched teachers' experiences and practices of providing democratic classrooms as a way of delivering quality education and lastly the subject understanding which refers to the facts about the curriculum implementation where teacher rely mostly on what they need to do in the classroom. The South African National Curriculum Statement R-12 (Department of Basic Education, 2011) for Mathematics, lists specific skills which school learners require. These skills include: "Develop the correct use of the language of Mathematics", "Learn to listen, communicate, think, reason logically and apply the mathematical knowledge gained". Learn to pose and solve problems" and "Build an awareness of the important role Mathematics plays in real life situations including the personal development of the learner" (DBE, 2011, p. 6). Thus the National Curriculum Statement R-12 (DoBE, 2011, 2012) emphasises that Mathematics is yet another form of a language. The National Association for the Education of Young Learners and National Council of Teachers of Mathematics (NAEYC and NCTM) (2002) suggested that within the classroom, teachers should enrich learners' natural interest in mathematics as well as to create a favourable classroom environment that helps learners to develop characteristics like curiosity, imagination, persistence and flexibility.

Van den Akker, et al. (2009) suggests that everyday knowledge is randomly learnt from discussions overheard, from the media, from watching parents, from punishments and praise. School knowledge is grouped into specific subject studies, like Mathematics, Literacy and other Subjects like Geography, which cultivate the learners' own language. The curriculum shifted from a competence curriculum (RNCS and NCS) to a performance curriculum (CAPS) (Hoadley & Jansen, 2012). A competence curriculum can be described as learner-centred while a performance curriculum is a content and teacher-centred approach (van den Akker, et al., 2009).

Ramatlapana and Makonye (2012, p. 20) "the Curriculum Assessment Policy Statement is more content-oriented", and that CAPS (2011) is a performance curriculum. Since the curriculum assessment policy statement (2011) is a prescribed curriculum according to Ramatlapana and Makonye (2012) it can be said that it is a performance curriculum where there is a representation of facts on how learners need to perform for them to proceed in different phases. Therefore CAPS (2011) followed the criteria of the performance curriculum as indicated by the above studies.

Askew et al. (2012), Hoadley (2007) as well as Taylor and Vinjevold (1999) have all noted evidence of very poor basic mathematics content knowledge levels and insufficient content knowledge by teachers. This signifies that teachers have to revisit their understanding and knowledge of Mathematics to teach successfully. Adler, et al. (2005) argue that, in order to achieve improved learner achievements in Mathematics, it is necessary to improve the professional growth component of teachers. The self-understanding of the pedagogic practice is what is significant as it results in improved learner performance. In addition teacher knowledge and understanding of Mathematics impacts on how learners learn Mathematics, (Ball 1999, Shulman 1986 and Wilson, Shulman & Richert 1987). There is an increasing amount of research that has been carried out on the teaching of Mathematics in the primary schools, National Teachers of Mathematics, (2000), Kilpatrick, Swafford, and Findell (2001), McCarthy and Oliphant (2013) as well as on how learners learn in Grade 1 (NEEDU, 2013). However, research on whether teachers understand their practice in teaching Mathematics to younger learners, particularly in Grade 1 is limited. These are: knowledge of representations of subject matter (content knowledge); understanding learners' conceptions of the subject; the learning and teaching implications that are associated with the specific subject matter; and general pedagogical knowledge (or teaching strategies). For knowledge-based teaching Khoza (2014) also includes curriculum knowledge, knowledge of educational environments, and knowledge of the purpose of education. These key concepts that Shulman refers to were significant to this study as they relate to what is expected from teachers in a classroom environment. This review also refers to studies of Mathematics that focused on curriculum concepts. They argued that by systematically answering the four main questions based on factual arguments, validity the internal consistency of a curricular product can be improved.

It is believed that every lesson taught in the classroom should be driven by goals-directed teaching strategies so that the teaching strategies of teaching Mathematics are aimed at achieving those objectives (van den Akker, at al., 2009). Van den Akker, et al. (2009) believe that Tyler's research emphasises the significance of a rationale and goal-directed teaching strategy which talks to four questions that relate to: what educational purposes the school should seek to attain, what educational experiences can be provided that are likely to attain these purposes, how can these educational experiences be effectively organised and how can we determine whether these purposes are being attained. Furthermore he emphasised that learning needs to be directed towards a certain goal and when this goal is not achieved, then the evaluation should be on why the goal was not met keeping in mind the essential knowledge expected by the curriculum and the experiences of the learners. Tyler's model requires that learners experiment in their learning which is what the constructivists emphasise as learning through discovery. For the teachers' understanding of their pedagogic practice, it depends on which concepts are chosen and the reasons for that selection. Stenhouse (1975) focuses on the process of teaching that leads to achieving outcomes through understanding the content. Kelly (2006, p. 8) believes that "curriculum is the totality of experiences the learner has as a result of the provision made". Hoadley and Jansen (2012) state that curriculum-as-plan, is the prescribed curriculum or the intended curriculum, since the view of the curriculum concentrates on the official curriculum. Whereas Kehdinga (2014) on the other hand states the curriculum is a political document, it always carries the principles of the ruling government. Kehdinga, 2014 and Hoadley& Jansen 2012) agree with the fact that a curriculum cannot be neutral as it will always carry the values and assumptions that reflect the interests of certain sectors of society and will discourage the values of others. However teachers have a responsibility to implement the teaching strategies that are intended for teaching Mathematics.

The direct teaching approach allowed teachers to concentrate on teaching strategies that focused on the methods they were using such as the drill method, rote/memory teaching, explaining and demonstrating practical procedures, which did not cater for the diversity of learners in the classrooms. The implementation of CAPS (2011) came with different approaches that spoke to leaner-centeredness which meant that teachers had to do away with direct teaching.

Killen (2000) states that since the teacher-centred approach involves teaching strategies such as the drilling method, a move from the competence curriculum to the performance curriculum meant that teachers needed to shift from a learner-centred approach to a teacher-centred approach (Hoadley & Jansen, 2012). The teacher-centred approach considers more specific aims than specific skills and there are also teaching guidelines that show what teachers teach and the learning outcomes required for coherence and effectiveness (Berkvens, et al., 2014). This has led to the call for a more learner-centred approach where learners are allowed to participate in their own learning. Hoadley and Jansen (2012) attest that the intended curriculum guides teachers in the CAPS curriculum. Hence teachers as technicians struggle with both the intended curriculum and the enacted curriculum when implementing teaching strategies during teaching and learning (Hoadley & Jansen, 2012).

The different learners in the classrooms also signify that teachers employ different strategies. Pinar (2012) brought a new dimension to the curriculum debate by arguing that by writing the American school curriculum and aligning it with standardised assessment, politicians silenced the complicated conversation about the curriculum, which is the core of education in a social democracy. Others point out the importance of statements of expected learning outcomes or behavioral objectives and still others describe the curriculum as a plan for instruction specific to a particular school or learner population (Lunenburg, 2011). In his seminal work on pedagogical content knowledge (PCK), Shulman (1986) points out that in order for teachers to practice effective teaching, they need to have knowledge of the subject matter because it is critical and central to effective teaching. The latter also depends on whether teachers are well trained and proficient in teaching mathematical concepts and skills. It is crucial to keep the learners optimally engaged and to ensure that the time spent on learning is increased so that teaching and learning remain within grade-appropriate objectives. Therefore, it is important that the curriculum clearly shows developments as it is happening worldwide. In term of practicality and sustainability there are potential problems because the CAPS (2011) policy document does not indicate that the decisions, policies and materials used by teachers fit the settings of the designed curriculum and that they are constructed with a view to the future and are unlikely to remain successful when support and budget fade over time (Berkvens, et al., 2014).

All in all implementation depends significantly on teachers (Chisholm & Wildeman, 2013, p. 96), because they are the ones who are essential in implementing the intended curriculum in practice (Berkvens, et al., 2014). A shift from this study approves the curricular spider web by van den Akker, et al. (2009), as the strong conceptual framework based on mutual understanding processes (Berkvens, et al. 2012) which also involves four criteria that rotate around the curricular spider web of quality education. Van den Akker, et al. (2009) and Khoza (2015a) argue that these are the basic foundation concepts to any curriculum. These concepts are important because they contribute in the implementation of the relevant teaching strategies of teaching.

2.5 Understanding pedagogy

Shulman (1986; 1987) refers to teachers' pedagogical knowledge as the knowledge of the subject matter that teachers should possess before going to class. Understanding pedagogy suggests the subject understanding as pedagogy is more externally dependent for the critical skills that the teacher needs to have. In essence it means that understanding pedagogy attempts to design a strategy that will help in teaching mathematics. The subject understanding of the curriculum was important in teachers' teaching but the poor achievements in Mathematics highlighted a dire need for the improvement of professional teacher development programmes in order to prepare them for teaching Mathematics. Speer, Smith and Horvath (2010) state that pedagogy means examining and describing the work teachers do that reveals instructional activities examined for their effectiveness on teachers' teaching. Meaning that in a classroom situation the teacher has to for example, revise the previous work or give some explanations first, before allowing learners to interact with the subject matter. Also this understanding relates to what the outcomes would be when teachers understand the pedagogy of teaching. It therefore follows that teachers should accept the responsibility to understand their pedagogical knowledge and the content they teach before they are able to work with learners in Grade 1. It is also important that teachers understand the methods of teaching in order for them to interact with the content knowledge Leach and Moon (2009) and Bertram (2004). The term 'pedagogical knowledge' was first introduced by Shulman (1986), and was subsequently expanded by Van Driel, Verloop, and de Vos (1998) and Cochran, King and De Ruiter (1991).

In this context, the transformation of education in South Africa has a mandate to investigate teachers' content knowledge and to give them confidence in teaching Mathematics in Grade 1. Only then will they be able to demonstrate excellence in their teaching of Mathematics (Ball, Bass & Hill, 2004). The knowledge of pedagogy, knowledge of learners' location, context specific knowledge; and the teacher's beliefs about the Learning Area to teach. This advocated for societal understanding where learners were taught to be confident about what they knew.

Darling-Hammond (2011) and Machaba (2013) agree that teachers of Mathematics not only have to be well versed in the content knowledge of Mathematics, but they also have to be acquainted with the methods to teach that content knowledge. The possibility exists that teachers' attitudes, instructional practices and their knowledge of Mathematics could improve should they observe progress and development in the learners they teach (Guskey, 2003). To achieve this goal, teachers' pedagogy should include the processes and practices of good teaching and learning which should evolve around commitment, values, methods used to teach, and strategies for evaluating learner learning. This resulted in teachers designing different approaches to teaching Mathematics. The findings prompted the researchers to look at different aspects that pertain to the teaching and learning of Mathematics in primary schools, and they finally focused on content specific pedagogical knowledge that pertains to particular learners in particular contexts in Grade 1. This finding corroborates Shulman's (1986; 1987) definition of pedagogical and content knowledge (PCK), confirming that this form of knowledge is knowledge used to transform subject matter content into forms more coherent to learners, as also posited by Geddis, Onslow, Beynon and Oesch (1993), Grossman (1990) and Marks (1990).

The term 'pedagogical knowledge' refers to a teacher's ability to represent and impart important concepts about a particular topic to learners in order to enhance learning. Pedagogical content knowledge (PCK), on the other hand, enables teachers to transform complex ideas into concepts that learners can grasp and assimilate. Shulman (1987) argues that merely developing general pedagogical skills is insufficient for both teaching and learning to take place. In his view, the key to distinguishing the knowledge base of teaching rests at the intersection of content and pedagogy.

Researchers such as Powell and Anderson (2002) as well as Strong and Tucker (2000) have contributed to the formation of the concept of pedagogical content knowledge and agree with what Shulman (1987) alludes to, namely that pedagogical content knowledge is a significant element that teachers require to be able to teach.

2.6 Understanding Mathematics content knowledge

According to Ball, Thames, and Phelps (2008, p. 389) "content refers to a wide range of aspects of subject matter knowledge and teaching of subject matter, and indeed, have used it differently across, and even in subject areas". Understanding the subject was key for the teachers to be able to teach according to Hill, et al. (2005). There are some important facts in this statement as teachers need to understand the content of the subjects they teach. The vertical knowledge takes the form of a hierarchically organised structure that requires coherent and analytically principled organisations, teachers' mathematical knowledge is an important factor in learners' educational achievement gains in both the first and third grades Hill et al. (2005). Clements and Samara (2009) contend that it is the knowledgeable Mathematics teacher who will transform everyday Mathematics into applied situations for learners. In the context of this study, the focus was on teachers' knowledge of Mathematics as this plays a significant role in understanding their practice. Guzey and Roehrig (2009) found that teachers' pedagogical reasoning mirrored their pedagogical actions. Teachers in the early phases have a responsibility to assist young learners in appreciating Mathematics whilst they are still very young. This is one of the specific aims of Mathematics teaching and learning (DoBE, 2011). Learners will only understand Mathematics if they are taught in a way that is conducive to the acquisition of mathematical skills. It is therefore a requirement that teachers have a keen interest in Mathematics and are committed to the teaching thereof. However, mathematical knowledge for teaching goes beyond the understanding and acquisition of basic mathematical skills. Teachers need to understand the space in which learners are learning and try to make that space conducive for the teaching and learning of Mathematics. Balasubramanian (2006) focuses on the teacher's role in teaching Mathematics and makes it clear that it is the teacher's function to look into what learners do and how they work with the teacher to understand Mathematics. Her study explored the challenges of teaching Mathematics in schools and she concluded that both mathematical content knowledge and pedagogical knowledge were lacking.

However, her findings drew on what Baker and Chick (2006) refer to as what challenges teachers in what they are expected to know as content and pedagogical knowledge, especially in Grade 1. Baker and Chick (2006) illuminate various challenges that teachers experience that impact their pedagogical skills and content knowledge. The findings by Baker and Chick (2006) and Machaba (2013) revealed that teachers either lacked mathematical knowledge, or struggled with the content knowledge of Mathematics.

Shulman (1986; 1987) contends that subject matter content knowledge refers to the teacher's understanding of what is to be taught (i.e., the facts), how the concepts are relayed, the organisation of the learning matter, and principles and structures of the subject. He further states that teachers need to draw on their understanding of these concepts and how they fit into the learners' context in order to teach. Teachers therefore do not only require content knowledge to understand their practice, but the teacher must show an understanding of why a particular topic is essential to a discipline, while another may not be as significant. Moreover, teachers must be knowledgeable and have an understanding of the subject matter themselves. They should demonstrate competencies regarding the rules that govern the subject matter. Shulman (1986, p. 9) further points out that the pedagogical content knowledge epitomises both the pedagogical content knowledge and an understanding of the subject area, although these two are not sufficient for teachers to use as their skills in teaching. What Shulman essentially argues as what a teacher knows, Khoza (2014) refers to as the learning signals and components and according to van den Akker, et al. (2009) they must all be incorporated in the teachers' teachings.

However, this is not sufficient for the early grades, as learners need to develop skills on how a certain topic is to be addressed. Sullivan and Wood (2008) argue that for Mathematics teachers to be effective, they need to be able to explicitly identify the curriculum documents that match the content that teachers will be teaching, and that they may even explain the Mathematical concepts to learners so that they understand Mathematics. This implies that Mathematics pedagogic and content knowledge is a blending of Mathematics content knowledge and pedagogic knowledge (Kazima, Pillay, & Adler, 2008). It is the specialised knowledge that teachers possess that is associated with content knowledge and the practice of teaching (Loewenberg, Hoover-Thames and Phelps, 2008).

In the current study, the second critical research question seeks to generate data on how pedagogic theories impacted selected primary school teachers' teaching approaches to Mathematics.

The teachers' specialised knowledge as key to teaching Mathematics (Carrillo, Climent, Contreras, & Muñoz-Catalán, 2013). The study considered this specialised knowledge from a different perspective, as it examined teachers' teaching practice in the early grades. The teachers in the study were expected to have specialised knowledge of teaching Grade 1 learners. They were also expected to be able to teach according to pedagogic theories pertaining to Mathematics, which research has shown to be problematic (Brophy, 1997; Rust, 1999; Loewenberg, 2008). Recent statistics have corroborated this finding, showing significantly low achievement rates in Mathematics in the administration of the Annual National Assessment (ANA) tests in Mathematics, after the inception of the Curriculum Assessment Policy Statement in 2011 (DoBE, 2011).

Although there might be certain unique differences, many similar concerns exist for Mathematics teaching and learning in the early grades. All teachers are guided by the curriculum; yet learners come from different contexts, and some learners in the classroom depend on the teacher's skills to teach them a particular topic. For these reasons one rule cannot apply to all teachers and all learners.

The curriculum involves the materials and programmes of study available for each Learning Area (Mertens, 2004). A curriculum is laid down for learners and contains reference to materials and resources that may be used to teach specific aspects of the curriculum. Such resources may be books, teaching packs, or audio-visual material. In South Africa, the new Curriculum and Assessment Policy Statement requires teachers to be able to adapt their knowledge about what to use when teaching and, especially, what to take into consideration when teaching learners from diverse contexts. Grossman (1990) supports the view that teachers should use what is available so that learners may understand what they are being taught. Curricular knowledge therefore assists teachers to make accurate pedagogical decisions in their teaching. Shulman (1985, p. 47) states that "… to be a teacher requires broad and highly organised understanding of knowledge", which prompted the research question in this study pertaining to teachers' understanding of pedagogical practice in Mathematics. The learning processes of learners in Grade 1 require designed pedagogies and extremely sensitive approaches.

According to the Shulman's (1987) model, there five most important components of a teacher's knowledge: These are referred to the knowledge of the content.

Scholars who have evaluated the CAPS (2011) argue that it is the outcome in terms of what teachers need to teach and how they should teach it, which often works against what teachers strive to address (Coetzee, 2012 and (Haussila, 2005). Ball (2008) attests that the constructivist approach in teaching Mathematics relies on what the teacher has taught together with what the learners know (prior knowledge), and this becomes evidence of how learners learn in the classroom. This is where the teachers' efficacy may be visible. A teacher's self-efficacy refers to particular competencies that bring about preferred conclusions of learners' commitment to teaching and learning (Armor, Conroy-Oseguera, Cox, King, McDonnell, Pascal, Pauly & Zellman, 1976; Bandura 1997; Ball &Cohen1999a, Brown 2002). Again, when teaching Grade 1 learners, one of the most significant key performance areas for the teachers is efficacy. Bandura (1997, p. 189) states: "What people believe can easily assist them to achieve their goals through their accomplishments in understanding Mathematics". Thus, when teachers value their learners, they will motivate them to learn. This issue is also addressed by Shulman when he refers to a crucial element that teachers require, which is to know the learners they teach. Hammond's (2000) study revealed that very little was done to improve teacher competence in preparing them for the professional world. In South Africa, it has been an issue of concern of many schools where teachers appear to be unprepared for the task of teaching Grade 1 learners (Taylor & Moyana, 2005).

Shulman's (1986; 1987) seminal work on teachers' "pedagogical content knowledge" argues that teachers have a distinctive form of proficiency knowledge, which he calls pedagogical content knowledge. This form of knowledge builds upon, but is different from, teachers' subject matter knowledge, or knowledge of general principles of pedagogy. According to his views, pedagogical content knowledge is a form of practical knowledge that teachers need to have in order to be able to teach. Turnuklu and Yesildere (2007) argue that both pedagogical content knowledge and knowledge of Mathematics are required for primary school Mathematics teaching. The latter research signifies that teachers have to understand what they are teaching; i.e., that there is a powerful connection between content knowledge and a knowledge of Mathematics teaching for them to be eligible to

teach Mathematics in primary schools. This implies that teachers cannot teach what they do not understand. Simply put: teachers must possess knowledge of Mathematics in order for them to teach Mathematics.

To address the first critical research question in this study, teachers were expected to refer to the different theories they applied in their teaching. This study aimed to create an understanding of teachers' pedagogical skills and, by means of an analysis of the data, it became evident that these pedagogical skills differed from one teacher to the next. The focus was placed on understanding what was underpinned by the works of researchers such as Geddis, Onslow, Beynon and Oesch (1993), Grossman (1990) and Marks (1990), who state that the knowledge teachers use to teach or transform content knowledge is that knowledge that learners use to understand what teachers teach. This will be discussed more broadly in Chapter Five when the data analysis is illuminated.

Pedagogical content knowledge (PCK) seems to be a challenge for teachers for many reasons. Teachers' feeling of insecurity has become evident in many areas, such as in their planning, in classroom interactions and arrangements, in content that should be suitable for particular learners, in the way different terms are explained, as well as in the different mathematical competencies of different teachers (Graeber 1999 & Ma1999). In this respect, the progression of pedagogic content knowledge involves the modification of teachers' understanding of the subject matter for themselves, as well as their ability to clarify subject matter using different approaches, reshaping it, and being able to deliver demonstrated activities for the benefit of the learners (Shulman 1987, p. 13). Teachers' content knowledge also refers to the knowledge of Mathematics shared mostly by teachers who are experienced in the field of Mathematics teaching and learning. Shulman (1986) posits that knowledge of content and learners (KCS) and knowledge of content and teaching (KCT) are complementary domains that impact on the knowledge of Mathematics teaching, particularly among experienced teachers, as they have acquired a vast knowledge of teaching and of the learners they teach.

Mathematics teachers who have little knowledge of the learning content cannot justify or evaluate the answers given by learners Darling-Hammond and Richardson (2009). Hence Sullivan and Wood (2008) maintain that teachers lack confidence in their mathematical knowledge. In this research it

was imperative to explore teachers' pedagogical knowledge in teaching Mathematics at primary level and also to understand their challenges in teaching Mathematics.

Teachers need specialised knowledge as well as skills to teach Mathematics in Grade 1. If they do not, there will be no progress in terms of the development of mathematical skills in our communities. Learners in the initial stages of their learning of Mathematics experience challenges, and for this reason the Department of Basic Education has suggested a number of interventions in the study of Mathematics and Science. The project popularly known as SACMEQ II for 2008 and van der Berg and Louw (2007) in which 15 countries from southern and eastern Africa participated. This begs the question whether specialised knowledge in terms of teaching Mathematics could be the key to these problems. It is only through specialised knowledge that teachers acquire effective teaching skills, and it is only through effective teaching skills that learners acquire logical reasoning and critical thinking skills. If the way that Mathematics is taught does not provide learners with these skills, then an important part of their preparation for life is absent. An article in The Mercury (August, 2014) by Mudaly on "teaching teachers" reported on an interview that the author had with Matric Mathematics teachers in an effort to determine if the problem of poor results emanated from Matric learners. The article reported on underperforming teachers; however, it was evident that the Department of Basic Education was aware of this problem but was not taking any action in an effort to protect teachers. Another case in point is an article by Steven Marais published in the Mail and Guardian (27 August, 2008). Based on poor examination results in Mathematics, this article argues that teachers are not sufficiently skilled to prepare their learners for the examinations because they themselves are unable to teach the new sections in the curriculum.

The National Education Evaluation and Development Unit (NEEDU) National Report (2012) reveals that teachers, especially in the Foundation Phase in schools where the LoLT is isiZulu, resort to teaching Mathematics in English because there are concepts that have no isiZulu equivalents in the Mathematics curriculum. Research suggests that young learners learn best in their mother tongue.

However, there are numerous factors that influence the choice of the language(s) of instruction in schools and higher education contexts. Some of these factors include the political, social, economic and cultural pressures that influence choices made by learners, parents, teachers, other members of the school community, Government, and higher education institutions (Halai and Karuku, 2012; Setati, Chitera & Essein, 2009; Nkambule, 2012).

According to Sherpard (2005) teachers use scaffolded learning and formative assessment to proceed in learning through what Vygotsky (1978, p. 187) terms as the "Zone of proximal development". The Zone of proximal development is achieved when a teacher supports learners to reach their developmental competencies of learning. This implies that learners need to work with another knowledgeable other to achieve what seems to be impossible to achieve on their own, thereby learning through this process of scaffolded guidance, so that eventually they are able to perform the task individually. There are different types of scaffolded learning. Teachers sometimes will scaffold learning where learners are guided to increase their knowledge. There is also the mediated learning through scaffolding; this happens when the teacher takes on the role of facilitator. Mediated scaffolded learning is where the teacher provides a systematic transition from the initial teacher-directed kind of learning towards the learners' ability to manage on their own. Such practices happen in Mathematics classrooms where young learners are struggling and, as the teacher intervenes, the learners eventually manage on their own. It also depends on the different tasks learners have to learn and the amount of work to be conceptualised. Alibali (2006) refers to 'instructional scaffolding' that is done to improve learning. It is important that learners be provided with support as they learn, because they learn differently. Learners are assisted with what they are struggling with in order to improve their learning.

It is also vital that teachers acquire new knowledge to equip themselves with the latest scholarly information that will assist them in their teaching and learning, and to revise the curriculum to suit changing global trends and needs. It is the teacher, however, who has to provide strong linkages between structures, processes and resources, and the learners. The Curriculum Assessment Policy Statement (DoBE, 2011) states that teachers are allowed to upgrade their teaching and learning, but there is always a limit due to age and the contextual factors of the learners taught at any particular

time. It is ultimately the teachers who are at the heart of the educational process and who are supposed to be performing optimally to achieve good results.

Teachers acquire and build their knowledge of teaching Mathematics via their teaching skills and specific approaches known to them, and that acquisition of knowledge determines how the teacher will progress in the teaching profession.

Mathematics also requires specific knowledge building strategies that suit each topic; for example, teaching fractions to a lower grade. Here teachers would adopt a skill where learners will work with the concept of a whole and divide it into two, and progress from there. The question is not whether the teachers understand their practice or not, but how the skills they have in Mathematics can be transferred positively to the learners. Hichman (1991) also supports this idea as he states that it is constructive approaches and ideas as well as teacher preparedness to teach learners that relate to what learners are learning.

Darling-Hammond (2000) asserts that there is growing evidence that such an aspect of teachers understanding their practice and approaches is vital in terms of learner performance. He further argues that although learners may have issues when their home language differs from the language of teaching and learning (LoLT), the language issue cannot contribute as much to learners' failing as the lack of teacher preparedness to teach subject content. Darling-Hammond's (2000) study was conducted in California and the findings revealed that teachers need more preparation before they "go out there and teach". Both a teacher's content and pedagogical knowledge are important criteria; however, more significant is whether this particular teacher is prepared to teach, and this holds true for Mathematics in particular.

Lerman (1993) describes two types of approaches in teaching Mathematics in Grade 1: the Euclidean approach, which refers to the teaching of Mathematics as a process which will expose learners to the deductive nature of Mathematics, and the Heuristic approach, also referred to as problem-solving. Lerman (1993) views the Euclidean approach as a way to arrive at a solution to a problem and therefore as the decisive aim of teaching and learning. Heuristics methods are used to combine knowledge gained in Mathematics in order to allow learners to solve real-life problems (Hoon, Kee & Singh, 2013). This in a way permits learners to solve problems and make judgments more quickly

and efficiently, and plays a significant role in both problem-solving and decision-making to stimulate interest in learning, as these are significant skills in learning Mathematics. Choosing a method is the teacher's prerogative as it depends on what he/she want to achieve in the lesson. Teaching Mathematics, especially in Grade 1, requires specialised skills.

According to Gill (2001, p 75), Mathematics is defined as "… the mathematical proficiency that anyone is expected to learn successfully". It is a known fact that more advanced mathematical skills become much easier when learners acquire sufficient skills in Grade 1.

Learners are dependent on teachers when they start their education in the early grades and it is imperative that these teachers have the necessary skills to instill a love of Mathematics in learners. This will, in turn, motivate them to pursue mathematical skills and applications later on in life. Bandura (1977) asserts that the self-efficacy of teachers in Grade 1 is a primary and powerful form of motivation and it is this aspect that motivates learners. Askew (2008) argues that teachers reflect on the theories they use to teach Mathematics and this is what assists them to diagnose their skills and knowledge of teaching Mathematics and any other Learning Area. Also, when they reflect on their teaching, it becomes easy as they follow certain specified guidelines when using the theories.

In the South African context, Anderson, Case and Lam's (2001) research findings on teachers teaching Mathematics in Grade 1 reveal that there is an adequate number of primary school trained teachers, but learners who pursue Mathematics at Grade 12 level do not want to pursue Mathematics as a career. This results in shortages in the field of Mathematics in the country. The policy statement (Curriculum Assessment Policy Statement) of the Department of Basic Education (DoBE, 2011) stipulates three areas of specialization, or core subjects, in the Foundation Phase, namely numeracy (Mathematics), literacy an life-skills (DoBE, 2011) though Life-Skills does not fall in the category of examinable Learning Areas. Unfortunately, learners are still struggling in both Mathematics and Literacy, which is evidenced by the low average Mathematics pass rate percentage of 37% in the Annual National Assessments for Grade 4 (DoBE, 2012) (Report by the Minister of Basic Education-Matsheqa).

Anderson, Reder and Simon (1997) posit that traditional cognitive standpoints typically treat knowing as the guidance of symbols inside the minds of learners. They explored the works of theorists who argue that learning is typically described as an individual's acquisition of knowledge, change in behaviour and knowledge structures, or growth in conceptual understanding. On the other hand, cognitive theorists argue that, while some learning takes place in a social context, what is learned can also occur independently from the context in which it is learned. Their study has contributed valuable insights into the importance and significance of the linguistic and cultural characteristics of a diverse learner population, and how this diversity relates to teachers' knowledge.

The issue of pedagogic knowledge as posited by Anderson (2002) and Strong and Tucker (2000) was significant in this study and was addressed in the same manner as them. Pedagogic content knowledge relates to the first critical research question as it highlights what teachers know in order for them to be able to teach Mathematics in Grade 1. This is addressed in detail in the data analysis in Chapter Six during the discussion of data generated through classroom observation of the teachers' lessons and in terms of the theories teachers used to guide learners to understand Mathematical concepts. Knowledge of the content of Mathematics includes teachers' knowledge of the concepts, procedures, and problem solving processes within the domain in which they teach. It is important that teachers understand the concepts, procedures, and problem solving skills to be able to succeed in teaching Grade 1 learners. Pedagogical knowledge is teachers' knowledge of teaching procedures, which is also crucial. Based on their content knowledge, teachers have to make sure that they teach in a developmental manner for learners to understand, organise, represent, and adapt mathematical content according to their diverse interests and abilities (Ball & Cohen, 1999).

Turnuklu and Yesildere (2007) argue that both pedagogical content knowledge and knowledge of Mathematics are required for primary school Mathematics teaching. Khoza (2015b) argues that it is the intellectual sphere or domain that allows the understanding of deciding whether learners can progress to the next phase or grade according to which content was used to test their abilities. This understanding is more on the performance base that requires facts not people's thinking. The latter research signifies that teachers have to understand what they are teaching; i.e., that there is a powerful connection between content knowledge and a knowledge of Mathematics teaching for them to be eligible to teach Mathematics in primary schools.

Understanding the subject knowledge was key in this research and this implies that Mathematics teachers require this knowledge and understanding in order for them to teach Mathematics. Baker and Chick (2006) examined the content knowledge of teachers teaching learners in Grade 1, and found that their teaching had to depend on different contexts. Arguably Mathematics teachers are guided by what they understand for them to teach the subject. Ball (2008) argues that teachers need knowledge in their teaching of Mathematics that will enable them to understand what knowledge to impart to the learners.

Researchers like Ball, Bass and Hill (2004), Knuth (2002) and Ma (1999) have revealed a poor understanding of mathematical concepts by teachers, and especially by teachers of learners in Grade 1. The poor performance in Mathematics among these learners signals inadequate teaching and learning processes that occur in this phase. For example, teachers of Mathematics not only need to do calculations correctly, but they also need to know how to use pictures or diagrams to represent mathematical concepts and procedures to learners. Moreover, teachers have to equip learners with explanations for common rules and mathematical procedures, and analyse the learners' solutions and explanations. Shulman (1987, p. 37) defines pedagogical knowledge as "… teachers' interpretations and revolutions of subject matter knowledge in the context of facilitating learner learning". Hence the point of departure for this study was embedded in a two-fold parameter:

- What pedagogic practices do Mathematics teachers in Grade 1 draw upon to understand teaching?
- How do Mathematics teachers' actual understanding of pedagogic theories effect the teaching and learning outcomes in Grade 1**?**

Learners come from different backgrounds, and teachers' understanding of this fact has the potential to enhance their practice. Thus, the differences among learners should be the point of departure for all the teachers if teaching and learning of Mathematics is to be meaningful. This is important because, particularly in South Africa, there is a need for teachers to know how to teach in diverse classrooms where the pre-service teachers will be provided with the skills, knowledge and attitudes essential to work successfully with diverse learners, particularly in Mathematics. This is in line with the requirements stipulated by the Department of Basic Education (DoBE, 2011) in terms of teaching

Mathematics, as is evident in recent guideline documents on Mathematics that expound on the importance of what is contained in the content and how that content is presented (DoBE, 2011).

Shulman (1987) advocates the use of metaphors in order to illuminate and illustrate complex ideas. Pedagogical content knowledge therefore relies on conceptual knowledge because in order for a teacher to use an appropriate metaphor, s/he needs to have a good conceptual knowledge of the topic that s/he is teaching.

The concept of pedagogical content knowledge is not new. Pedagogical knowledge refers to a professional knowledge base required by teachers (Van Manen, 1999, p. 13). Central to pedagogy is the notion of being able to distinguish between what is appropriate and what is less appropriate for learners, and to be able to determine appropriate ways of teaching and assisting learners. The best laid plans and programmes can go awry if there are no competent teachers who understand and are committed to the educational goals of the nation Brophy (1997) and Rust (1999). Teachers are the interface between the curriculum and the learners. This pedagogical content knowledge links content, learner and pedagogy, revealing a special kind of teacher knowledge. Teachers in Grade 1 need to have self-efficacy, intrinsic motivation and goal orientation to understand the pedagogical knowledge for laying down sound foundations. These skills will allow them to work effectively and be able to implement relevant teaching strategies that will suit the learners. They will then also be able to use relevant learning instructions and useful technological tools for the benefit of the learners. The studies discussed here were pushing for the subject understanding hence Shulman (1987) made it clear the content knowledge was significant in learners' understanding the content taught.

2.7 Understanding Mathematics teaching and learning activities

Pedagogy according to Shulman (1987) is the distinguishing, more comprehensive principles of knowledge of teaching. Whereas Watkins and Mortimer (1999) state pedagogy is the act of teaching together with its associated discourses. It is what the teacher needs to know, and the skills one needs to command in order to make and justify the many different kinds of decisions of which teaching is constituted. Therefore the product of effective pedagogy is the learners' "… acquisition of knowledge, skills, attitudes and dispositions, demonstrated both within and outside of the school context" (Vaughn & Baker 2006, p. 132). The teaching and learning activities cannot come from the

self-understanding or maybe what the community understand but definitely from the subject knowledge of the curriculum. Ginsburg and Ertle (2008) state that the mathematics curriculum learners should be well organised and should provide classroom activities involving strategies regarding the manipulation of objects in order to guide teachers while they plan and teach mathematics. Adler (2002) argues that teachers' use of mathematical resources supports the pedagogies of Mathematics in the classroom.

Balfour, Mitchell, and Moletsane (2008) assert that, compared to urban schools, there is less development in rural schools, if any. Teachers who are more focused on using Mathematics resources support learner-centered approaches and are more ably equipped to assist learners to understand the concepts. The rural areas are in dire need of qualified Mathematics teachers, but the recruitment and retention of qualified teachers tends to be problematic in disadvantaged areas. Setati and Adler (2000) assert that there is evidence of teaching Mathematics in rural areas using code-switching as one of the methodologies because the teacher and the learners share the same language; as a result the only resource that can be used is code-switching. This requires an understanding of subject knowledge which is designated as the relationships among and connections of ideas that enlighten in order to give importance to, for example, mathematical procedures in the classroom (Parker, 2006). Adler, Slonimsky and Reed (2002) draw a comparison between the knowledge that an expert may have on his subject; for example, a mathematician's knowledge of Mathematics, and that of a Mathematics teacher. The view is that a teacher needs a special kind of knowledge of his/her subject which is referred to as "teachers' conceptual knowledge-in-practice" (Blumberg, 2008, p. 56). For example, when we speak of mathematical knowledge, what is this referring to? Is the focus on what the teachers who are teaching Mathematics know? Or is it how a teacher's knowledge of Mathematics impacts on the learners so that they are able to understand Mathematics? Is it also significant that the teacher who is teaching Mathematics understands the learners' contexts in order for him or her to teach in a way that will allow learners to conceptualise what is being taught? Or should we focus on knowledge of wider issues such as mathematical appreciation? Similar questions may be asked with regard to knowledge of the pedagogy of Mathematics. The understanding of what has to be taught happens to be a challenge, as mutual relationships occur among the different aspects of knowledge. Specialised skills are needed to teach Mathematics, especially in Grade 1.

According to Gill (2001, p. 69), Mathematics is defined as "…the mathematical proficiency that anyone is expected to learn successfully". It is a known fact that mathematical skills become much easier when learners start learning these skills in Grade 1. According to Gill (2001), conceptual understanding is the comprehension of mathematical concepts, operations and relations.

The significance of conceptual knowledge for this study was to explore teachers' understanding of their pedagogical knowledge and to determine how their understanding related to what they taught and how content was linked to the teaching process. Conceptual knowledge of Mathematics refers to the underlying structure of Mathematics, and the relationships of ideas that relate and give meaning to mathematical procedures (Eisenhart, Borko, Underhill, Brown, Jones & Agard, 1993, p. 9). On the other hand, teachers of Mathematics are said to require what is called 'teaching specialised mathematical knowledge' (Ball, Thames & Phelps 2008). Conceptual knowledge is therefore significantly linked with content knowledge, as this defines what it is that teachers are responsible for teaching in the classroom. Hence, what they teach is content derived from the curriculum. Content knowledge is also closely linked to teachers' understanding of the learner's knowledge (Blumberg, 2008). This definition is particularly true for Mathematics teachers, as conceptual knowledge is a significant component of mathematical understanding (1988). Ball, et al. (2008) state knowledge of Mathematics, that is specific to the task of teaching, includes several types of content knowledge which involve common, specialised, and pedagogical knowledge. There is widespread agreement that teachers' mathematical knowledge has a profound effect on instruction and learner achievement (Phelps, 2008, p. 35). This argument was significant in terms of this study as specific knowledge for different tasks in Mathematics is important. For example, teachers' knowledge of the learners' approach to concepts such as fractions and doubling and halving in Mathematics can be different to what the learners perceive about the same concepts; therefore allowing learners to understand concepts through the teachers' knowledge is vital (Tirosh, 2000). Although this study examined how Grade 1 teachers taught mathematical concepts, the focus was not on what the teachers taught learners to understand, but on how the teachers' theories impacted on their learners' ability to learn. This issue was referred to briefly in the introduction to this study, where it was pointed out that learners in South Africa perform poorly in Mathematics from Grade 1 and also throughout their schooling.

Procedural knowledge consists of rules or procedures for solving mathematical problems (Star, 2005, p. 7). This researcher argues that when conceptual knowledge is paired with procedural knowledge, teachers can understand their classroom practices better. Teachers' conceptual knowledge, when coupled with procedural knowledge, assists them in knowing when and how to link procedures and content appropriately in their teaching (Hiebert, 2013). This research advocates for the facts on how the content can be dealt with in order to understand classroom practices. Therefore it is quite safe to say that this study moved towards the subject understanding of the teachers' practices.

Adler, et al. (2005) advocate a growing support for the idea that there is a special way that teachers understand and apply knowledge in their teaching of Mathematics. She maintains that this process is different from how a mathematician would use Mathematics. Since teachers work with Mathematics as something that needs to be learnt, they first need to understand the content and ideas of Mathematics in order to make it accessible to their learners. Kennedy (1997) also focuses on teachers' conceptual understanding of subject matter, arguing as follows:

> The main aim of reformers teaching is to instill a deeper understanding in learners of the central idea and issues in various subjects and to enable learners to see how these ideas connect to, and can be applied in, real world situations. It therefore makes sense to require that teachers themselves also understand the central concepts of their subjects and see these relationships. (p. 6).

Jacobs (2005, p. 165) argues that learning is "… experiential and sits comfortably within the ambits of social constructivism and contextualised teaching and learning". Learners understand the contexts within which they exist and any relation to their context may make more sense than high levels of abstract Mathematics. However, using contextual factors to teach is often difficult for teachers to adapt to because of their having had no or very little training to do so. Similarly, Fischer and Fischer (1979) assert that since knowledge is socially determined, it is a teacher's willingness to provide an atmosphere that encourages interaction in the classroom that would be of benefit to the teaching and learning process. Knowledge may be declarative, procedural, or conditional. Jacobs (2005) asserts that declarative information is factual and involves knowing the concepts of a given task. Procedural

knowledge refers to information on how to apply meta-cognitive strategies. Conditional knowledge is an awareness of when and why one strategy may be superior to another or be more appropriate to use.

Teachers who identify and teach these components of the tasks are helping learners to develop their cognitive control over a process (Saravanakumar, 2012). This refers to a personal perspective of one's own learning abilities as well as those of others.

2.8 Understanding the teacher's professional knowledge of Mathematics

Lichtenstein, McLaughlin and Knudsen (1991) as well as Ponte, Beijaard and Wubbels (1994) refer to teachers' professional knowledge of Mathematics as the knowledge that empowers teachers to teach it with confidence, authority and enthusiastic vigour. In order to develop professional knowledge for a Learning Area, teachers need to know what must be learnt, how that content is to be taught, and how the content is to be organised for teaching (Horsley & Matsumoto, 2010). There have been numerous dynamics in teachers' professional knowledge where emphasis is placed on the traditional ways of teaching as opposed to the new constructivist approach to teaching. Carpenter and Lehrer (1999), and Hiebert, Gallimore, Garnier, Bogard-Givvin, Hollingsworth, Jacob, et al. (2003) believe that teaching Mathematics, especially in Grade 1, is not just about transferring information to the learners, especially if teachers expect learners to understand the intricacies of Mathematics. Instead, teachers should try to increase the learners' knowledge based on what the learners already know. These researchers suggest that the constructivist approach is the preferred method by which learners may be expected to learn efficiently. They also contend that for learners to build their knowledge, they have to be taught thinking skills.

Carpenter and Lehrer (1999) further assert that when teachers are teaching Mathematics, they have to work with the mental activities of the learners because it is through cognitive processes that learners will develop a relationship with mathematical concepts. For teachers to embrace the constructivist approach, they need to allow learners to understand the approaches that the teacher has designed. Lubienski and Mewborn (2001) believe that the focus of mathematical knowledge lies within the cognitive domain. Cognitive perspective, knowledge and beliefs are major concepts of the

teacher's classroom practice; hence a central goal of teacher education and training is to benefit potential teachers by assisting them to attain new knowledge and beliefs.

Shulman (1986; 1987; 1992) created a Model of Pedagogical Reasoning which comprises a cycle of several activities that a teacher should complete for effective teaching. The concepts of this model are comprehension, transformation, instruction, evaluation, reflection, and new comprehension.

2.9 Understanding the assessment Mathematics teachers administer

Assessment is classified in different forms, i.e. assessment for learning, assessment of learning and assessment as learning as specified by van den Akker, et al. (2009). In this research assessment is used as a general term that incorporates a wide range of methods or approaches for evaluating learners' performance and attainment. This will be explained as how the teachers will assess their learning as they continue to teach. Harlen (2005) discovered that teachers understand summative assessment as a process by which they gather information of their students' learning in a planned and systematic way. They base this on their professional judgment, which may not be reliable. This suggests that teachers' understanding of assessment is flawed. Assessment in the teaching and learning system and in the day to day activities is a norm, regardless of its purpose at that point in time. In the Foundation Phase, assessment is 100% school based, with the Annual National Assessments and Provincial tasks used to improve the quality of basic education, "with particular focus on the critical and non-negotiable outputs and activities" (DoBE, 2013). Assessment also focused on what learners know (presences), not on what they do not know. Contrary to C2005, CAPS is more specific and indicates what content is to be taught and when to teach it. What learners need to learn is clearly laid down in curriculum documents. It is content and teacher-centred and assessment is subject specific. Unlike in C2005 where it was assumed that learning could take place anywhere, in CAPS teaching and learning takes place in a specific environment, i.e. the classroom (Hoadley & Jansen, 2012).

Toohey (1999) recommends that if assessment techniques and assessment criteria are clearly set, it is the best way to help learners understand how they must achieve learning outcomes. On the other

hand, Biggs (2003) emphasised the strong link between the curriculum and the assessment where to the teacher assessment is at the end of a lesson but to the learner it is at the beginning.

A case study conducted by Khoza (2015b) on learners' and teachers' reflections on their practices of CAPS revealed challenges with the how learners are assessed, especially if the Mathematics teachers do not have clearly specified goals for the assessments. The Outcomes Based Education system was criticised because of its complex language, inadequate resources and immense teacher preparation and teachers were faced with many challenges that had risen in all major assessments such as complication of implementation. As a result Outcomes-Based Education was reviewed (Kenton, 2002). Taking into consideration the fact that the OBE was basically a competence based curriculum it allowed integrated approaches to determine learners' progress. The participants in (Motshekga, 2011) indicated that they followed a curriculum assessment policy which specified the use of both formative and summative assessments to assess the learners. Moreover, Black and Wiliams (2009) describe formative assessment as activities carried out during and at the end of a lesson which provide feedback to modify teaching and learning activities.

Hoadley and Jansen, 2012) argue that summative assessment is used to measure whether or not the learning outcomes have been achieved at the end of a programme whilst also allowing the learners to perform using the collection of facts for their progression. This performance based curriculum allowed grading to be generated that reflects the learner's progress.

2.10 Understanding different approaches used for teaching

In examining teaching approaches to Mathematics education, as a result of a systematic review of existing literature it was revealed that there are two main pedagogical approaches (Cakir, 2008). These are the traditional and constructivist teaching strategies. The traditional approach is more teacher-centred whereby the teacher is the most active in the classroom and this depends on the self-understanding of the teacher and the decisions made for choosing this kind of an approach. The teacher allows the community understanding to be able to decide on the kind of an approach to be used and give lots of explanations.

The constructivist approach to teaching is defined as learner-centred teaching with the stress on strategies such as discovery–based teaching, problem-based teaching and is situated cognitive based. In this approach learners dominate in the lesson and the teacher facilitates the lesson. Researchers further stated that the Curriculum and Assessment Policy Statement (CAPS) (2011) and apartheid curriculum (Christian National Education – CNE) are driven by the traditional teaching approaches/strategies which preferred the content-centred and teacher-centred approaches respectively (Khoza, 2015a). However there were concepts that influenced the curriculum in positive and negative ways that led to teachers having different understandings of their pedagogic approaches to teaching especially Mathematics. However it is always recommended that teachers and their teaching approach need to cater for the learners.

2.10.1 A learner-centred approach

MacNab (2000) suggests that the use of a learner-centered developmental psychology by teachers is a fundamental requirement for the successful teaching and learning of Mathematics. Teachers in the 21st century are subscribing to the Vygotskian approach to teaching, commonly known as the learner-centered approach. Such an approach requires teachers to understand their pedagogical skills and to have sufficient content knowledge as learners are guided by what the teachers have learnt.

Teaching learners reasoning skills and critical thinking skills is essential as the ability to think mathematically is important if learners are to process mathematical knowledge adequately. In order to be able to teach learners to think mathematically, teachers themselves are required to be proficient in thinking mathematically. When teachers are encouraged to take responsibility for their own personal development in becoming critical teachers within the Mathematics education field, they will be able to master their pedagogical teaching and content knowledge. Teachers are expected to continue to educate and empower themselves (Hindle, 1997; Polk, 2006; Rose, 2004). Brodie (2004) proposes that the importance of content knowledge is complemented by the equal importance of pedagogic knowledge. New content knowledge may be linked to alternative approaches and strategies in teaching these new concepts and ideas. Teachers ought to be proficient in their content knowledge and they need to know which methods and strategies are more effective in delivering the content. Grouws and Cebulla (2000) recommend that when teaching Mathematics, teachers should use different types of methods to cater for various learners' abilities.

Also, alternative approaches allow for variations in teachers' pedagogical practices to accommodate different learners in the classroom. These different types of approaches allow variations and meaningful learning for different learners.

According to Blumberg (2008), a learner-centered approach requires that teachers employ different teaching strategies, as this approach emphasises a variety of methods that shift the role of the teacher from a "giver of information" to a "facilitator of learner learning" (p. 29). Blumberg further argues that teachers traditionally focused on what they did, and not on what the learners were learning. Blumberg points out that what teachers often do results in passive learners who do not take responsibility for their own learning. This traditional method is referred to as "teacher-centered teaching". In contrast, "learner-centered teaching" occurs when teachers focus on learning strategies that their learners engage in. It therefore follows that if learners are to become active learners in a learner-centered classroom, it is necessary for teachers to be effective in maintaining interest and improving the understanding of the subject content of Mathematics. Teachers may use their tacit and explicit knowledge to assist in this regard. This kind of an approach is pushing towards the community understanding of the teacher practice hence learners have to take center stage.

Goodell (2006) comments on how teachers can improve their pedagogical skills using the constructivist approach. He used questionnaires as a data collection method and his evaluation of the findings clearly revealed that teachers had to allow learners to "discover" and think for themselves. He further posits that the constructivist approach allows learners to learn from what the teacher knows, and that is why it is significant for teachers to know the content and have pedagogical knowledge before attempting to teach in any classroom. Goodell's (2006) findings indicate that teachers need to develop these proficiencies to teach Mathematics in a way that is comprehensible to learners. Goodell (2006) further looks at teaching and learning skills in Grade1 and the abilities that teachers should instill in learners:

- the development of computation skills;
- problem solving;
- the ability to think rationally;
- reasoning skills;
- critical thinking skills; and
- the ability to justify and prove (Goodell, 2006, p. 201).

Moreover, in the context of a learner-centred approach, it is vital that the teacher disengages from learning activities so that learners, even those as young as in Grade 1 can take responsibility for their own learning (Blumberg, 2008).

2.10.2 Inquiry-based learning

Inquiry-based learning is a Mathematics teaching theory with multiple definitions. According to Magee and Flessner (2012), inquiry-based learning provides learners with opportunities to critically assess their learning whilst at the same time managing their own learning. Even Grade 1 learners are expected to be involved in discussions where they find their own solutions using what they have learnt at home to solve mathematical problems. Hinrichsen and Jarrett (1999) assert that when teachers implement inquiry-based learning in the classroom, the learners eventually take ownership of their learning. The constructivist theory favours inquiry-based learning because learners become active in generating information, as everybody constructs their own knowledge through sharing information. There is also an increase in the responsibility of knowledge generation.

As the teacher facilitates learning, learners are able to solve their own problems. Learners are socially interacting with one another whilst learning and, as a result, they develop their social learning skills. Learners learn to reach goals in terms of the group's responsibilities and they eventually acquire self-confidence in their learning. Davidson and Kroll (1991) argue that there is significant progress made with the use of cooperative learning. Mathematics is one of the challenging Learning Areas where learners need guidance either from the teacher or from their fellow learners to do well; group learning seems to offer a solution to these challenges.

Also the inquiry-based approach seems to be advocating for the subject understanding of the teacher practice as it requires knowledge acquisition.

2.10.3 Group learning

Teachers have listed many challenges associated with teaching Mathematics to large groups. There have been innovations in research on teaching smaller groups and this kind of learning seems to be beneficial to both learners and teachers. Thus, human context and interaction are important and they require, inter alia, a process of modelling. Modelling requires a teacher within the cognitive domain or subject area to demonstrate a task that the learner can experience and construct (Leach & Moon, 2009). Conceptual modelling of a task will help learners to eventually take responsibility for doing the task (McLeod & McKinnon, 2007). Through modelling, the teacher provides the learner with a step-by-step demonstration of what is required of him or her. This process needs to be guided not only by the principles as stipulated in the curriculum, but also by what is in the best interests of the learner (Baker, 2001). Modelling is quite a creative strategy which is very effective when the teacher and learners are accessing meaning during reading and writing. Teachers are expected use creative approaches in order to engage learners in creative learning through doing practical things like, engage learners on working with different shapes like triangles, pentagons, circles and squares (Bolden, Harries, & Newton, 2010). Teachers can do this using the smaller groups then emphasise cooperative learning, where learners are involved in healthy competition whilst discovering their own knowledge. Dale (1998) argues that the differences in the learners' abilities create different roles for learners, like leadership roles which are easily developed.

2.10.4 Experiential learning

Hartshorn & Boren (1990) propose that experiential learning is based on the notion that when learners are actively involved in the learning of any Learning Area, learning takes place. Hartshorn and Boren (1990) insist that Mathematics is abstract; therefore, in order to make it understandable, the use of learner and teacher support materials (LTSM) and resources is recommended. LTSMs are useful because they assist learners to move from a concrete to an abstract level; however, teachers must carefully select the resources that will assist learners to identify with and understand the activities.

Howden (1986) points out that there are concrete, semi-concrete, semi-abstract and abstract levels at which learners can solve problems. The concrete level is when learners use actual objects to solve the problem, the semi-concrete level is when pictures of objects are used, and the semi-abstract level is when learners use symbols to represent concrete objects.

2.10.5 Guided discovery learning

The teaching and learning of Mathematics requires reasoning, procedural skills and the teacher's pedagogical and conceptual knowledge (Rittle-Johnson, Siegler, & Alibali, 2001). Guided discovery learning is problem solving that happens before the teacher gives instruction to the learners. It allows learners to discover and invent their own solutions through cogitating on the problem they are about to solve. Learners could discover learning or invest in solutions that do not pertain to the problem at hand because this is done before instructional guidance. Guided discovery learning has to do with a teacher's practices when teaching a particular Learning Area. In the teaching of Mathematics, problem solving strategies allow teachers to use guided discovery learning as one of the approaches that learners can use to think and to invent their own knowledge. According to Loibl and Rummel (2013), guided discovery learning depends largely on a teacher's practice. However, they argue that the quality of learning could be compromised if learners invent incorrect responses. What will allow teachers to elicit positive results is their practice in the classroom. Kapur and Bielaczyc (2012) argue that guided discovery learning expects learners to solve problems in their own way, prior to the instruction by teachers. Based on this theory, learners are expected to work on their own while the teacher is available as a facilitator. In this manner the learners devise their own ideas to solve mathematical problems while the teacher assists learners who happen to struggle with their work. As a result, guided discovery learning could guide teachers to provide instruction prior to intervention.

2.11 Understanding the location/groups that the Mathematics teachers teach

To motivate learners in the classroom environment, effective classroom management is a vital requirement. Chukwbikem (2014) asserts that resources used in the classrooms should be informative, practical and suited to a range of early grade settings. The curriculum should also provide examples of how teachers can create a stimulating environment for their learners by making use of the most critical period of rapid development in learning.

Considerable research has been conducted into teachers' mathematical knowledge (content knowledge) and its relationship (or lack thereof) with effective teaching Grossman, 1990; Wilson, Shulman & Richert, 1987; Shulman, 1987; Askew, Brown, Rhodes, Johnson & William, 1997; Rowland, Turner, Thwaites & Huckstep, 2009). Research indicates that beyond the owning of the content knowledge, good teachers understand how learners come to know their content as they teach them and where the learners have encountered difficulties. Teachers should then be available to assist learners with learning and match content with teaching approaches/methods (Carolan & Guinn 2007).

Schmuck and Schmuck (2001) maintain that adopting different perspectives in the classroom can allow for different learner dynamics. The self-understanding of the teacher drives the content of the curriculum to be taught. Community understanding seems to play a significant role in the various places where teachers teach. People have a different understanding of what a rural area could be, in this study the rural areas were the schools where the resources were lacking. Positive classroom dynamics will elicit different learning climates that learners will trust; this will make them feel supported while in the classroom (Dornyei & Skehan, 2003). Also Stenhouse (1975) lists how the process of teaching leads to achieving outcomes through understanding the content. The teacher's personality that comes into play when teaching, the environment in which a teacher teaches, and also the influences of the resources used for teaching impact on how the teacher interacts with the learners. These concepts were significant in this study because teachers in the early grades have a responsibility to understand the learners they are teaching. As a result, their self-efficacy is what will make them accessible to learners in the early phase of education. It is the responsibility of the teachers in Grade 1 to motivate learners to do well in all their learning areas. Bandura's (1986; 1997) social cognitive theory asserts that there are a number of issues that allow teachers to develop self-efficacy.

Shulman (1987, p. 8) defines pedagogical content knowledge as the blending of content and pedagogy into an understanding of how particular topics, problems or issues are organised and adapted to the diverse interests and abilities of learners, and how they are presented for instruction. There is much emphasis on the content, the pedagogy and what learners are supposed to be learning and how they should be learning. The argument is whether teachers understand the pedagogy they are using to teach learners Mathematics.

Therefore, for teachers to have an understanding of their pedagogy, it is important that they know what to plan for in order to address the curriculum, that they know the content, and that they are familiar with the methodology to deliver that content. The classroom is where the teachers and the learners make sense of their learning.

A study by Stipek (2001) concluded that teachers who were confident in their Mathematics knowledge produced learners who were confident in Mathematics. This statement suggest that this study was advocating for the community understanding of the teacher practice. It therefore follows that a teacher's knowledge and understanding of mathematical concepts will result in a positive outcome for the learners who are learning Mathematics. For example, it becomes the teacher's responsibility to display learners' work on classroom walls as it reflects their own learning. Dorman (2001) and Frazer (1998) argue that it is what happens in the classroom environment that allows learners to learn effectively. It has been shown that learners learn effectively in a positive environment, especially where the learners see their work displayed. Dorman (2001) further argues that the success of the classroom environment is measured by learning efficacy. This requires an exhibition of the work done by the teacher and the learners in the classroom, because it is how both teachers and learners measure their effectiveness and competency in their specific activities. Schunk (1989) refers to teacher and learner efficacy as a positive motivator for learners to continue to work optimally. Bandura (1997) also refers to the visual representation of learners' work as "teacher and learner effectiveness" (p. 32) as this is how they demonstrate their worth. Bergle (1979) concurs, and states that effectiveness in the Mathematics classroom results from content knowledge that allows the teacher to first determine the required resources and then to employ the practice needed for teaching a particular content area effectively.

This study investigated the suggestion by Ball, et al. (2008) as well as Ma (1999) who agree that the effective teaching of Mathematics requires teachers who know the content in order to teach in a profound and connected way. Even if teachers' knowledge in terms of the curriculum may not be significant, their understanding of the learners they teach may have a profound impact on the effective acquisition of mathematical skills among their learners.

However, it remains important to have knowledge of the content as well. Both conceptual knowledge and content knowledge are vital in the teaching of Mathematics, as these concepts of knowledge are the underlying structures of Mathematics and an integrated and functional component of mathematical ideas (Eisenhart, et al., 1993; Kilpatrick, et al., 2001). Hill, et al. (2005, p. 73) refer to mathematical knowledge for teaching in the elementary grades and presented remarkable and groundbreaking research for the Mathematics education community. In the current study, the investigation to address the second research question evaluated whether teachers' ways of teaching was effective. This was done by means of observing their teaching practice and determining whether the learners responded positively to instruction. An attempt was made to draw similarities between this research and the investigations carried out by Ball, et al. (2008) and Ma (1999).

Darling-Hammond and Richardson (2009) and Copley (1999) found that teachers' mathematical knowledge predicted mathematical achievement during the first and third grades. Their results suggest that measures of teacher knowledge should at least be content specific and, better yet, specific to the teaching of a particular grade level. Teacher preparation and faculty development in training teachers, and how to use teaching tools, require appreciation of the complex set of interrelationships between artefacts, users, tools and practices. In particular, it requires teachers to become sensitive to the demands of harnessing and integrating technology, pedagogy and content. The learner seeks to understand the actions or instructions provided by the tutor (often the parent or teacher), then internalises the information, using it to guide or regulate their own performance.

The National Council of Teachers of Mathematics (NCTM, 1992) also supports the notion that learners will use the knowledge acquired to make sense of the mathematical concepts learnt from problem-based learning. This is the type of learning where learners use their acquired skills and knowledge to understand and develop their thinking in Mathematics.

Walker (1971) claims that the experience of learning in a classroom depends entirely on the desire to learn and this is fulfilled by the attitudes of the learners. Blatchford, Kutnick, Baines and Galton (2003) argue that Mathematics teachers need to acquire 'knowledge-based pedagogy'; this is referred to as the robust knowledge constructed by learners in their classrooms who learn in groups according to their needs. For knowledge-based pedagogy to take place, learners have to be in an effective learning space and in a social environment that allow them to learn.

The NCTM (1992) further believes that Mathematics is a subject that requires effective and efficient functioning of individuals in society. Moreover, Mathematics is a subject that should be enjoyable. Since Mathematics has been identified as one of the core skills, the appreciation and enjoyment of Mathematics is one of the national goals for Mathematics education (CAPS, 2011). This goal is coupled with the task of nurturing the learners' self-assurance in their ability to apply mathematical knowledge to solve real-life problems. Motivated and self-driven teachers are able to motivate their learners, provided that the curriculum and their pedagogical skills are accessible to the learners.

Changes in the education system, with special reference to the National Curriculum, can be unsettling for teachers. In this regard, Bernstein's pedagogic device theory will clarify the concepts of classification and framing to understand the rules and regulations teachers need to follow for their practices, especially when dealing with gateway subjects like Mathematics. Bernstein's (1982) classification of the curriculum refers to how teachers relate information in order for it to make sense to the teachers as well as to the learners. There will always be different ways of looking at how knowledge is transmitted. Bernstein's (1973) pedagogic device theory provides the rules where the education being transmitted is used to relay external powers. Teaching and learning do not have to be communicated passively. Teachers and learners need to be actively involved in transmitting and receiving information in a way that will be suitable for them. On the other hand, framing refers to how this content is transmitted and received by learners. The relationship between these three is that when the content to be transmitted is solid, teachers who are transmitters of knowledge will distribute what is real and then assess the learners to determine whether they have acquired content knowledge. The recognition and realisation rules are in effect functions of classification and framing, where the recognition rules "create the means of distinguishing between, and so recognising, the speciality that constitutes a context" and where realisation rules "regulate the creation and production of specialised relationships internal to that context" (Bernstein, 1990, p. 102).

How these rules are classified allows teachers to teach Mathematics in ways where learners are able to acquire the knowledge in terms of Mathematics acquisition and lessen the challenges in this Learning Area. Bernstein (1999, p. 153) defines the pedagogic device as an action of knowledge transmission by teachers to learners. Knowledge comes from the "knower", i.e., the teacher, to the learners, the "acquirers", instead of the knowledge being socially constructed by both the teachers and the learners sharing their experiences. It must be noted that even if the study refers to teachers

of young learners in Grade 1, it does not mean that these learners could not share knowledge of Mathematics from home.

Fleith, (2011) argues that both teachers and learners believe that the classroom environment improves creativity which in turn provides learners with the confidence to make positive choices in their learning. In the South African context, the classroom environment has been a burning issue, as many schools deal with overcrowding and violence. The significance of the classroom environment allows teachers to find ways of teaching, irrespective of the challenges. The responsibility lies with the teachers to render their teaching space both attractive and functional. Some physical aspects to consider are room arrangement, seating, bulletin boards, white board displays, lighting, and temperature. A clean, safe, attractive and comfortable classroom will help build a classroom community and stimulate learning. Teachers need to provide a favourable learning classroom environment that motivates learners to learn Mathematics spontaneously. Ginsburg and Ertle (2008) argue that physical classroom environments differ in terms of quality and management. For example, if the existing physical classroom environment is unappealing, it needs to be improved, because a classroom environment that is conducive for the learning of Mathematics is one that has numerous resources and materials that stimulate learners' curiosity to learn Mathematics. Teachers may need different room arrangements for whole group and small group activities as they incorporate small group work/instruction areas in the classroom to allow for a pleasant atmosphere in their learning environment. Designate a 'quiet zone' or independent working area for those who work better with fewer distractions, or an area for learners who need to catch up on work. Store frequently used materials and equipment in close proximity to the learners, are examples of improved classroom management.

2.12 Understanding the environment of Mathematics teaching: Different contexts - the rural, township and urban schools

Most rural and township schools are still lacking in terms of development, particularly in Mathematics and Literacy (Jansen (1998) and Chisholm (2004c). Teachers' understanding of the location of the learners allows them to design their curriculum according to how the learners understand the content.

Rusznyak and Walton (2011) emphasise that it is important that teachers are capacitated to develop good lesson plans that will meet the needs of learners and the demands of the subject content. Gardiner (2008b, p. 13) states that rural communities are difficult to reach "… as the physical conditions in schools are inadequate and learner performance in comparison to schools elsewhere (e.g., townships) is at a lower level". Despite the significance of the teacher element in the education sector recognizing that teachers remain crucial players in ensuring quality teaching and learning in rural schools, very little research has been done to assist teachers in the rural and township areas. This is the reason behind the influx of learners from the townships to urban schools (Kumalo, 1998, p. 15). In pursuit of quality education, parents exercise their democratic right to choose the right school for their children, which has resulted in increasing learner migration (Pampallis, Narsee & Mampuru, 1998, p. 9). Schools in rural areas suffer in terms of poor teaching and learning resources. Moreover, teacher development in terms of workshops seems to be taking longer or does not happen at all. Nkambule (2011, p. 342) asserts that even after 1994 "… rural education and rural development in education has [sic] just remained stagnant". This has resulted in the considerable difference in learner performance in the Annual National Assessment as the lack of resources in rural schools severely challenges the development of teaching and learning. Some of these schools lack electricity, running water and proper classroom space and, as a result, classrooms are overcrowded. There is also a high rate of unqualified Mathematics teachers in rural schools.

The teaching and learning environment is much more significant than a classroom where learners in primary schools are said to understand Mathematics better in a positive environment. The classroom space allows for complex dynamics and influences among learners and these influences could be responsible for increased learner learning. Killen (2000) states that a positive environment is a physical and emotional environment that encourages teaching and allows learning to take place.

Research done by (McNally & Blake, 2009)state that teachers need time to understand how to use the materials and the preparation time to make the materials relevant, consistent, practical and sustainable in the classroom. Their claim is that teachers can present their Mathematics lessons anywhere as long as learners are able to associate their learning with the environment. This raises different issues as the teacher would have to understand their practice for the smooth running of the

curriculum and also understand the learners' context. Thus pushing the understanding of the learners' context to that of community understanding.

2.13 The Gap of Knowledge

Mathematics teachers' professionalism, which is the knowledge and skills on how to teach young learners Mathematics seems to be a challenge in the South African schools. The relationship between the development of beliefs and the extent to which the teachers' practice is exercised in the classroom affects how learners learn (Park & Oliver 2008). Learners will understand Mathematical concepts when they are taught in approaches that is are beneficial to the acquisition of these concepts of which is what is lacking in the teaching of Mathematics as learners perform poorly. The research was to determine whether Mathematics teachers in Grade 1 had a clear understanding of their role and responsibilities in order to address the needs of young learners of which is what seems to be lacking in the Primary schools.

2.14 Summary

This chapter considered available literature on teaching practice theories with emphasis on teaching Mathematics in the early grades. Because each learner is unique and comes from a particular context, various teaching approaches were considered. Furthermore, the literature review explored the need for teachers' knowledge of pedagogical practices, content knowledge, and curriculum knowledge. The objectives of this chapter were therefore to understand the different scholars who researched the phenomenon of understanding the effect of teachers' practices on their pedagogic practices in teaching Mathematics in Grade 1. Hill, Rowan and Ball et al. (2005) also recommend that teachers should strive to improve their mathematical knowledge by increasing their content knowledge of the Learning Area.

Fosnot (1996) Ernest (1998) and Gifford (2010) illuminate new ways of teaching Mathematics and the responsibilities of teachers. Hill, et al. (2005) advocate the teaching of learners through problem-solving and discovery as being the best way for teaching Mathematics.

This chapter further identified issues relating to the objectives of the study to determine teachers' understanding of the pedagogical choices they make in teaching Mathematics in Primary schools. Furthermore the ways in which such understanding impacts on learners' acquisition of mathematical concepts were also clarified. The next chapter addresses the approaches that underpinned the theoretical aspects of this study. What emerged from this chapter is that teachers who understand their pedagogic practice in order to increase the learners' understanding of Mathematics had confidence in their teaching practice.

CHAPTER THREE

THEORETICAL AND CONCEPTUAL LENSES USED FOR EXAMINING THE PHENOMENON

3.0 Introduction

The previous chapter provided an overview of relevant literature appropriate to the phenomenon on understanding teachers' pedagogic practices. This chapter engages with the theories and concepts that were used to analyse, interpret and discuss the research findings of this study. The theories and concepts discussed in this chapter impact on how the study as a whole conceptualizes teachers' understanding of their pedagogical practices in teaching Mathematics in Grade 1. In the process, the discussion creates a unique understanding of teachers' practices in Grade 1.

This chapter comprises three sections. The first section discusses the process of learning from the sociology of education theoretical perspective. The second section discusses the theoretical lenses used to produce and analyse data and the processes involved in the teachers' understanding of their pedagogical practices in teaching Mathematics in Grade 1. As pointed out in the previous chapters, such data concern ways in which these teachers understand their pedagogical practice for learners to acquire mathematical concepts. Finally, the chapter concludes with a discussion of the theoretical gaps in studies that have been conducted and that this study endeavored to engage with.

Kerlinger (1986, p. 9) defines a theory as a "set of interrelated constructs, definitions, and propositions that presents a systematic view of phenomena by specifying relations among variables, with the purpose of explaining and predicting phenomena". Silver (1983) states that to understand a theory is like travelling in someone else's mind and, whilst travelling in that mind, trying to think like that particular person. This is one way of discovering how other people think and make decisions.

3.1 The constructivist theory

This study was underpinned by the theories of three constructivist theorists namely Piaget (1973), Vygotsky (1978) and Bernstein (1999; 2000, 2004). However, the focus was predominantly on Vygotsky and Bernstein as the main theoretical contributors to this study. The study used a learning theory not a teaching philosophy because the teachers' understanding of their practice lies with the teaching and learning that takes place in the classroom. In order to engage with the phenomenon under investigation of the teachers' understandings of their pedagogical practices in teaching Mathematics in Grade 1 - focus was placed on the constructivism theory. The key concepts of constructivism being that knowledge is not passively received from others but it is constructed as the learner makes meaning of the world around him or her. The teachers' practices play a significant role in learners acquiring the skills of understanding their world.

The learning concepts, referred as the ten components of a curricular spider web according to van den Akker, et al. (2009) allow teachers to understand their practice with different learners. This promotes both the community understanding and the subject understanding of teachers' practices. Literature endorses the community understanding of the teachers' practices as constructivism states that learners construct their knowledge and understanding of the world through their experiences (Bull, 2009). As described in earlier chapters, teachers understand their practice through the concepts that guide the curriculum. Their self-understanding of pedagogic practices involve the profound and vital understanding of mathematics thinking which is connected to how they use their expertise to support learners in understanding Mathematical concepts. The knowledge of the representation of the subject matter (subject understanding) is related to what the teacher is able to share with the learners in Mathematics learning. These key concepts determine the relationships among classroom practice, the participants who participate when Mathematics is being taught (the teachers, learners, policy statements and documents), the context, and the content knowledge of teachers to teach what they believe the learners can learn by taking into consideration each learner's context. It is a teacher's engagement with the learning content that enables the discovery of meaning (Novotná Moraová Krátká Stehlíková, 2006). When learners are in the process of learning, they seem to be engaged in a learning process that allows them to engage with both the teacher's knowledge and the teacher's skills, as well as with the support materials and mathematical knowledge.

The constructivist theory was relevant to this study because it refers to how learners learn; and because learning is much more than a memory exercise, teachers also learn from their teaching. Slavin (1997) refers to learning as the understanding and the application of knowledge that teachers/learners use to solve problems, to discover things for themselves, and to work with different ideas to find solutions.

The constructivist theory looks at teaching practice as an epistemology that assumes that learners construct their own knowledge on the basis of interaction with their environment. Prawat (1992) identifies four epistemological assumptions that are at the heart of constructivist learning, namely:

- knowledge is physically constructed by learners who are involved in active learning;
- knowledge is symbolically constructed by learners who are making their own representations of action;
- knowledge is socially constructed by learners who convey their meanings to others; and
- knowledge is theoretically constructed by learners who try to explain things they do not completely understand.

These four epistemological assumptions were addressed in the findings of this study. The ideas of Vygotsky (1978) were applied in this study because they illuminate how the teacher and the learner interact through a process known as the learning place for both the teacher and the learner. The boundaries of the Zone of proximal development (ZPD) (Vygotsky, 1978) as determined by learners' level of independent performance and their level of assisted performance are personal, flexible, and constantly changing is a concept defined as the gap between what a learner has already mastered (the actual level of development) and what he or she can achieve when provided with educational support (potential development). Both the learner and the expert appropriate cognitive products (a statement, tangible product or an action) but use it in different ways, which may not always be the one intended (Moschkovich, 2002). The latter scholar further states that the teacher is perceived as the person who has more knowledge (i.e., the expert) while the person receiving knowledge is the learner; therefore the teacher as an expert and the learner as the knowledge receiver interact in a mutually beneficial way.

Emmer and Hickman (1991) also support the idea that teachers use constructivist approaches and ideas in the Mathematics classroom. Because this study employed constructivist theory to inform the findings, Grossman (1990) and Marks (1990), scholars who are grounded in constructivist theory approaches, are also referred to in the discussions as their arguments illuminate understanding of teaching and learning using the constructivist approach. It is a theory that allows different teaching approaches because the teachers have some knowledge of the learners in the classroom and they therefore allow the learners to use their pre-existing knowledge to create additional knowledge through active participation. In the literature review (Chapter Two), reference was made to the National Council of Teachers of Mathematics (2002) (NCTM) as the body representing Mathematics teachers in the USA of all the grades. This body has provided teachers with guidelines on constructivist approaches and on how to teach Mathematics. The NCTM also recommends concepts that can be used for Mathematics teaching in the classroom. Moreover, the problem-based learning endorsed by this body supports the type of classrooms where learners are actively learning and where learning occurs as an activity. The approaches expounded by this theory were popular in the twentieth century because they promoted learner-centeredness which provided Mathematics teachers with useful approaches in understanding how learners understand Mathematics using their own basic knowledge.

However, the task of reconstructing a pedagogy for Mathematics on the basis of a constructivist view of learning is a significant challenge, and one that the Mathematics education community has only begun to wrestle with. Constructivism provides a useful framework for thinking about Mathematics learning in classrooms, and therefore contributes in important ways to the effort to improve classrooms where Mathematics teaching takes place. The term ‘pedagogy’, as referred to above, means all the contributions made for learners in order for them to learn Mathematics in the classroom. As such the concept includes not only the multifaceted work of the teacher, but also the contributions on how the classroom is designed, as the learning of curriculum designers, educational material developers, and educational researchers.

Contrary to the constructivist approach to learning, the transmission model has been criticised because it is viewed as a teacher-based as well as an instruction-based teaching methodology and therefore teacher orientated. It emphasises content, encourages passive rote learning and memorization, and provides the learner with no genuine understanding. Activities undertaken in the constructivist learning environment are learner-centered and learners are encouraged to ask questions, carry out their own experiments, make their own analogies and come to their own conclusions Brooks and Brooks (1999). The constructivist learning environment sustains an atmosphere which enables learners to have life-like experiences and flexible time and place for their effective learning in the classroom (Aygoren, 2009). Within the constructivist learning environment, learners' needs, expectations and interests are met and learners' active participation in the learning process and their social interaction amongst peers are promoted (Brooks and Brooks (1999), Saban (2003), Fer & Cırık (2007), Karadag, Korkmaz and Caliskan (2007). In this regard, as the constructivists view the learners as the co-constructors of knowledge, they place value on the perceptions of the learners about their learning environment.

Moreover, the constructivist approach emphasises that learning is the learners' construction of their own knowledge in their own minds. The teacher in the classroom has the responsibility to guide learners to restructure their existing ideas and to provide opportunities for learners to apply their own thinking to understand what the teacher is teaching. This is the constructivists' view of how learning is supposed to be. They refer to the teacher as an evaluator for the learners' prior knowledge at the beginning of any lesson.

However, this study focused on the understanding of teachers' pedagogical practices in teaching Mathematics in Grade 1. It is in this context that Bernstein's (2000) pedagogic device perceives the significance of the deeper knowledge of teachers. The pedagogic discourse is controlled by what the curriculum is about. Then the pedagogic skills which entails the teachers' understanding of the content knowledge and the skills for curriculum acquisition can be socially understood. Teachers are regarded as providers of knowledge because they have the understanding of the curriculum. Bernstein further defines knowledge as the degree of summarising of meaning within socio-cultural practices that embrace terms, concepts and phrases (Bernstein, 2000).

He states that knowledge sometimes has stronger semantic gravity and sometimes weaker semantic gravity. This happens as both the teacher and learners engage in the learning matter. If the teacher possesses stronger semantic gravity, then it means there will be lesser meaning to the practice. This depends on what the teacher has as pedagogic knowledge. For example, the concept 'to take-away' can have multiple meanings for learners, especially for the additional language learners because these learners arrive in the classroom with prior knowledge acquired at home.

Teachers using constructivist theory should be seen creating a background for learning in which learners become engaged in interesting activities that encourage and facilitate their learning. In this way learners will learn in a way that will be entirely theirs. The behavioural implications of the physical and social environment are transmitted in different ways to allow the learner to learn in his/her own way. Teachers teach in different contexts, using different approaches to teaching and also working with different learners. In this situation constructivists believe that knowledge is a human product which is socially and culturally constructed. It is created by individuals who create meaning through their interactions with each other and with the environment they live in; reality is constructed through human activity and learning is a social process. Constructivism emphasises the importance of culture and context in understanding what takes place in society and constructing knowledge based on that understanding Derry (1999), Kim (2001) and Von Glasersfeld (1990) refer to constructivist learning as follows: "….. the learning that is a product of teaching or of teachers' provision of information. Teachers see themselves as responsible for filling learners up with knowledge, as if learners are receptacles and knowledge is a product". This viewpoint is closely associated with many contemporary theorists like Bernstein (1990) and Bruner (1996) as both are also constructivists. These are the constructivists who believe that learners' active involvement in the classroom is relevant for their attainment of knowledge and skills. It is for this reason that this study drew on Bernstein (1990) as a prime theorist.

It has been argued that learner-centered active learning focuses on transmission teaching rather than on discovery learning (McCarty & Schwandt, 2000). Researchers like Slavin (1990) and Hiebert, et al (2003) subscribe to the constructivist theory as a preferred approach where learners will be able to learn in such a classroom.

Ball, Lubienski and Mewborn (2001) believe that the focus of mathematical knowledge lies within the cognitive domain and it is imperative that teachers embrace constructivist theories as an approach to teach Mathematics in Grade 1 to assist learning to take place. Constructivist learning allows the learner-centered approach to dominate as teachers engage with their learners in the learning process.

Constructivism also refers to existence of learners' previous knowledge based on what they are interacting with as they learn; thus new knowledge acquired in the classroom is integrated with previously acquired intellectual constructs Zimmerman and Schunk (2008). The acquisition of knowledge in teaching and learning allows teachers to interact with learners to develop their thinking through the constructivists approach. Eggen and Kauchek (1994) and Prawat and Floden (1994) suggest that constructivism involves situations where learners use their experiences to actively construct understanding that makes sense to them, rather than acquiring understanding by having it presented in an already organised fashion. The teacher-centred approach that is opposed by constructivists is referred to by McNally and Blake (2009) as the kind of pedagogy that promotes and encourages passive learning by learners. Moreover, it is viewed by constructivists as authoritarian because it is what the teachers who have the authority in the classroom do, rather than using the time to enlighten learners.

Furthermore, as new ideas are introduced, current practices may be questioned and even rejected, but until such a major shift occurs, current practices shape what is considered useful (Woolfolk, Novalany, Gara, Allen & Polino, 1995). Thus, constructivist theories can rightly be seen to be a view of learning that considers the learner as a responsible, active agent in his/her knowledge acquisition process (Smith, 1993). It is from this perspective that constructivists contend that it is a learning theory which purports that learners construct their own understanding based on prior learning and social interaction, and where learners take charge of their learning to construct their own knowledge. In this context constructivism explains the nature of learning that is driven by learners and their thinking in the classroom (Brooks & Brooks, 1999).

According to the constructivist theory, knowledge is not external to learners' minds, but learners assisted by teachers use their interpretation skills or explanation of something presented to them to create knowledge. The construction of knowledge is transformed through a teacher's experiences. The teachers are there to guide learners towards achieving their goals and as a result constructivism is the appropriate tool to transmit knowledge, since constructivists view knowledge as theoretically constructed. The behavioural implications of the physical and social environment are transmitted in some way to the learner. Furthermore, constructivists view learning as the process by which human beings adapt to their experiential world of knowing. Constructivists maintain that, instead of looking for a simple, short, straightforward path to learner success, the teacher encourages the exploration of the potential pitfalls and misconceptions with the aim of developing broader, more resilient concepts. Wood, Bruner and Ross (1976, p. 90) describe scaffolding as the foundations of learning that allow learners to acquire more knowledge and assists them to achieve goals that might be beyond their understanding without help. The issue of acquiring knowledge had profound pedagogical and learning implications for this study because it explored the vital early stage of learning Mathematics where learners either succeed or fail to grasp a concept. The constructivist theory is based on a learner's active participation in problem-solving and critical thinking regarding a learning activity that is relevant and engaging. The constructivist theory was therefore pertinent to this study as it encourages learners to acquire Mathematical concepts, particularly in Grade 1. Moreover, to acquire knowledge the learners need the assistance of their teachers. It is not only learners who learn in this process, but also the teachers as they acquire the ability to understand the needs of the learners they teach so that they are able to assist them. This makes it easier for learners to make connections with what is taught and refine their thinking. This clearly shows that learners are not merely empty vessels but are in fact accumulating knowledge that builds on prior knowledge.

Balfour (2007) argues that teaching without resources means the teacher focuses more on contents of the programme, whereas teaching and learning are supposed to be the transmission channels of knowledge. Teaching and learning require support materials to be used when teaching. Such materials need to add value to the content that is taught and also pay particular attention to the knowledge to be transmitted. By using support material, the pedagogy will not be transmitted to

passive participants in the classroom, as both the teacher and the learners will be taking part in the transmission of knowledge.

The curriculum used by teachers happens to be a body of knowledge transfer and distribution; without the curriculum teachers will be lost in terms of what and how to teach, therefore it is imperative that the curriculum serves the purposes of teaching and learning. Its centrality is also influenced by the purposes that it serves in society. Curricular conceptions differ greatly, but most theorists agree that the pedagogical act is closely connected, with differences in patterns of authority, control and social order (Bernstein 1975), where horizontal knowledge or everyday knowledge acquisition seems to be the unspoken and less visible. In the pedagogic device where curriculum is taught, language can be learnt and spoken. Bernstein (1975) believes that knowledge from what is logical can be transmitted and horizontal knowledge can also be acquired. This happens socially; that is, in the presence of peers. It was imperative in this study to investigate the underlying principles of how teachers create a qualitative pedagogical environment that caters for early learning, as constructivists believe in the creation of a positive learning environment for learners to acquire knowledge. In this regard, Bernstein (1999) contends that the acquisition of horizontal knowledge structures is difficult for learners in the early phases. Furthermore, he contends that recognising and constructing legitimate transcripts are more tacit and problematic in horizontal knowledge constructions.

Mathematics as a Learning Area could also be considered as a horizontal knowledge structure as it consists of different languages to solve problems. Sometimes the language used by teachers to teach Mathematics can be logical and could be used in the classroom to teach language. It becomes horizontal knowledge in our grammar because we can all understand what is taught. This is simple language that can be understood by everybody where Mathematics plays a significant role. The constructivist theory recognises that learning is an active process; therefore learners should actively participate in learning activities with a high level of treating the information as their own, leading to personalised meaning (Ally, 2004, p. 18). The learning activities should be rich and authentic in nature, and they should be situated within the context of the information being presented.

This concept was discussed in Chapter Two and is also one of the factors that is addressed in the data analysis in Chapter Six. Constructivist learning should facilitate learner construction of knowledge for collaborative and cooperative learning, especially where there is a problem to be solved. In communicative horizontal knowledge, the language used for problem solving should facilitate the construction of knowledge and skills, drawing from the knowledgeable other to the acquirer.

The effectiveness of the circulation of information among learners implies that engaging in practice may well be a condition for the effectiveness of learning. In this information circulation of knowledge the teacher may use resources, as the learners are too young to make up their own knowledge; but this does not mean that they have no knowledge at all. In constructivist learning environments, learners need to be given control over the learning process by participating in the goal setting process with the teacher (Ertmer and Newby 1993; Kanuka & Anderson 1999; Ally 2004, p. 19). Learners are also to some extent presenting their own questions and hypotheses and testing their knowledge for validity (Fosnot, 1996, p. 29). Learners in a constructivist learning environment must be given the opportunity to reflect on their learning as part of the process of internalisation of information (Ertmer & Newby, 1993; Fosnot, 1996, p. 29; Kanuka and Anderson 1999). The learners construct their knowledge using thinking informed by their world and this creates learning spaces where they are given activities that are meaningful to them. Then the teachers have a responsibility to conform to what Shulman (1987) refers to as effective classrooms where teachers are expected to teach effectively by focusing on the key concepts.

The teacher's role in offering context to young learners is significant since learners often depend on the teacher for their learning, and it becomes the responsibility of the teacher to provide information. Hence the learner-centredness notion might be a challenge, but this does not signify that it cannot be done. This is also because learners learn mostly complex phenomena differently. Many theories have been put forward on how learners learn. Different learning theories define the concept of learning from their own perspective, thus bringing different approaches to understanding the learning process. Learning theories can be categorised as objectivist and/or constructivist (Holt-Reynolds (2000).

Bernstein (2000, p. 6) maintains that the way in which knowledge is made confidential "carries the message of power", and as a result it characterises the transformation of social divisions. Education cannot be transmitted in a passive way, otherwise the acquirer will not be empowered. Teachers are expected to empower learners in the classroom, therefore the social division of power and the classification of knowledge cannot occur. Bernstein's (1990) expert appropriation and learner appropriation involve joint productive activity, developing shared attention and meanings, and taking another's product for one's own use. This 'taking for one's own use' involves both interpreting a product within one's own knowledge system and using the product based on this interpretation. Taking these common features, appropriation in general can be defined as taking the product of joint activity for one's own use (p. 8). In a classroom setting, the teacher is responsible for structuring interactions and developing instruction in small steps, based on tasks the learner is already capable of performing independently.

Learners need to understand the instructions given by the teacher, then process the information given, using it as a guide to adjust, regulate and understand their own actions. From a social perspective, a writer's choices are always based on the background and dependently reliant upon, motivated by differences in social activities taking place, in writer-reader relations, and by constraints on the progress of the interaction. Sometimes teachers as a result cannot expect weak writers to improve simply by equipping themselves with the strategies of good writers. Instead, what comes to mind is the different ways of scaffolding. Ball, et al. (2001) emphasis the role of the "more knowledgeable other" in ensuring that learners read and write at the highest possible levels with the comfort of knowing that they are under the teacher's guidance. In both instances, the role of the teacher is not seen as imposing but allowing learners to learn in their comfortable spaces.

Classroom interactions between learners and teachers become partnerships that are created among people communicating for a common purpose, which is teaching and learning. These classroom interactions were also addressed in the literature study in Chapter Two and will be referred to in the data analysis chapters where different types of approaches used by teachers in classrooms will be discussed.

However, an examination of their underlying commonalities provides insight into the role played by affect in learning and creativity. In the reciprocal emotional support offered by partners in collaboration, whether they are learners in Grade 1 acquiring a new language or creative endeavours, there is an energetic interplay between their interactions and the ways in which they appropriate emotional support, Ginsburg, Lee and Boyd (2008). This is the kind of learning where the constructivist theory proposes that learners must be active participants in their own learning through conversations and exchange of ideas with teachers and other learners who assist them in reaching new horizons of understanding. Encouraging learners to take responsibility for their own learning is very important. There could be a fine balance where teachers act as mediators of knowledge to the learners' learning process, as this is the first formal learning for learners in Grade 1 where the acquisition of knowledge can sometimes be difficult. Teachers are required to be understanding and have empathy towards very young learners in order for them to receive knowledge**.** Social constructivism emphasises the significance of cultural and context understanding. Derry (1999) states it is what societal construction is all about. There are detailed traditions about reality and learning referring to the community understanding of the knowledge, i.e. where teachers will have to understand the traditions of that particular culture for them to be able to understand the society. In this study the community understanding is about learners' competency in Mathematics skills and refers to what learners know and understand.

Cockburn and Nardi (2003) explain that these skills are transmitted by the use of teaching resources that assist learners to connect with what the teachers are teaching. In that way they are able to develop their individual talents and identities. As stated earlier that social constructivism has to do with social practices (McMahon, 1997) and Stenhouse (1975) agrees when he focuses on the process of teaching that leads to achieving outcomes through understanding the content where the environment in which a teacher teaches influences the resources used for teaching to impact on how the teachers interact with the learners. Social constructivism refers to the emphasis of a hands-on teaching approach (Christie, 2005) where the learners' views matter. This study used the idea of critical constructivism which requires teachers' understanding of their practice to challenge learners to be agents of social change. The creation of new understandings where there is a collaboration between teachers' practices and the learners' active learning for a common goal which is emancipation.

3.2 Bernstein's pedagogic device theory

Bernsteinian (1996) pedagogic device theory is the theory that investigates the way that knowledge is structured in order to suit the practice. He suggests that the pedagogic device is not a discourse but a rule which inserts two dialogues, that is the dialogue or discourse of skills and their relationship to each. That means the instructional skills are rooted in the regulative discourse. When transmission of knowledge takes place, the rules that run or govern pedagogy take over. It was these rules that the study interacted with on the premise that teaching and learning become social interactions which are not structured to regulative rules. However, rules that govern the pedagogic device are laid down by the curriculum and teachers are required to follow its stipulations. These regulative rules bring power to Mathematics teaching, whether or not they are applicable to the group that is receiving the knowledge. Bernstein' pedagogic device theory (1996, p. 42) becomes a complex theory but it is the most suitable in translating knowledge into communication. Teaching and learning change knowledge that is produced, presenting it in the form of a curriculum which is then reproduced in the classroom. For Bernstein, the field of knowledge generation is dominated by a social order and there are distributive rules that serve to regulate access and usage of knowledge. For teachers, knowledge is presented in the form of a curriculum that is loaded with different beliefs about what is deemed as knowledge that is suitable to be acquired in the classroom. The constructed and constructing nature of knowledge is not only concerned with what learners have experienced or learnt in the classroom, but it is also dependent upon the characteristics of the knowledge itself.

Bernstein's work on codes, the pedagogic device and knowledge structures can be used to show how the structuring of intellectual and educational knowledge specialises actors and discourses in ways that shape social relations, institutional organisation, disciplinary and curricular change, identity, consciousness and habitus (Maton, 2007, p. 87). The pedagogic device is defined by Bernstein as collaborative rules whereby knowledge is converted into classroom knowledge, where the teacher uses the curriculum as the rules and the distribution of the content knowledge and the assessment of learners as the evaluative rules (Bernstein, 2000). The pedagogic practice, according to Bernstein (1990), has as its core function ways of observing what happens in the classroom while teaching and learning are taking place. He refers to that which takes place in the classroom as "ordering and disordering" (p. 9). This is where the rules and procedures are reformulated into knowledge.

Teachers use this pedagogic device to formulate their knowledge that they transmit to the learners in the classroom. For teachers to understand their pedagogical practice, they therefore need to understand the curriculum. The pedagogic device responds to the rules made by people in authority for those they lead. The teachers are expected to take the lead in teaching and learning as they are in a leadership position when they lead learners in the transmission of knowledge. It is teachers who decide which pedagogical practice they can use to achieve these goals. Bernstein (1999) elaborates on this in that hierarchical knowledge structures create very general propositions and theories, which integrate knowledge at lower levels. In a way, when rules are imposed on issues, it becomes difficult for teachers to be able to function in such situations. The teacher is able to work and transmit horizontal knowledge because it is common to everybody; however, this is not guaranteed in the lower grades. Then the hierarchical knowledge structures appear to be directed towards greater integrating suggestions, operating at abstract levels. Teachers and learners will be challenged by hierarchical knowledge as knowledge becomes more difficult. However, it is then that the acquisition of knowledge will be compromised as teachers will be working at a higher level of knowledge than the learners they work with. Bernstein (1999, p. 159) explains: "The vertical discourse, as it takes the form of a coherent, explicit, and systematically principled structure, becomes difficult as different types of laws are used to explain different language policies. Even the language used does not cater for everybody".

The general sense of learners learning through the constructivism theory means that they are able to use their everyday language to understand what the teacher teaches in order for them to understand and create their own individual new understanding, based on their prior knowledge Richardson and Ice (2010) examine the use of cognitive approaches for instruction through an overview of three views of learning and instruction for learners to learn constructively:

- learning as response acquisition;
- learning as knowledge acquisition; and
- learning as knowledge construction.

The above three instructions were used to focus on whether teachers understand what they taught learners for understanding Mathematical concepts. These three concepts were dependent on the teachers understanding of their practice. The learners have no power regarding what and how they should be taught. These power dynamics distribute knowledge differently for different people. Learners themselves understand what is taught differently. Rose (2004) calls this the hidden curriculum, in that the content of the curriculum and the way it is passed on to learners disregards classroom inequalities.

In context, the central idea of constructivist theory is that mathematical knowledge cannot be transferred as a ready-made knowledge from teachers to learners, but is reconstructed by each individual learner (Von Glasersfeld 1990). Furthermore, Bernstein's pedagogic device theory recognises that each learner comes with his/her own concepts and 'knowledge' constructed out of his/her experiences about how things work, and any teaching strategy which does not take this into account is likely to fail. This requires a will and openness to listen to learners and to find out about the differences in their learning needs. Thus, in this context, perhaps the teacher's first task is to help learners articulate as clearly as possible their own ideas about a certain topic or problem, preferably in small groups, so that each becomes aware of what the other thinks; in this way they can 'negotiate' a solution with others. Thus the learner becomes an active participant rather than a passive listener in the learning process, which results in genuine understanding and enlightenment. This becomes important because people's knowledge as human beings exists in their culture or in their way of life. Wood, Cobb and Yackel (1995), for example, assert that understanding learning as a process of individual and social construction gives teachers a conceptual framework with which to understand the learning process.

3.3 Bernstein's views on the curriculum

Bernstein (1996) equates horizontal discourse to everyday or 'common-sense' knowledge, which is typically transmitted orally and is localised, context-specific and context-dependent. As an example, Bernstein suggests a conversation between smallholders in which strategies for improving production are exchanged.

What is most significant about this form of discourse, according to Bernstein, is that it promotes divisions in teaching and learning. In other words, the knowledge acquired during horizontal discourse is integrated into the daily meanings of everyday life (Bernstein, 1999, p. 160).
It is significant for teachers to understand their pedagogic practice as they have to understand the curriculum in the three levels, (intended, planned and formal). These three levels as guided by curriculum concepts mean that teachers have to understand what is the self, community and disciplinary knowledge that guides the tool they use in the classroom for learners to understand Mathematics.

Curriculum experts like Tyler (2013) looked at the significance of a rationale and goal-directed teaching strategy and referred to the four guiding questions to be answered by teachers in order to understand their practice. What educational purpose should the school seek to accomplish, the educational purpose to be provided, and how the educational experiences can be effective for the teaching and lastly what tool could be used for the determination of the purposes of teaching using the curriculum. Further Khoza (2014) refers to visions and goals as significant before teaching can take place. Van den Akker, et al. (2009) looked at the curriculum as involving different divisions which are supra (international), macro (national system), meso (school), micro (classroom) and nano (learner) as significant. Bernstein's (1999) pedagogic device theory states it is the pedagogic practice that leads to the skills and content for teaching. Therefore understanding the concepts of the curriculum could assist the teachers to understand their practice. The importance of a horizontal discourse in Grade 1 is that learning is facilitated by the utilisation of this knowledge to solve the problem, which should be in line with learning objectives. Learners will then be allowed to draw on their prior knowledge in order to understand the context taught. Horizontal knowledge is what the learners interact with in their daily lives. It is a requirement that their learning will emanate from the known to the unknown, where the teacher will be able to assist them with the acquisition of knowledge. The teacher is also involved in resolving the problems by continuously asking appropriate leading questions, which assists in guiding the learners. Learners are further required to reflect, discuss and defend the application of their knowledge or skills. Horizontal discourse thus consists of "culturally specialised segments" (p. 169) that are embedded in a specific context and are of particular relevance to the acquirer's everyday life.

Vertical discourse, by contrast, consists of "specialised symbolic structures of explicit knowledge" (Bernstein, 1999, p. 161) and is not segmentally organised but is concerned with situation-independent meaning within an integrated knowledge system. Vertical discourse usually has a written form and equates to 'school' knowledge. Within the vertical discourse, Bernstein distinguishes between "horizontal" and "hierarchical" knowledge structures (p. 169). Horizontal knowledge structures, exemplified by the social sciences and humanities, "take the form of a series of specialised languages with specialised modes of interrogation and specialised criteria for the production and circulation of texts" (Bernstein, 1999, p. 159). It was for these reasons that Bernstein's (1990) pedagogic discourse was deemed significant in this study. Essentially, learners can develop mathematical knowledge from their everyday knowledge, because everyday knowledge does not only cater for the teacher but also for the learners.

The teacher training aspect has a vital role to play in how learners acquire knowledge in the classroom situation. Bernstein (1990, 1996) further distinguishes between a horizontal discourse and a vertical discourse. For him, a vertical discourse takes the form of a clear, coherent, systematically and principled structure; there is an order that is followed and the series used determines the language to be used. Bernstein (1990) further argues that knowledge acquired in the informal domain cannot be transferred across in an intact manner into the official domain of schooling. Bernstein's (1990, 1996) theory of pedagogic practice completes two related and important aspects in knowledge construction:

- completing a theory of school knowledge and transmission by focusing on framing rules and demonstrating how and what education is transmitted; and
- relating to the process and content of transmission to differences in social class and in calling for an analysis of the consequences of those differences in curriculum and pedagogy.

Bernstein has provided a tentative integration of structuralist and conflicting approaches within the sociology of education, and this is the reason the pedagogic device theory was significant in this study.

Bernstein (1975, 1996, 2000) asks pedagogic questions on how teachers teach to analyse how a pedagogic text is put together, and what the rules of its construction, circulation, contextualization, acquisition and change are. He asks questions on how power and control are interpreted into the values and principles for communication and how these principles of communication happen to be different in order to allow learners to think and generate possibilities of learning in the classroom.

Bernstein further argues that pacing is "the rate of expected acquisition; that is, the rate at which learning is expected to occur ... Pacing rules, then regulates the rhythm of the transmission, and this rhythm may vary in speed" (Bernstein, 1990 p. 76). If learners have control over the amount of time spent on content, weak framing over pacing is obvious. The teacher who focuses on learner-centered approaches will deal with learner performance as compared to teacher-centered approaches that do not require prior knowledge and experience. If teachers slow their pace to suit learners, this would not allow the hierarchical rules to take over teaching and learning. Learners exercise greater control over interactions and participation, and control is personalized. Personal control is more likely to occur within classroom situations that are characterized by "the absence of explicit structure" (Al-Ramahi & Davies, 2002, p. 63).

In Bernstein's (2000) view, his model of knowledge transmission provides an overview of "how the distribution of power and the principles of control interpret into classification and framing values which choice out recognition and realisation rules to create contextually appropriate texts" (p. 18). The point is that there is a differential distribution of power and control relations across different social classes, and these produce different practices and forms of consciousness. It is through the codes that we see the differential positioning of subjects of different social class groupings, dominant and dominated.

In the classroom where learners come from different backgrounds, the classroom dynamics will be varied. In this context, horizontal discourse will vary with the way the culture segments and the specialist activities and practices vary. Knowledge is segmentally differentiated and, because the discourse is horizontal, it does not mean that all segments have equal importance. Clearly, some will be more important than others.

Moreover, scaffolded learning is a requirement in learning in the early phase as learners cannot acquire any skills on their own, and the teacher's guidance plays a significant role in introducing learners to their cultural realities.

A horizontal discourse entails a set of strategies which are local, segmentally organised, context specific and dependent for maximising encounters with persons and habitats. The 'knowledges' of horizontal discourse lead to segmented, structured acquisitions as learners will understand the context in different ways. Furthermore, as learners acquire knowledge, it arises from discrete segments and pedagogic practice may well vary with the segments. In the case of horizontal discourse, its 'knowledges', competencies and literacies are segmental and they are contextually specific and 'context dependent', embedded in on-going practices, usually with strong affective loading, and directed towards specific, immediate goals, highly relevant to the acquirer in the context of the learners' lives (Bernstein, 2000, p 159). This contrasts with the progressivist models of literacy where the concept of 'learner voice' reduces teachers to no more than facilitators who "give the learners some space to voice their own interests in their own discourse" (Cope & Kalantzis, 1993, p. 18). The appropriate pedagogic approach to Mathematics teaching therefore means that teachers have to engage with learners in the language and context learners understand. In such a case the hierarchical knowledge structures are not used for the development of learners and their knowledge, but are seen and used as the development of theory, which is more of an all-purpose theory that may not work for the lower grades.

In the case of horizontal knowledge structures, teachers' knowledge cannot apply because the set of languages which constitutes any one horizontal knowledge structure is not translatable, while different and often opposing assumptions are made of each language. A language has its own criteria for legitimate texts, what counts as evidence and what counts as legitimate questions, or what constitutes a legitimate problem. In the case of hierarchical knowledge structures, the acquirer does not have the problem of knowing whether the learner is speaking a mathematics language or any other language; rather, the only problem is one of correct usage. Because a horizontal knowledge structure consists of an array of languages, any one transmission necessarily entails some selection and some privileging within the set that is re-contextualised for the transmission of the horizontal knowledge structure.

This is similar to how observations are fixed in the acquisition of the specialised languages of a horizontal knowledge structure with a weak language formation.

Schunk (2008a) views constructivism from a psychological and philosophical perspective, contending that individuals form or construct much of what they learn and understand. The way in which people try to make sense of situations or how people create meaning is the main concern in the constructivist learning theory (Wilson and Lowry 2000). Teachers are thrown into the deep end to acquire knowledge themselves. In the constructivist learning environment, learners are asked deliberately to take action in order to create meaning from what they are studying. In other words, learners adopt the role of seekers and problem solvers, while teachers become facilitators and guides rather than presenters of knowledge, while learners learn how to use and apply such knowledge in diverse contexts (Dunlop & Grabinger 1996). The constructivist theory of learning also refers to the environment as a place where learners may work together and support each other as they use a variety of tools and information resources in their guided pursuit of learning goals and pursuing problem-solving activities (Wilson, 1996). This requires constructivist learning environment opportunities that provide learners with sufficient areas to research, experiment, and pose hypotheses for the problems they encounter (Jonassen, Peck and Wilson,1999).

Bernstein (1990) asserts that the general propositions or theories which are the most powerful are those under which the greatest amount of knowledge can be incorporated with intentions. He adds that there may be many such hierarchies. A hierarchical knowledge structure directs its motivation towards the most powerful heights. In other words, the general propositions or theories which are the most powerful ones are those under which the greatest amount of knowledge can be subsumed. Bernstein (1990) has introduced the concept of the pedagogical device which explains the hierarchical mode of the unfolding of the educational practice and process. The pedagogical device is a concept that allows for an analysis of the process by which knowledge is translated into curriculum and then transmitted through pedagogy (Luckett, 2010).

In other words, where the curriculum is planned in a top-down presentation, it relates to how meaning is re-contextualised, from esoteric knowledge into a more palatable form suitable for educational purposes and settings. The device comprises three fields of practice, namely a field of production, where new knowledge is created; a field of re-contextualisation, where this knowledge is transformed into curriculum; and a field of reproduction, where the curriculum knowledge is taught and evaluated.

Often, these three fields represent different sites. For example, knowledge may be produced in schools, re-contextualised into curriculum for schools by the Department of Basic Education (DoBE), and reproduced for learners in schools.

Bernstein's theory of pedagogic discourse, with the instructional discourse embedded in the regulative discourse, allows different ways of transmitting knowledge, hence acknowledging that learners are unique. In the instructional discourse there are different ways of knowledge transmission and acquisition that will provide different competencies to those who receive the knowledge (Bernstein, 1990, p. 211). The instructional discourse is always embedded within the regulative discourse, which means that the hierarchical relationships between the acquirer and the transmitter regulate the selection, sequencing, pacing and evaluation criteria of knowledge. Pedagogy consists of a social relation between the transmitter and acquirer where the rules of evaluation always lie with the transmitter. In this sense the social relation of pedagogy is always asymmetrical, thus the relations between the transmitter and acquirer are always unequal (Bernstein 1996). This theory provides the means to define the nature of the instruction from different positions where control is through learning; this allows the power from the person transmitting (teachers) to be central to them and to control what they are teaching.

Learners are viewed as the centre of learning in that they become empowered (MacGillivray and Croft, 2011). The process of learner empowerment includes decision making, critical thinking, reflection, and the recognition of multiple viewpoints. Empowerment cannot exist without a democratic environment, and this cannot be achieved without action. Therefore, empowerment involves action, and action involves change (Sorensen, 1999).

The constructivists believe in guided learning where the teacher does not take center stage, but is able to assist where help is needed in order to achieve realistic goals, which is what constructivist teachers do. They create a context for learning in which learners become engaged in interesting activities that encourage and facilitate learning. Learners in this study were learning Mathematics in an additional language which was a challenge for many of them.

According to Cope and Kalantzis (1993, p. 6), "… natural' literacy learning is simply an inefficient use of time and resources. It leads to a pedagogy which encourages learners to produce knowledge in a limited range of written genres, mostly personalized recounts". Thus, when young learners learn Mathematics, they become more dependent on the teacher and it becomes impossible for them to create their own understanding of mathematical concepts, which can become problematic for the learners.

A thorough critical engagement with how learners learn in a classroom requires a specification of the sociological processes that control and influence the way the developing learner relates to his/her environment. It requires an understanding of how certain areas of experience are differentiated and are made specific and stabilised, so that what is relevant to the functioning of the social structure becomes relevant for the learner. The focus on knowledge, its construction, reproduction and distribution in learning environments is central to the debates in the sociology of knowledge and education as a field of study, but how this learner will function or learn in a school situation different from home, remains one of the important topics in an attempt to understand the learning process.

The development of such understanding was extremely valuable in this research because this study focused on learners' acquisition of mathematical concepts in Grade 1. In this study the specialized discourses of Mathematics, with their own unique generating and evaluating procedures, were examined, as the central premise of constructivists is that human knowledge is constructed and that learners build their new knowledge upon the foundation of previous learning. This view of learning is in contrasts to one in which learning is viewed as the passive transmission of knowledge or information, a view in which reception, not construction, is key. Active involvement of learners is the only way learners should interact with the learning content.

Constructivism also implies that learners are encouraged to acquire their own knowledge instead of copying it from authority, be it a book or a teacher, in realistic situations instead of de-contextualised, formal situations such as those propagated in traditional textbooks. In the context of the Mathematics classroom, learners acquire their own knowledge through collaboration in meaningful tasks used by both teachers and learners.

Bernstein (1975) attempts to provide a theory of the construction of pedagogic discourse and argues that it is concerned with the classification rules of the pedagogic device that deals with the production and reproduction of knowledge that is directly linked to the transmission of knowledge, which distinguishes between the different forms of knowledge that can be differentiated through their language and disciplinary construction. These different forms of knowledge that take place in the classroom have diverse pedagogic discourses that can either be in a horizontal or vertical arrangement.

Bernstein (1977) distinguishes clearly between instructional and regulative discourse. The former refers to the transmission of skills and their relation to each other, and the latter refers to the principles of social order, relation and identity. Bernstein's experiment highlights the unequal access to power, which contributes to keeping the working class learners from gaining access to literacy and thus to power. Both these aspects of pedagogic discourse may be described in terms of classification and framing concepts, and a variety of pedagogic structures may be generated according to their organizing principle; that is, in terms of their underlying code. The form of the code (its modality) contains principles for distinguishing between contexts (recognition rules) and the creation and production of specialised communication within contexts (realisation rules). The field of reproduction is where the pedagogic setting and certain practices are exercised (Bernstein, 1990). He maintains that the pedagogic device provides the condition for the construction of pedagogic discourse (Bernstein, 1982, 1990).

3.4 Summary

It was revealed in Chapter Three that constructivist thinking supports the view that learners come with their own concepts and 'knowledge' that is constructed out of their experiences and new knowledge that the teacher has assisted them to acquire. This is community understanding of the curriculum. Teaching and learning is achieved through interaction with peers, the knowledgeable other and the teachers in the classroom. Furthermore, such knowledge is determined in part by how well new ideas fit within an accepted community of practice.

Thus, constructivism can rightly be seen to represent a view of learning that considers the learner as a responsible active agent whose knowledge acquisition occurs from different perspectives that embrace learner-centred approaches. Teachers are viewed as facilitators who assist learners in discovering their potential whilst imparting skills and knowledge. This is where scaffolding as part of the learning and teaching process is crucial. In the context of this study, scaffolding seemed to be one of the more relevant pedagogic choices, particularly where learners learn Mathematics in an additional language.

The choice of Bernstein's pedagogic device theory provided the theoretical framework for this study.

CHAPTER FOUR

RESEARCH APPROACH AND DESIGN

4.0 Introduction

Chapter Three dealt with key theories and concepts that framed the collection and analysis of data and the interpretation of the research findings in this study. The works of the constructivist theorists Vygotsky (1978) on the Zone of proximal development and Bernstein (1990, 1996) on the pedagogic device theory respectively enhanced my critical engagement with the research findings. Furthermore, what stood out in Chapter Three was that most of the key concepts derived from Bernstein (1990, 1996) and Vygotsky (1978) linked learners' shared understanding, as these theories play a significant role in determining whether teachers understand their pedagogic practices which may be related to learners' abilities to recognise differences between curriculum details and pedagogy. Most importantly, it was illuminated in Chapter Three that, given the broader purpose and the research questions of this study, careful consideration needed to be given to the choice of the research sites, the research methodology, the research design and instruments, the sampling technique, the study participants, and the rationale for these choices.

This methodology chapter is organised into different sections. The rationale for the research methodological choices made is discussed, the reason for the selection of the research sites is provided, and the logic behind the selection of the research participants in this study is explained.

Maree (2009, p. 78-79) states that "qualitative research is based on a naturalistic approach that seeks to understand phenomena in real-life situations". Hence the study employed a qualitative research approach that facilitated the production of in-depth and rich data. Creswell (2013) supports the use of a qualitative research approach, stating that such an approach allows the researcher an opportunity to engage intensively with the participants by means of face-to-face interactions. This is achieved by talking to and seeing the respondents behaving in their real-life context. The chapter begins with a discussion of the interpretive paradigm, which was the research paradigm chosen for this study. The chapter concludes with a brief discussion of the limitations of the study and how such limitations were negotiated.

4.1Critical research question

As already established, the study focused on an examination of teachers' understanding of pedagogical practices in teaching mathematics. To this end, the main research question was: **What pedagogic practices do teachers in Grade 1 draw upon to understand teaching Mathematics in Grade 1?** As evident from the critical research question, the broader purpose of the study was to understand the nature of the impact that Mathematics teachers' understanding of their pedagogic choices have on teaching mathematical concepts in Grade 1. What pedagogic practices do teachers in Grade 1 draw upon to understand teaching Mathematics in Grade 1? And how do Mathematics teachers' actual understanding of pedagogic theories effect the teaching and learning outcomes in Grade 1**?**

4.2 Rationale for examining teachers' understanding in teaching Mathematics

Henning (2014) suggests that teachers teach to assist learners to make meaning of Mathematics by engaging them in different situations such as inspiring learners to explore the natural world and its practices. However, according to Fleisch (2008), the teaching and learning of Mathematics in primary schools are in crisis. Mathematics is referred to as a gateway subject, and therefore Mathematics teachers should actively introduce mathematical concepts and be able to incorporate research-based teaching strategies and the use of mathematical language through different contexts (NCTM, 2013). Ginsburg, Lee and Boyd (2008) add that strategies such as projects, teachable moments and play should also be used when teaching mathematical concepts. This research therefore endeavored to determine whether teachers in Grade 1 had a clear understanding of their role and responsibilities in order to address the needs of young learners in the Mathematics classroom.

The NCTM (2013) asserts that in order for teachers of young learners to effectively teach 'the big ideas', they need to help learners to recognise and understand that there is a connection between these 'big ideas' and other subjects. Teachers must guide and encourage learners to communicate their mathematical thinking in a profound and sustained manner. It is clear that the teaching of Mathematics has to be organised and well planned in order to address the NCTM's suggestions on how to teach Mathematics in Grade 1 classrooms.

A second focus of this research was to determine whether teachers understood the 'what' and the 'how' that they should deal with in addressing the challenges of teaching Mathematics, especially in the lower grades. I intended to establish this by means of semi-structured interviews that were conducted in two schools where the respondents were teaching Mathematics to Grade 1 learners. I also engaged in classroom observations to closely observe the participants when they were actually teaching Mathematics. These two data generation methods were supported by document analysis, which served as a process of triangulation which increased the validity of the findings. The documents that I perused comprised teachers' files, policy documents and learners' journals. The learners' journals were also significant in this research as they served as evidence of the work done by the learners after the teaching process, and I could determine if learning had actually occurred.

4.3 Research sites

The two research sites, which are referred to using aliases in this study in the interests of confidentiality, were located in two different contexts: **Mthandeni Primary School** was located in a suburban area and **Bathandenibonke Primary School** was located in a former Black township area. Many factors, both internally and externally, influence what and how teachers teach and learners learn Hiebert et al. (2003b), and the two research sites in this study were no exception. This was not intended as a comparative study; however, the two diverse research sites demonstrated how schools can differ despite being in the same district where teachers attend the same workshops under the guidance of the Department of Basic Education. As posited by Hiebert and Grouws (2007), many internal and external factors impacting the two schools influenced the 'what' and the 'how' the teachers taught and how the learners acquired learning. It could also be argued that the differences observed between the two schools were predominantly due to the type of management employed in each school. In this regard, Gibberd (2007) states that some South African schools have good infrastructure in terms of their teaching and learning resources, whilst others have deficiencies in their essential services such as water and sanitation.

4.3.1 Mthandeni Primary School

This school is situated in what can be termed an 'advantaged' community. These are communities that are doing very well in terms of the resources available in the school. The schools in the vicinity of these communities happen to be doing well too. This school was well-resourced during the apartheid era as it had received sufficient funding and had better facilities, better teaching and learning resources, was better equipped, and had better qualified teachers than many schools in disadvantaged communities Alexander, Badenhorst, and Gibbs (2005). This school was reserved for Coloured children during the apartheid years and it was classified under the House of Representatives (HOR). The school is situated in an industrial area which has attracted many people in search of work opportunities. Currently, the school admits mostly black South African learners who speak isiZulu and isiXhosa, but it also accommodates a few learners from foreign countries. The school's language of learning and teaching (LoLT) is English.

At the time of the study, this school had sufficient teaching and learning facilities and electricity and piped clean-running water were readily available. I observed an abundance of teaching and learning materials such as overheard projectors, computers, white boards and other teaching aids. The school is situated in an open field that allows for various outdoor sports. The two spacious sports fields are complemented with all the necessary equipment required for extra-mural activities. There are approximately ten brick buildings that house an administration block, classrooms, a laboratory, a library, a resource centre, a uniform shop, a tuck-shop, and a news room. The data revealed that there were approximately thirty learners per classroom at the time of the study. This was a significant observation, as research has shown that class size is important in terms of how teachers interact with learners whilst teaching. That is to say, the number of learners in a classroom plays a significant role in terms of the teachers' pedagogical skills and their ability to pay attention to all the learners during the teaching and learning processes. At the time of my visits, there were 41 teachers, of whom two were African, thirty were Asian, and eight were white. The school had an enrolment of 1 200 learners and a staff complement of 51 post level one teachers. There were forty state paid teachers and eleven School Governing Body (SGB) paid teachers. Among the 11 SGB paid teachers, two filled the posts of HODs.

4.3.2 Bathandenibonke Primary School

In comparison, the situation at this school was quite different at the time of the study. Bathandenibonke Primary School is a township school and the principal was very skeptical about receiving me as a researcher at the school, as he felt that this would compromise the teachers' academic teaching time. However, in the end he agreed to allow my research to be conducted at the school. This school is situated in a rural area. The community where the school is located appears to be disadvantaged and there were a number of informal settlements around the school. The school building looks dilapidated and very old. There is a place next to the school that seems to be the playground because all the learners gather in that open area during break time. All the classrooms in this school have desks. I did not see any laboratory or science room. The school is about twenty five kilometers away from a small town. The school's language of learning and teaching (LoLT) is isiZulu. As I approach the Grade 1 one classroom where I am meeting Batha-Phumeza- research participant No. 4, I note that the learners sit in groups of three and some in four.

The principal's office is situated in what used to be a classroom. The furniture comprises old desks that have been refurbished and there are books piled on the floor. The other three management team members (Deputy Principal, and two Head of Departments (HoD's) also use one of the classrooms as their office. We had an informal discussion with the principal and he revealed that the school has an enrolment of 450 learners. He also specified that this is the highest number in five years as learners sometimes leave the school to go to the urban area schools where some of the parents are employed. The principal of Bathandenibonke Primary school revealed that the enrolment for the year was 450 and 15 teachers which include two HoD's and one Deputy Principal.

4.4 Target Population

For the purpose of confidentiality, the participants were given pseudonyms that refer to which school they were teaching: teachers with the prefix Mtha- represent Mthandeni Primary School, whereas Batha- as a prefix represents the participants from Bathandenibonke Primary School. The broader purpose of the study was to understand what impact Mathematics teachers' understanding of pedagogical practices has on learners' acquisition of mathematical concepts in Grade 1, and to this end the research participants were purposively sampled in this study.

Purposive sampling is a method used to select study participants for information-rich data from a particular location to address the purpose of the study. Cohen, Manion and Morrison (2007) state that "purposive sampling is used in order to access 'knowledgeable people'; those who have in-depth knowledge by virtue of their professional role, power, and access to networks, expertise or experience" (p. 157). Because this study employed a qualitative research approach, it required a small, purposive sample to elicit rich, detailed data. In this instance, two criteria that applied to the sample selection were to investigate only teachers of and learners in Grade 1.

In selecting the participants purposively, I endeavored to enhance the validity and reliability of the findings by minimizing the effects of biasness. The use of variety of approaches being the semi-structured interviews, classroom observations, document analysis increased the validity and trustworthiness of my study (Yin, 2009). The learners learning formal Mathematics in an additional language formed part of the sample. I purposively chose the Mthandeni and Bathandenibonke Primary Schools because they represented an advantaged and disadvantaged school from the apartheid era respectively. In Mthandeni Primary school, the LoLT was English and catered for all the learners in the schools whereas at Bathandenibonke Primary School though their LoLT is isiZulu some of the Mathematical concepts that cannot be pronounced in isiZulu are taught in English and learners understand them in the same language which is why teachers code-switch at some point.

Gobo (2008) argues that purposive sampling requires detecting cases within extreme situations and within a wide range of circumstances in order to maximise variation. For this reason the Mthandeni and Bathandenibonke Primary School teachers in Grade 1 were purposively sampled. Creswell (2007) argues that purposive sampling involves the researcher's intentional selection of individuals and that researchers may hand-pick cases to be included in the sample on the basis of their judgment of their typicality. Cohen, et al. (2007, p. 103) argue that it is important that the researcher learns from the research participants from whom the data are generated. In this regard, using a limited number of research participants afforded me the opportunity to search for and find in-depth understanding of how they taught in their different contexts. As a qualitative researcher I therefore studied a small sample of purposively chosen Mathematics teachers in Grade 1, as I needed to procure data of cases of a given process and within a given context.

4.4.1 Table of the Target Population

Research Participants	Gender	Age	Teaching Experience	Professional Qualification
Participant No. 1 Mtha-Anelia	Female	29	7 years	B.Ed.
Participant No. 2 Mtha-Zumile	Female	40	25 years	Masters
Participant No. 3 Batha-Buyile	Female	49	14 years	PGCE
Participant No. 4 Batha-Phumeza	Female	35	10 years	Masters

4.5 Sampling technique

In qualitative research, a population sample (in this study Mathematics teachers and Grade 1 learners) requires proper selection and reasons need to be given for this selection. The research sites were purposively selected, not for a comparative study as I have mentioned, but to reveal the differences within school contexts and to investigate whether teachers regarded their pedagogical practices differently. According to Newman (2000, p. 198), "purposive sampling occurs when a researcher wants to identify particular types of cases for in-depth investigation". The purposive sampling was used to select Mathematics teachers in Grade 1. Sampling is defined by Dawson (2007) as a process of choosing a smaller, more controllable number of people from an entire population to take part in the research. Flowers, Weisz, and White (2005) argue that purposive sampling refers to all expected elements that can be included in the research. Echoing similar views are Goddard and Melville (2001) who describe a sample as any group of people or an individual who can be used as the subject of the research interest. In this study Grade 1 Mathematics teachers of the two research sites were deemed appropriate, as they were expected to understand the pedagogical practices required to teach mathematical concepts in Grade 1. The four research participants were Grade 1 teachers.

Two of them were furthering their studies. One had a Master's Degree in Educational Leadership: Management and Policy and the other had just graduated with an Honours Degree in Psychology. Table 4.1 is a diagrammatical presentation of the demographics of the research sample:

4.6 Rationale for not comparing the two research sites

The purpose of the study was to do the research in two different sites but not to compare the findings for the purpose of a comparative study. The sources of data were four teachers in two research sites that catered for Grade 1 to Grade 7. However, this study was concerned only with Grade 1 as this is the grade where learners begin their formal schooling. In light of the purpose of this study, it was appropriate to observe practitioners' pedagogical practices in Grade 1 classrooms and to evaluate how these practices were used at the beginning of the formal education of learners – i.e., in the early years.

The two schools with different contexts and demography were purposively selected. It was envisaged that any issues encountered at the two schools would facilitate a deeper understanding of teachers' practices when teaching Mathematics in Grade 1, without a formal statistical comparison of the data being necessary. In this regard, research has shown that principals and Heads of Department generally assume instructional responsibilities such as coordinating and supervising instruction, monitoring learner learning, and supporting teacher development (Hallinger, 2003, Hallinger & Murphy, 1986; Murphy, Hallinger & Mitman, 1983).

4.7 Research design

Kgobe (2000), a case study is a design for investigations in many fields, especially when evaluations are conducted in which the researcher develops an in-depth analysis of a case. Such cases are often a program, an occasion, or an activity involving one or more individuals. Gray (2013) argues that if a case study is carefully planned, it can provide a powerful means of exploring situations where there is uncertainty or ambiguity about a phenomenon or an event. Creswell (2013, p. 45) defines research design as "a plan for conducting a study" that will show how and what kind of data will be collected by the researcher and from whom and in what manner the data will be collected. The design also needs to stipulate how this data will be analysed.

Harding (1987) describes the discussion on the research methodology as a theory and analysis of how the research will be conducted and states that it should provide reasons for using techniques in relation to the kind of knowledge or understanding the researcher is seeking. Moreover, the research design captures the rationale for identifying the specific research sites, the research technique used, and the sample.

Given the fact that qualitative methodology formed the research approach of this study, this chapter plays an essential role in clarifying the methodological choices that facilitated the data collection, analysis and evaluation.

4.8 Ontology, epistemology and methodology

The researcher's belief on knowledge is aligned with Gordon's (2009, p. 45) statement that, according to constructivism, "knowledge is not waiting to be discovered but it is constructed by people who are out in the world to discover it". Cohen, Manion, and Morrison (2011) state that an interpretive paradigm rejects the idea that there is one objective reality that can be known, but that its ontology takes a stance that there are multiple realities that are subjective. It is for this reason that the two research sites were purposively sampled without the purpose of comparing them. Rather, it was to see how teachers understood their pedagogical practice in different contexts.

Epistemology in research refers to what the nature of the association or relationship between the knower and what can be known could be. In this research, knowledge was created by means of interactions with the research participants in relation to my own (i.e., the researcher's) beliefs (Creswell, 2013). In research of this nature, the researcher's beliefs are difficult to ignore as the research topic speaks to what the researcher has experienced and observed to be happening. In this context, I was aware of pedagogical practice requirements as I have been a Grade 1 Mathematics teacher. However, I took great care not to let my beliefs and perceptions have an impact on the research results, and I remained sensitive to the fact that my "critical practice" needed to be tempered with objectivity in order to approach the qualitative nature of this study (Maxwell, 2004).

The lenses that I employed to frame this study were Bernstein's pedagogic device theory and Vygotsky's social theory. As social constructivists, both these scholars relate to how teachers should teach using the constructivist approach. Bernstein (1990, 1996 & 2000) suggests that, according to the pedagogic device theory, transmitted knowledge is first acquired through three interrelated rules, namely distributive, re-contextualizing, and evaluative values that are later communicated to make meaning. For the purposes of this study, I maintained an objective stance despite my personal interest in the theme of the research, and I avoided generalising the data. Generalisation is common in case studies, but I was acutely aware that the data generated were from four research participants only and therefore that the sample was too small for universal conclusions (Guthrie, 2010).

4.9 Research paradigm

A paradigm refers to the fact that the epistemology could be reached when data are generated by a joint effort of the researcher and the participants. The axiology of this paradigm granted the researcher an opportunity to facilitate the generation of data. However Blanche, Durrheim and Painter (2006) state that a paradigm is an all-encompassing system that integrates practice and thinking and that defines the nature of enquiry along three dimensions: ontology, epistemology and methodology. Blanche, Durrheim, and Painter (2006) identify three types of paradigms, namely a positivist, an interpretive, and a constructionist paradigm. For the purpose of this research, I have chosen the interpretive paradigm. Given the fact that this was a social study that examined teachers' understanding of pedagogic practices in teaching Mathematics and the impact their practices had on learners' acquisition of mathematical concepts in Grade 1, the study fitted comfortably within the interpretivist paradigm. The interpretivist paradigm requires the researcher to collect data that will assist in the logical construction of the world where the research participants are situated. Ponterotto (2005) refers to an interpretivist paradigm where the researcher cannot accept that reality is just there and available, and in this study reality was created in terms of what knowledge the teachers have to pass on to the learners and which skills on mathematical understanding the learners could acquire from what the teachers taught.

To understand what pedagogical practices are, teachers refer to Ponterotto (2005) view of the interpretivist paradigm, as it does not accept reality "as is"; nor can the researcher simply accept what is real as being "as is" (p. 67). This would occur in classrooms where teachers teach using appropriate pedagogic practices in order to afford learners opportunities to learn.

The interpretivist paradigm locates subjects and objects within inter-subjective social fields that structure and constrain activity. This means that the study subjects (i.e., the teachers) were actively involved in the reproduction of these fields, the study field, namely Mathematics.

Cohen, Manion and Morrison (2000) suggest that, due to the demand to understand the subjective world of human experience, efforts are made to get 'inside' the study participants in order to help them understand themselves from within. This became relevant in the interpretivists approach where the study focused on written, verbal and non-verbal forms of communication regarding teachers' pedagogical practices in the classroom. Furthermore, constructivists assume that effective learning occurs where there is collaboration amongst people. Teaching and learning as a concept, is understood as the research paradigm that incorporates research approaches that emphasise the meaningful nature of individuals' participation in social and cultural life (Denzin & Lincoln, 2000).

The rationale behind choosing the interpretivist paradigm centered on the fact that the theoretical and conceptual frameworks of constructivism that underpin a study will view knowledge as socially constructed. This knowledge construction does not only refer to learners' learning, but also to teachers' understanding of their practice. This is affirmed by Cohen, et al. (2004 & 2007), and Babbie and Mouton (2001). Fossey, Harvey, McDermott and Davidson (2002) specifically refer to interpretivists as "… the participants' voice provides for their own human actions where they seek to understand and describe meaningful social action through direct, detailed observation of people in order to arrive at an understanding and interpretation of how people create and maintain their social worlds (p. 720).

The interpretive paradigm that was employed in this study was informed by the case study methodology. The bulk of the data were collected in the classroom setting where the teachers were teaching amidst a variety of activities. Both the teachers and the learners were observed. Because the study focused on teachers' pedagogical practices, the main sources of primary data were observations, semi-structured interviews and document evidence. These data collection methods will be discussed later in this chapter. Interpretive inquiry, as was used in this study, characterises how learners as individuals understand the world and how their diverse backgrounds and contexts may be interrelated with their learning environment and the interactions that occur there (Maree, 2007, p. 61). This became evident as the study progressed.

The interpretive research paradigm assumes that people employ interpretive structures that necessitate understanding, and that the nature of the local background ought to be articulated (Bernstein 1999). The teachers' understanding of their pedagogic practices that impacted learners' acquisition of mathematical concepts were illuminated as the study progressed. The underlying assumption of the interpretive paradigm is that the whole needs to be examined in order to understand a phenomenon. The interpretivist paradigm was also selected for this study using Vygotsky's social theory as the theoretical framework. The justification was that both teachers and learners learn as they work together. The research was carried out in a natural setting (i.e., in classrooms in two schools) and, as a result, frequent visits to the schools were important.

Constructivists refer to pedagogy as that which each learner brings to the classroom; i.e., his/her own concepts and knowledge constructed from their experiences. In this study, interpretivism was understood as "… views that understand human behaviour, relationship and products" (Bandura, 1997). This was the reason for observing how the teachers understood their pedagogical practices and how their learners were able to learn in terms of their own experiences and actions. The learners who were involved in this study were in their respective classrooms with their teachers. The teachers and learners were aware that a researcher was present in their classroom to observe and evaluate.

Considerable time was spent at the two schools for classroom observations because qualitative observational methods are often used as non-interviews (Kvale, 1996).

Qualitative interviews were conducted with the four research participants. Qualitative interviews are widely implemented for their deliberate empowerment of the respondents, in the sense that they become co-researchers. In this context the interviewer tries to empower the respondents to take the lead and to point out important features of the phenomenon as they see it. By so doing, the researcher can verify and confirm the data (Denzin & Lincoln, 2000).

4.10 Qualitative approach

According to Creswell (2013, p. 18), a qualitative approach in research is "… one in which the inquirer often makes knowledge claims based primarily on constructivist perspectives (i.e., the multiple meanings of individual experiences and meanings socially and historically constructed) with the intent of developing a theory or pattern. In this approach, the researcher also uses strategies such as inquiries and narratives, or case studies. The researcher collects open-ended, emerging data with the primary intent of developing themes from the data (p. 31).

Maree (2007, p. 78) states that "qualitative research is based on a naturalistic approach that seeks to understand phenomena in real-life situations". I therefore employed this approach because it afforded me the opportunity to engage in data generation processes that produced in-depth and rich data. In this regard, Creswell (2013) emphasises that a qualitative approach allows the researcher an opportunity to interact intensively with the participants by engaging in face-to-face interactions, and by talking to and observing the respondents behaviour in their real-life context.

In other words, qualitative research focuses on investigating, understanding and discovering meaning and explaining particular phenomena through the experiences and/or perspectives of the participants, particularly within areas of educational thought and practice (Hitchcock & Hughes, 1995; Leedy, 1993; McMillan & Schumacher, 2001. Flick (2007, p. ix) is of the view that one could interpret, make sense, explain and describe social phenomena 'from the inside' in three plausible ways. This implies that, using the qualitative research approach, the language of the subjects is important because the "actual words of the subjects are thought to be critical to the process of conveying the

meaning systems of the participants which eventually become the results or findings of the research" (Filstead, 1979, p. 37). The researcher's discoveries are presented as the findings of the research. According to Cohen, et al. (2007, p. 47), research methodology is a "range of approaches used in educational research to gather data which are to be used as a basis for inference and interpretation, for explanation and prediction". With this definition in mind, the methodology relevant to this study was the qualitative research methodology used to gather data that addressed the critical questions and the accompanying sub-questions. In the context of this study, the main problem statement was to examine teacher's understanding of pedagogic practices in teaching mathematical concepts. The main research question placed the teachers at the center of the inquiry; as a consequence, they became the focal point of the investigation. This was done by means of observations, semi-structured interviews and documentary evidence. It was also significant to look into what pedagogical theories these teachers drew on as this will enable the reader to understand how these theories were implemented in the classroom.

Engaging with the study qualitatively meant that observations of the classrooms were required as the teachers were teaching in their natural setting. This research had to be conducted qualitatively because in this way a deeper insight into the issues of how teachers practice their pedagogical skills to teach mathematical concepts in Grade 1 could be reached.

Qualitative research emphasises lived experiences and the way people make sense of their experiences in order to develop rich and meaningful data (Higgs, Horsfall & Grace, 2009). This occurred by observing teachers in the classroom while they were teaching. With a qualitative research approach, the researcher is allowed to use interviews, conversations, field notes, recordings and photographs to observe and interpret in order to make sense of the research participants' behaviors/engagement /responses towards a phenomenon under consideration in a given natural setting, in this case study, it was Mathematics classrooms at the two study sites.

In a qualitative approach, the inquirer often makes knowledge claims based primarily on constructivist perspectives (the multiple meanings of individual experiences and meanings socially and historically constructed) with the intent of developing a theory or pattern.

It also uses strategies for enquiry such as narratives or case studies. The researcher collects open-ended, emerging data with the primary intent of developing themes from the data. This is another reason why the qualitative research methodology was selected in order to achieve the objectives of this study. A feature of qualitative research is the inclusion of the construction of meaning; i.e., how people conduct their lives. This is how active meaning arises out of social situations and is handled through interpretive processes. In the context of this study, teachers' and learners' behaviour were context-related, their multiple realities were constructed holistically, and data were produced by studying their human behaviour within their social contexts.

Qualitative research was selected over quantitative in this study because in quantitative studies, research participants are restricted; i.e., their voice is not heard. They are simply compressed into numerical data in a study, whereas qualitative research produces the information-rich data that it promises (Cohen, et al., 2007). Creswell (2011) emphasises that a qualitative approach is an impressive approach that affords the researcher an opportunity to interact intensively with the participants by engaging in face-to-face interactions.

Qualitative research is also used to gain new perspectives and more in-depth understanding that may be a challenge to express quantitatively. Because qualitative research methodology allows for the integration of varied strategies of construing data, this method ensured that this particular research produced a reliable and precise elucidation of the situation. In addition to being in-depth as well as subjective in nature, interpretive, qualitative studies are conducted on individuals in their natural settings, in contrast to quantitative studies that are conducted in well-ordered settings (Falconer & Mackay, 1999). For this study, all these features were significant as it involved the gathering of rich data through qualitative methods using interviews, classroom observation and documentary evidence as research instruments. Moreover, rich data were presented holistically from the perspective of the research participants (Morrow, 2005).

Qualitative research uses multi-methods to secure an in-depth understanding of the phenomenon under study. Multi-methods add "rigor, breadth, complexity, richness and depth to any inquiry" (Flick, 2002, p. 229). The multi-method data collection method was employed because this was a case study and data were generated from only two research sites. I used a qualitative research methodology to collect and evaluate the data. Qualitative research uses a naturalistic approach that seeks to understand phenomena in context-specific settings, such as real-world settings "… where the researcher does not attempt to manipulate the phenomenon of interest" (Patton, 2002, p. 39). In this study the teachers and learners were observed in their natural setting in the classroom.

The qualitative research located the teachers' activities as they interacted with the learners in order to see how they taught in their contexts. My investigation involved an interpretive, naturalistic approach by observing people in their natural settings. I endeavored to interpret the phenomenon under study "in terms of the meaning people [brought] to them" (Denzin & Lincoln, 2005, p. 3). Warren & Nisbet (2000, p. 7) argue that qualitative research is "… more open-ended as it is more concerned with being attuned to who is being researched than with the setting out of a precise route for all to follow".

4.11 Case study

Cohen, et al. (2011) state that interpretive paradigm rejects the idea that there is one objective reality that can be known. Instead, they argue that its ontology takes a stance that there are multiple realities that are subjective. For this reason I expected to find multiple realities from my participants' responses which would be influenced by their different experiences and backgrounds. The interpretive paradigm grants the researcher an opportunity to facilitate the generation of data by asking semi-structured interviews and by utilising probing questions to dig for deeper meaning for the intensive understanding of the Mathematics as a subject practices. It also allows the interpretation of data (axiology) by means of which knowledge is generated through consensus between the researcher and the participants (i.e., epistemology) (Creswell, 2013).

Walter (2006) argues that methodology refers to the frame of reference for that particular research that is influenced by the paradigm we choose. Lichtman (2006) outlines different types of methodologies that can be used in qualitative research such as ethnographies, grounded theory, case studies, phenomenology and narrative research. The case study seemed to be one methodology I could use to understand Mathematics teachers understanding of their pedagogic practices. By using semi-structured interviews, classroom observations and document analysis, I felt I could be able to gather rich data from the research participants. Yin (2009) refers to a case study as a study within a particular context to gather rich descriptions. Also the case study was chosen because of its flexibility in accessing data. Yin (2009) emphasises that a case study assists the researcher to be engaged in a study to systematically explore and gain an in-depth understanding of a particular case in its context. In this context the generation of data should be conducted systematically, such as in different phases in the real-life setting of the participants in order to allow each data tool to generate the most valuable and desired data. McMillan and Schumacher (2001) highlight that a qualitative study incorporates a case study and that its analysis focuses on a single phenomenon, regardless of the number of sites or participants in the study.

As a result, this study adopted a multiple case study approach in which a single concern (teachers' practices in teaching Mathematics) was a focus. Four Grade 1 classes (cases) were selected to demonstrate the issue (Creswell, 2013). Even though Yin (2009) suggests that multiple case studies may compare and then generalise results, this was not applied in this particular qualitative research as I felt that generalization should be avoided because the sample was relatively small and each case existed in its unique context (Creswell, 2013).

The case study was selected because of its flexible form of analysis that I felt would be most suited to a study of teachers' understanding of the impact of their pedagogic practices on learners' acquisition of mathematical concepts. A case study is viewed by many qualitative researchers as the most flexible form of inquiry; this was also most suited for this particular phenomenon within a teacher-education context (Yin, 2009).

According to McMillan and Schumacher (2010, p. 485), a case study is "qualitative research that examines a bounded system (i.e., a case) over time in detail, employing multiple sources of data found in the setting". Creswell (2013, p. 265) states that the case study is considered a research issue, meaning that it focuses on what needs to be researched. In this research the focus was to investigate whether teachers understood their practice in teaching Mathematics in Grade 1.

De Vos, et al. (2011) state that any case study comprises a descriptive investigation where the research will look into how things are done to explain or justify the behaviour. A descriptive case study distinguishes itself from other types of case studies by its preoccupation with articulating a descriptive theory (Yin, 2003). This was an exploratory study that examined the impact Mathematics teachers' understanding of their pedagogical practices on learners' acquisition of mathematical concepts. Yin (1989, p. 82) states that case studies allow researchers to "reveal the multiplicity of factors that interact to produce the unique character of the entity that is the subject of study".

Deciding on a case study was an appropriate choice, particularly because Dowling (1998, p. 43) argues that "… a case study means that the researcher sets out to understand and describe a setting with which he/she is unfamiliar". In this context, I was unfamiliar with the pedagogical practices at both the study sites. Moreover, a case study does not claim to produce an objective or truthful account of reality, but aims to offer versions of the researcher's experiences of reality (Tuckett, 2004) which is what the researcher set out to do.

According to Stake (2000), case studies are intrinsic and instrumental. The aim of an intrinsic case study is to obtain a better understanding of a particular case itself, rather than of particular phenomena. Therefore, the theory structure is not a concern if the case already exists as a 'given', such as the evaluation of an existing programme (Polit & Beck, 2004). For an instrumental case study, the researcher selects and investigates the case to provide insight into a particular issue. This study selected a case that provided the best clarification of the research question, as posited by Polit and Beck (2004). Hence, it was a means to an end. The main difference between an intrinsic and an instrumental case study is not the case, but the "purpose of the study of the case" (Luck, et al., 2006).

However, differentiating between intrinsic and instrumental case studies is not straightforward because there are no clear lines of distinction, but rather "a zone of combined purpose" (Stake, 2006, p. 402).

A case study suited the fact that this study aimed to describe 'what it is like' to be in any particular situation in an educational context, and to capture a close-up view of what was real and how the participants described their practice within the reality of lived experiences of thoughts and feelings in a particular situation (Cohen, et al., 2000, p. 181).

In order to investigate how the teachers' pedagogic practices in teaching Mathematics impacted learners' acquisition of mathematical concepts, a strategy was devised to intensely focus on the teachers' skills, and the case study was the best research design to achieve this. Case study designs are solid, as they have the ability to study a situation within its context which becomes a means to an end. As referred to by Mouton (1996), the researcher's design is a plan of action and sometimes may become a broad strategic plan. Case studies are referred to as the logical inquiry into an occurrence or set of related events that aims to describe and explain a phenomenon of interest (Yin, 1994).

Yin (2009) distinguishes between three forms of case studies, namely descriptive, exploratory and explanatory. According to Diezmann (2002), descriptive case studies are focused and detailed, and propositions and questions about a phenomenon are carefully examined and articulated at the outset. This articulation of what is already known about the phenomenon is called a descriptive theory. The influence of a descriptive case study lies in the withdrawal of the researcher's understanding of the data by referring any findings to what the participants are revealing. Descriptive case studies seek to divulge outlines and influences, in relation to theoretical constructs, in order to advance theory development. Some researchers refer to descriptive case studies as exhaustive case studies; which is a semantically helpful term for directing the researcher's desired level of intellectual perception of the phenomenon. A second type is the explanatory-causal case study, which tries to interpret phenomena to the point of answering the 'why' questions on a theoretical basis.

This type of case study demands theoretical reasoning. The third type is the exploratory case study, goes beyond description and tries to provide an understanding of the case against the background of its context, which demands a hermeneutic process. This type of case study is often used as a basis for later extended analyses; e.g., for hypothesis construction in survey research, or in addition to a survey (Lamnek, 1995). It helps to demarcate the borders of the case and it provides sureties significant to the truthfulness of the completed case study. From the perspective of positivist research, all types of case studies can be connected, because they have the following comparable aims: case studies depict reasonably incontestable details of people, place, events, connections and progressions of the case, a description that others would likely make if they had been there. Case studies also give a clear picture of what is happening, without making decisions about the structured and rational performance of the phenomenon; and lastly, case studies have the power to develop and expand on significant concepts (McMillan & Schumacher, 2010).

In the context of this study, the aim was to ensure that this research would yield rich, detailed and in-depth data from the research participants through qualitative semi-structured interviews, documentary evidence and classroom observations. The case study describes beliefs, customs and behaviour that are in scripted and are based on information collected through exploration (Harris & Johnson, 2000). As this study was an enquiry into teachers' understanding of their teaching of mathematical concepts in Grade 1, and because learning appears to be very sensitive and political, it was appropriate to use a qualitative framework. This enabled me to listen to the teachers' and learners' voices without judgement or bias, and I could therefore present the findings from the perspective of the research participants. Furthermore, the study was concerned with a critical reflection of the research participants' experiences on how mathematical concepts were acquired in an additional language. The plan of action was therefore to visit both Mthandeni and Bathandenibonke Primary Schools a number of times. The process was characterised by intensive, on-going, face-to -face semi-structured interviews and conversations with the research participants.

The core data generation tool of this study comprised the research participants' views and perceptions that were procured during in-depth, open-ended and semi-structured interviews that were conducted on a one-on-one basis. It became imperative that the semi-structured interviews became conversations, as the teachers seemed keen to discuss their teaching practices.

These open-ended semi-structured interviews generated meanings that the research participants attached to their knowledge, behaviours, and activities. Denscombe (2003) asserts that a case study involves how people describe their culture in a most dense way to emphasise their way of life and understanding from the point of view of those involved. The case study is therefore an inquiry where the researcher uses different types of sources of evidence to emphasise the details as viewed from the perspective of the research participants (Yin, 2009). This method was selected as being the most appropriate methodological choice that would allow the exploration of the kinds of issues this study hoped to engage with. Many of the tenets of a case study derive from the interpretivist philosophical stance, which has at its core the idea that "all human activity is fundamentally a social and meaning-making experience" (Eisenhart, 1988, p. 102).

De Vos, Strydom, Fouché and Delport (2005) state that the case study design becomes a technique of choice, especially from the researcher's perspective, so this choice was exercised in order to get closer to the research participants through semi-structured interviews, conversations and classroom observations. The semi-structured interviews and conversations were also recorded. The reasoning behind having semi-structured conversations was to allow more time with the research participants and to understand their way of life, especially during classroom observations. Lesson observations enabled me to generate more data. In this regard Hammersley (1990) asserts that a case study has three methodological principles: naturalism, understanding, and discovery, which are used to provide the rationale for the case study. Wolcott, cited in Henning (2012), describes a case study as a research strategy designed to understand "the way of life of an identifiable group of people". Maree (2007) attests that a case study assumes that all human behaviour is intentional and observable; therefore research should be orientated towards understanding the reasoning behind people's actions.

4.12 INSTRUMENTS OF DATA GENERATION

4.12. 1 Semi-structured interviews

The purpose of using interviews in research is to collect data, and in this case the semi-structured interview was a resource-demanding data collection method. This research involved three instruments, namely semi-structured interviews, observations, and documentary evidence. The semi-structured interviews enabled me to ask follow-up questions that were predetermined; most of these questions were based on each interviewee's particular responses. The LoLT in one of the research sites was isiZulu and in the other one was English. This afforded me the opportunity to develop the interview in a productive way, allowing the participants to report on what they would do to counteract any challenges that they had mentioned. All the comments provided by the participants were thoroughly explored. Creswell (2013, p. 221) argues that a semi-structured interview allows "a process of gathering open-ended, first-hand information by observing people at a research site". He further argues that observation requires "careful attention to visual detail" (p. 222).

Where observations are used as a data-capturing mechanism "… as they afford the researcher the opportunity to gather live data" (Cohen, Manion, & Morrison, 2013, p. 80), semi-structured questions are used in order to obtain as many details as possible. Semi-structured interviews allow for the research participants to answer from their own frame of reference rather than being confined by the structure of pre-designed questions. In a semi-structured interview, research participants express their thoughts more freely and the interviewer can increase the amount of data collected, thereby increasing the validity of the study (Denzin & Lincoln, 2000).

By using semi-structured interviews, I was able to encourage the research participants to talk beyond what was an 'official account' of their daily task. I spent about 30 minutes with each of the research participant on our first meeting as I wanted to understand why these Mathematics teachers opted for the approaches they chose. Also when I returned for classroom observations I spent about 20 minutes with each research participant because that was the time to look into how the planning was going to be incorporated in the continuous assessment as well as paying particular attention to the context of the learners. I could ask questions that addressed areas of interest and could probe for more detail from several conversational directions.

This provided the respondents with opportunities to report their 'official account' and to provide any possible contrasts with their own opinions or to comment on others' 'less official' behaviour, as suggested by Denzin and Lincoln, (2000). Hitchcock and Hughes (1995) state that semi-structured interviews provide much more scope for discussion and are used to collect qualitative data by setting up a situation (the interview) on how learners learn, particularly if they are additional language learners. The use of semi-structured interviews was appropriate for the study due to their flexibility and the fact that they allowed my participants to express themselves freely. "The purpose of interviews is to obtain present assemblies of persons, experiences, events, actions, feelings, claims, and concerns, and they can also be used to reconstruct past experiences or predict the future" (Lincoln & Guba, 1985, p. 268).

The semi-structured interviews with the Grade 1 teachers were used to gain an in-depth sense of the participants' views on a particular topic (De Vos, Strydom, Fouché, & Delport, 2005). Semi-structured interviews are performed with an open, relaxed structure and also allow the researcher to explore more and ask questions for clarity before analysing the data and communicating the findings. These semi-structured interviews integrated effectively with the observations carried out in the classroom. Furthermore, the semi-structured interview schedule yielded data concerning abstract phenomena, such as how the curriculum was perceived as an aid for teachers' use in order for them to achieve good results in the classroom.

4.12. 2 Classroom observations

It is important for researchers to gather original first-hand data. Classroom observations offered me the opportunity to gather original data from the respondents. Given the fact that the nature of the study required the gathering of data on how teachers teach, classroom observations were used. Also, going back to the sub-question: **How do pedagogic theories and disciplinary conceptualisation impact the teaching of Mathematics in Grade 1**? classroom observation was one of the key techniques of social research by means of which I was able to triangulate data. Cohen, et al. (2007, p. 228) assert that there are four options for researchers to use: continuous observation, time interval observation, event observation, and time-point observation. The main focus was on continuous observation as it was imperative to discover how teachers understood their pedagogic practices while

they were teaching mathematical concepts. For this reason the primary data that are generated by means of interviews are augmented by other methods of data generation such as surveys, documentation review, observation, and the generation of physical objects (Yin, 2009). The distinctive feature of observation as a research process, according to Cohen, et al. (2007, p. 396), is that it offers the researcher an opportunity to gather 'live' data from naturally occurring social situations so that the researcher can look directly at what is taking place in situ, rather than relying on second-hand accounts.

The classroom observation as an approach was chosen for this study to observe what and how the teachers were teaching. Tools for this technique included an observation schedule (Appendix I), with items specified for observation like body language; the response of learners to the teachers and vice versa; and the presence of learning aids such as books, stationery, notes and self-made notes in response to the reading and writing tasks. The first research question: **What pedagogic practices do teachers in Grade 1 draw upon to understand teaching Mathematics in Grade 1?** was addressed through the semi-structured interviews and the observation of teachers' classroom practices. These observations occurred while the lessons were in progress and were aimed at the creation of a broader picture of the learners and their attitudes towards learning mathematical concepts. The observations focused on how the teachers implemented pedagogic theories and how disciplinary conceptualization impacted their teaching of Mathematics in Grade 1. I used an observation schedule that assisted me in verifying the teachers' responses during the interviews and to gather data from naturally occurring social situations which promoted an understanding of the school context and school culture. Observation refers to that which is seen and heard and is the researcher's version of what occurred. Chang-Kredl and Wilkie (2016) refer to the "double hermeneutic" which makes reference to the observation and interpretation of the data in a two-fold manner. This means that the researcher observes as a participant and is in direct contact with the events by observing actions, language use, symbols and other artefacts while observing the learners as they are taught.

For this research, relying only on the semi-structured interviews and classroom observations could not be sufficient, as the document analysis was used to compare data from teachers. Nieuwenhuis (2007) asserts that document evidence is a data source that overlaps with the other sources. The documents are used as a source of information that is valuable to qualitative researchers. Mouton (1996, p. 53) offers one important reason for using multi-methods of data collection when he asserts that "the multi-methods technique is used for the betterment of the research".

In the case study, classroom observation plays a significant role where the researcher becomes part of those being observed in order to get to know them, their language and their thinking. Maree (2007) argues that classroom observations are important instrument for data gathering because when recorded efficiently it can provide the reader with an "insider perspective" and it places the researcher in the participants' shoes. Bertram (2004, p. 90) states that "observation is going to the classroom and observing what actually takes place there". For this reason I visited the Grade 1 classrooms frequently.

However, I took cognisance of the requirement to remain a participant observer and to record only that which was observable. The curriculum provided the information on how learning should be integrated when teachers were teaching Mathematics. The teachers' lesson preparation provided a reasonable guide as to the depth and extent of the mathematical concepts and content that had to be taught. However, it became problematic when the teachers unintentionally diverged from their planned lessons or did not implement other forms of learning in Mathematics. Added to this dilemma was the fact that I had to simultaneously make notes, observe, and make sense of the teachers' lesson presentation. Notes from what was observed would have been easier, but this would have disturbed the natural environment of the classroom situation. The transcription was also done as the interviews took place using shorthand notes that were transcribed into relatively meaningful chunks of information that were used in the triangulation processes.

4.13. 1 Documentary evidence

Documentary evidence was one of the data generation procedures or techniques that were used in this research. As research cannot solely rely on the research participants' voices, it was imperative to use documentary evidence to generate additional data that could also be used for the purpose of triangulation. This technique was significant because it was able to provide the data that would have been difficult to access. Documentary evidence may be defined as "records of events or processes and procedures that are produced by individuals or groups" (Maree, 2009).

There are many different documents in schools that guide teaching and learning and that are required for the implementation of policies (Cohen, et al., 2007, p. 249). In the context of this study, documentary evidence included journals, study guides, learners' activity books, assessment books, record books, and school policies on Mathematics pedagogy. The documentary evidence was important, especially when teachers were responding to the sub-question: **How do Mathematics teachers' actual understanding of pedagogic theories effect the teaching and learning outcomes in Grade 1?**

This research question served as a guideline to the 'what' and the 'how' that I had to consider when observing what the teachers used as concepts to understand their pedagogic practices. Because documentary evidence is self-explanatory, it was required for analysis and interpretation, and this involved "an understanding of the information relayed and the underlying values and assumptions of the author, as well as any arguments [that were] developed" (Cohen, et al., 2007). For the data to be rich, the research had to make connections between what was in the documents, what was observed in the classrooms, and what was revealed during the interviews.

4.13.2 Learners' work

The learner's work was one of the instruments that were used in order to understand the impact of teachers' pedagogical practices on the learners' ability to acquire mathematical skills and concepts. The learners had to complete an activity after the teaching intervention. Viewing the learners' work enabled me to recall what the teacher had endeavored to teach and whether the learners

attained the required level of knowledge and understanding. This is shown in the example below. The teacher had taught two mathematical concepts, ‘equal to’ and ‘not equal to’, and the example from a learner’s work book shows how this learner related to the concept of equal to:

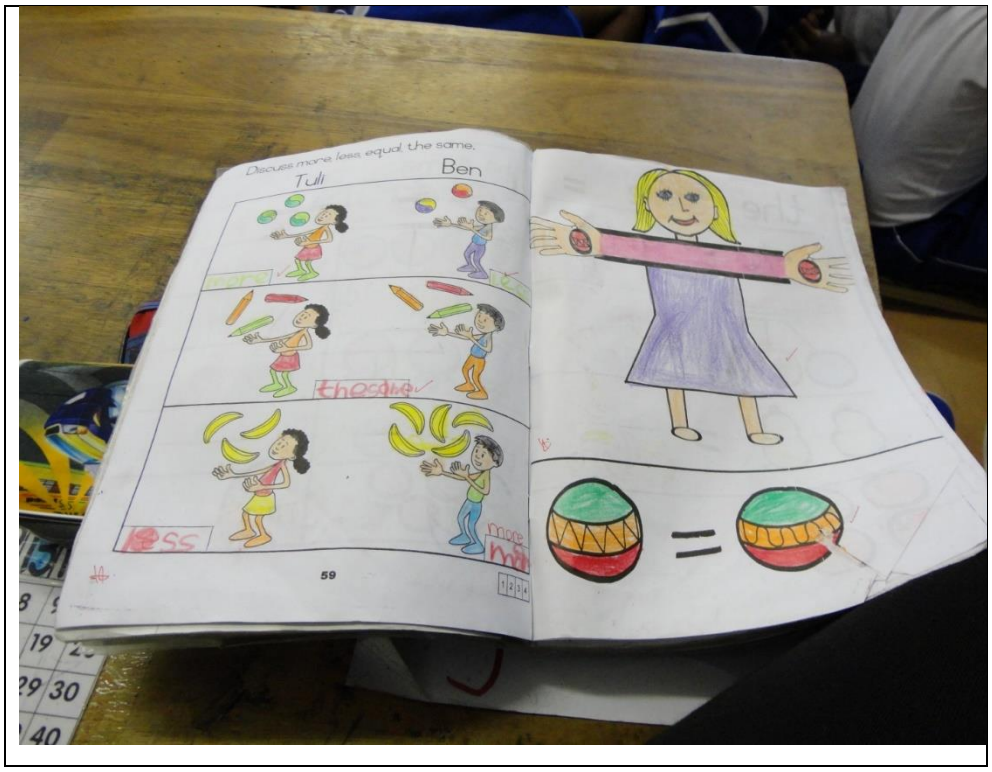


Figure: 4.13.2.1 An example of a learner’s written work that demonstrates the acquisition of a mathematical concept.

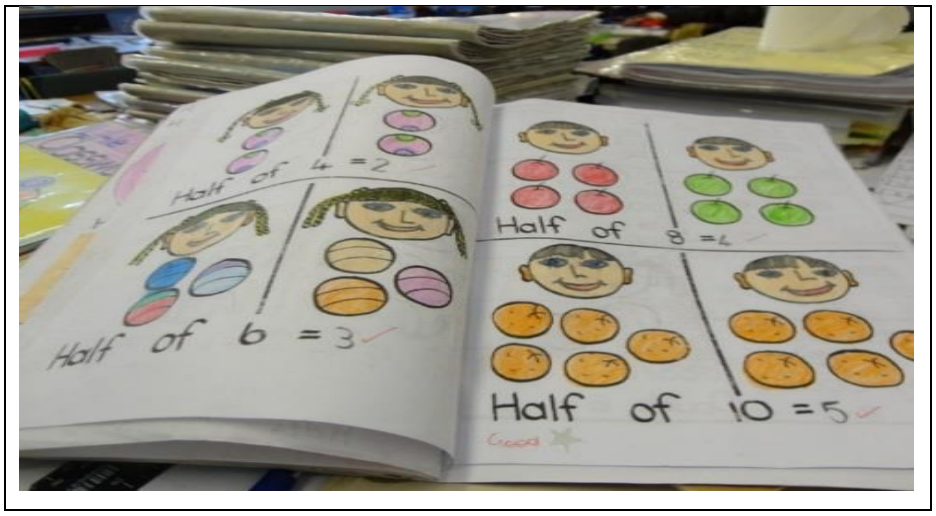


Figure: 4.13.2.2 An example of a learner's work to illustrate how knowledge was used to make sense of what was understood in order to construct their own knowledge.

4.14 Ensuring trustworthiness – Triangulation of data

Participants need to be informed that their participation is voluntary and that their information will not be used for purposes other than the current research and this is an important aspect. Furthermore, Shenton (2004) suggest that paying attention to the following dimensions will increase trustworthiness in a qualitative study: transferability, dependability, conformability, and credibility. Adherence to these requirements strengthens a study and for this reason each is discussed below.

4.14.1 Transferability

Transferability is anxious with the degree to which the findings of one study can be applied to other situations (Shenton, 2004). For Kuper, Lingard, and Levinson (2008) transferability as the applicability of the research findings to another setting and this definition is in line with that of Rolfe (2006) when he asserts that transferability is defined as the extent to which the findings can be transferred to another context. To be able to do this, a researcher needs to provide thick descriptions of the research process (Shenton, 2004), For this purpose the researcher fully defined all the research steps from beginning to end, as this may assist other researchers who may have interest in conducting a similar study**.**

4.14.2 Dependability

Golafshani (2003) argues that dependability refers to the consistency of any research findings. In order to ensure that there is trustworthiness in a study, Elliott, Fischer, and Rennie (1999) assert that validity in qualitative research is entrenched in the principle of dependability. Dependability focuses on giving accurate and direct information pertaining to the study. In this context, the interviews were audio recorded with the verbal and written permission of the participants. The recording facility on a laptop was used to record the interviews and participants were later requested to listen carefully to the audio recordings. This was done to check whether what was recorded was what the participant had said during the interview.

This process is reinforced by Krefting (1991) when he argues that summarised of typed interviews can be given to participants for their verification. He further asserts that spending substantial time with participants to verify the data assists in enhancing the trustworthiness of the study. In this regard, the researcher use substantial time with the participants to confirm the footages and the transcripts and to provide guidance and clarity which assisted in terms of obtaining rich data (Toolkit, 2009). The advantage of spending sufficient time with the participants was that they were afforded opportunities to express themselves freely and to verify and even augment the data if they felt that it was necessary.

4.14.3 Conformability

Conformability is anxious with whether the findings reflect the experiences and ideas of the participants and it assures that the position of a researcher does not influence the findings, (Pool & Reitsma, 2013). Gerryts (2013) discloses that checking for members assists participants to confirm the elucidations expressed by the researcher. The participants were therefore granted opportunities to indicate if the researcher's interpretations were in line with their contributions during the interviews. Finally, the participants were given an opportunity to verify the transcriptions.

4.14.4 Credibility

Kiplinger and Hamilton (2008) define credibility as the findings reflecting the reality and lived experiences of the participants and the truth value of the information obtained from the discovery of human reflections. Baxter and Eyles (1997) asserts that credibility is established while the study is being conducted. Four teachers from two schools were interrogated by using three data generation methods namely classroom observations, semi-structured interviews and document analysis. The purpose was to ensure the trustworthiness (or credibility) of the data by comparing the findings based on all three research approaches used in this study. This is also referred to as triangulation (Decrops, 1999).

Triangulation of the data allowed a process of validation to ensure that no inaccuracies occurred in the presentation of the findings (Bertram & Christiansen, 2014). For the triangulation of data, the use of multiple sources of data was significant because my interpretations and relevant findings could be confirmed by more than one data source. Patton (2002, p. 248) states that "triangulation within a qualitative strategy can be attained by combining both interviewing and observations, [thus] mixing different types of purposeful samples".

Burgess (1985, p. 171) refers to the triangulation process as an attempt at understanding an interpretation compared to that of the study participants. Looking at the learners' and teachers' journals supported the correlation between these two data sources. In trying to reconcile my understanding with what Burgess (1985) recommends, the central focus for me as the researcher was not on explaining the observations, but on describing what was taking place in the classroom. The use of multiple data generation tools added trustworthiness to the findings of this study, as purported by Maree (2009).

Guba and Lincoln (1985) present four criteria to measure trustworthiness, namely credibility, dependability, transferability and confirmability. This was a qualitative study that was aimed at understanding whether teachers understood their pedagogical knowledge of teaching Mathematics; therefore the credibility of the study relied on what the teachers did that showed (or did not show) their understanding of their practice. Validity in effective research remains inarguably vital, and

unacceptable research is worthless (Cohen, et al., 2007). Thus the researcher using a case study has the responsibility to ensure that the study is trustworthy and credible. I relied on what the teachers were saying about their pedagogic practice in order to understand if they have an understanding of what they were doing. Transferability is when the results that are found can be generalised in context (the findings can be applied beyond the study). During the classroom observations the participants were constantly asked whether they were still comfortable with the researcher in the classroom (Lincoln & Guba, 1985).

Creswell (2012) argues that we can use 'member checking' to examine the accuracy of our findings by taking our reports back to the participants to ensure that our interpretations as researchers are correct. The researcher went back to the research participants and discussed the findings of the study with them in follow-up semi-structured interviews (Creswell, 2013). However, I have mentioned that this study was not intended to compare cases but to illuminate what the data confirmed through the data generation tools used in this study.

In this study validity was concerned with understanding the constructs and practices of particular pedagogical practices. In enhancing validity, and thereby the reliability of the findings, the study relied on two techniques, namely triangulation and sampling. (Both have been discussed in preceding sections). While Cohen, et al. (2007) record that widely held views of reliability seem to adhere to positivism rather than qualitative research (p. 200), there is a need for qualitative research to be just as reliable. Patton (2002) argues that validity and reliability are two factors that any qualitative researcher should be concerned about while designing a study, as these element are crucial in analysing the results and judging the quality of the study. The documents that were analysed in this study were the Curriculum Assessment Policy Statement (CAPS) (2011), and teachers' journals that contained, inter alia, their lesson plans, work schedules, and assessment records of the work done in Mathematics. I also perused the learners' journals and work books. The learners' journals served as evidence of the activities done in the classroom on a daily basis. The data obtained from these documents were analysed and the findings are discussed in the following chapter.

Lincoln and Guba (1985) argue that the trustworthiness of a research report depends on issues of reliability, validity, trustworthiness, quality and rigor used to differentiate good research from weak research. It is for this reason that testing and increasing the reliability, validity and rigor of my study was important. Interpretative validity was indicative of whether the participants' meanings or perspectives of the events and behaviours were accurately reported. Emphasis was therefore placed on the perspectives and language of the participants rather than on the interpretations and terminology of the researcher. Eliciting comments from the participants on the findings was important in maximising the interpretative validity of the findings. In this context it was important to discuss my interpretations of the data with the participants in terms of the concepts used and the theory developed from the data. This was done before the final evaluations were presented.

4.15 Ethical considerations in conducting the study

Bell (2014) states that any kind of research need to be guided by the principles of respect for people or the research participants, the generosity of the researcher as well as and justice to people. Ethical issues refer to the honest philosophies the researcher needs to take into account before and after considering any research. I had discussions with the research participants at the outset to explain what the study was about and most importantly that they had the right to withdraw from the research at any time should they feel uncomfortable with no negative consequences.

The research participants in this study were guaranteed confidentiality regarding their names and the names of the research site (in this case the school) throughout the research process. The ethical issues according to Creswell (2013) occur in all the phases of a research development. After being authorised ethical clearance to conduct the research study by the University of KwaZulu-Natal, the researcher made sure that all the research participants assigned pseudonyms to conceal their identity. The research participants signed the research-participant information and informed consent, the interview consent and the recording consent forms. All these forms were translated into the appropriate language(s) of the research participants. Permission was also requested from the Department of Basic Education in order to conduct the study because I wanted to conduct my study in Grade 1 classrooms. For this research it was also imperative for the researcher to consider conformability, which is to represent the data as stated in the data generation tools (Polit & Beck,

2012) and dependability. For dependability in this study the researcher provide original evidence of data generated from the semi-structured interviews, and semi-structured observations. Bitsch (2005) states to ensure the stability in the data, the researcher had return the semi-structured interview transcripts to the research participants in order for them to confirm the validity of the information. Dependability of data is the extent to which same findings could be repeated if the same research instruments were simulated with similar respondents under similar conditions (Creswell, 2003). The credibility in this study was achieved by providing evidence of persistent observation, and by triangulating using different sources, different methods and sometimes multiple sources The triangulation is defined to be "a validity technique where as a researcher merge among multiple and different sources of data in a study" (Creswell & Miller, 2000, p. 126).

4.16 Data analysis

The data analysis was discussed, followed by an exploration of the issues of validity and trustworthiness and how these were addressed before, during and after the generation of the data was generated. The issue of the outline of the ethical issues were significant in this study because this defined how the researcher engaged with the research participants. Data analysis in qualitative studies involve the process of breaking up the data into portions and reunifying the parts again into a coherent whole (Boeije, 2010).

This implies that when data are analysed, the focus should be on relevant information that answers the research questions. Gibbs (2002) describe data analysis as a close or systematic study. Data analysis is therefore a process of making judgment of data in teachers understanding of their practice among others. The definitions of the situation and noticing patterns, themes, categories and regularities that emerged as the transcripts were analysed. The transcribed data from the interviews were analysed and categories that emerged were identified. It was also significant to allow the Mathematics teachers to look into the transcripts in order to confirm what I have written whether it is what they were saying. This was done through the reflective activity as the very first stage of the data generation process. The research participants were each given a list of ten questions that had been derived from the theory used, van der Akker (2009) curricular spider web. This process was

significant because the generated data were then scrutinised with reference to the ten themes from the spider web conceptual framework as a data analysis theory.

The data analysis concerns classifying and ordering information to answer questions. The data obtained were analysed qualitatively using words to describe and interpret participants' responses. The theoretical framework assisted in the analysis of the data. A content analysis plan was used and data were first summarised and then categorised, after which themes were assigned to those categories. This process resulted in the development of general conclusions which related to the research questions (Maree, 2009, Cohen, et al., 2013).

Flick (2006, p. 252) states that documents can be seen as "communicative devices" this allowed me as a researcher to look into the data that was produced whether it was aligned to what was intended. Also how this data responded to the qualities of natural context. The teachers' journals /files were studied which included the teachers lesson plans were. The research looked at the Mathematics teachers' understanding of their practice therefore allowing me also to look into what learners were writing as they were given assessments. Each data generated was analysed using themes, then generated data were then examined with reference to the ten themes from the spider web conceptual framework.

The data that had been obtained from the reflective activity, the semi- structured interviews and the group discussion were transcribed and compared in order to generate meaning. This was done by repeatedly reading and highlighting key words in the transcriptions for accuracy purposes and to pay attention to participants' explanations so that frequent comments and experiences that emerged were filtered. Attention was also given to possible contradictions. The understandings of pedagogic practices were then grouped into different themes which played a vital role in answering the research questions. The issue of the trustworthiness of data is vital when conducting a research investigation, as it addresses the requirements for honesty and transparency in research.

4.17 Possible limitations

Maree (2009) states that the possible limitations that could affect the research should be spelled out as well as their resolutions. The research was done in schools where teachers knew that the researcher was also a teacher and this created a possible concern of being seen as an assessor. The threat of power relations in the interview process, the respondents' alternative views and opinions were constantly sought and the interviewees were treated the same in all respects. To work on the power relations I made sure that I went to the schools before data generation to explain the reason for the research. On the first visit to the schools the researcher was able to explain to the research participants that the study's aim was to understand teachers' pedagogical knowledge and had nothing to do with assessing the teachers.. This information was clarified in the research participants' letters. The other limitation was that this research is a small study therefore the sample size and results of the study cannot be generalised (Cohen, et al., 2011). However the use of multiple data generation tools added trustworthiness to the findings of this study (Maree, 2009).

In this research I also had to develop the research questions and also the classroom observation tools that the teachers did not know about. These had some limitations to the study as I had to explain some of the research semi-structured questions and classroom observation schedules.

4.18 Summary

In this chapter I discussed the choices made for the research methodology in order to collect data for a case study. The reasoning behind these methodological choices was presented. The purposive selection of the research participants and the research sites was an endeavor to enhance the validity and reliability of the findings, in that the participants were selected in such a way that the effects of variables would be minimized as proposed by Levine, Ramsey and Smidt (2001). The researcher also discussed the reasons for selecting the interpretive paradigm as a framework for the study (Guba & Lincoln, 2005). The nature of a case study and the processes of data collection, sampling, and data analysis were discussed. While acknowledging the usefulness of a case study and its applicability in critical realism ontology, the discussion also pointed out some of the challenges of conducting such a study.

As the researcher, I had to be mindful that the study had to enhance the validity and reliability of the findings and this was done through the different types of data collection techniques (i.e., semi-structured interviews with teachers, classroom observations, and documentary analysis). In this chapter I focused on the research approach and design of the study. The research paradigm and data generation techniques and most importantly the rationale behind the methodological selections were clarified. It was also important to enlighten the readers about the sampling procedures that were followed in this study. The next chapter discusses how the data were analysed in order to address the critical question: **What are the teachers' understanding of the pedagogic practices they choose and what impact does this understanding have on the learners' acquisition of mathematical concepts**? This chapter will also address the sub-questions regarding the pedagogic theories and disciplinary conceptualisations teachers drew upon to teach mathematical concepts in Grade 1. In Chapter Five the generated data is analysed and interpreted and the findings are discussed.

CHAPTER FIVE

DATA PRESENTATION AND DISCUSSION ON PEDAGOGIC PRACTICES AND DISCIPLINARY CONCEPTUALISATION THAT MATHEMATICS TEACHERS DRAW UPON

5.0 Introduction

The previous chapter considered the research approach and the research paradigm that underpinned this study. The research tools used to generate the date were described, namely semi-structured interviews, classroom observations, and document analysis. Data generation was done at two sites, Mthandeni and Bathandenibonke Primary Schools. For ethical reasons, the schools are identified in this study report by pseudonyms. In all normal functioning schools, there are sets of school documents that can be accessed to procure information; hence I requested and was granted permission to look into the teachers' practices with reference to a number of relevant documents. The discussion of the data presented in this chapter was generated in response to the following research question: **What pedagogic theories and disciplinary conceptualisation(s) do the teachers in Grade 1 draw upon to teach Mathematical concepts?** To generate data in relation to this research question, Shulman's (1987) key concepts in pedagogic content knowledge were incorporated.

5.1 Understanding of the knowledge of the educational context by Mathematics teachers

Pertinent questions were asked during the semi-structured interviews to determine which pedagogic theories and disciplinary conceptualisation(s) the teachers in Grade 1 drew upon when teaching Mathematics in Grade 1. For authenticity purposes, the respondents' answers are offered verbatim in this study report, and their responses are thus unedited.

Mtha-Anelia, research participant No. 1, stated:

> I use strategies like play, discovery and games activities as they are very important when learners are learning and also they allow learners to enjoy whilst learning in a relaxed way and when they are playing they share knowledge and ideas freely during play.

Batha-Phumeza, research participant No. 4, response was:

> The playing of games and singing of songs allow the learners to learn in their own way whilst focusing on learning and make learning fun, which is allowed in the lower grades.

It was clear that Mtha-Anelia, research participant No. 1 and Batha-Phumeza, research participant No. 4 were in favour of the constructivist theory, mainly focusing on the social constructivism as they stated that their understanding of the knowledge of the educational context refers to learners being taught using a play oriented approaches. Social constructivism allow learners to learn in their social spaces whilst being taught. Learning take place where learners are engaging in social activities (Christie, 2005). The teachers' understanding of their practice is focused on the community understanding which is termed the competence or horizontal curriculum (Bernstein, 1999). Play, discovery and games activities occur when the learners are learning whilst the teachers incorporates play teaching strategy to interact with the appropriate of teaching strategies for young learners in the Primary school.

These two responses were from teachers who taught in different contexts but the responses gave the impression that the teachers were aware that learners learn as they play. According to Hmelo-Silver (2004) it is how the teacher facilitates learning that allows learners to construct their knowledge in an enjoyable and fun way. The responses suggest that the teachers in both contexts understood that learners learn as they involve themselves in games and the singing of songs. This finding supports The NAEYC (2002) and NCTM (2002) which state that when learners are exposed to different approaches of teaching when they are taught to acquire mathematical skills, they understand the content and concepts better as these are simplified by the resources used by teachers.

Batha-Phumeza, research participant No. 4. She had furthered her studies in the hope that this would contribute to her teaching skills. In her interview she stated the following:

> Learners in Grade 1 are young and many of these learners did not attend pre-school; as a result they need all the visual aids and innovations they can use to learn. Also, for us teachers we need teaching resources. It's hard to start teaching them at this stage and expect great results.

Learners in Grade 1 have difficulty learning in spaces where there is no support for their growth and development. Learners who are assisted with resources as they learn tend to do well in terms of understanding concepts. It is surprising that there are still such challenges in the rural areas in Mathematics teaching after the intervention of the "No Child Left Behind" act (NCLB) (DoBE, 2002) that mainly focuses on teacher development in Mathematics. The National Council for Accreditation of Teacher Education (NCATE) (1990) proposed rigorous, in-depth professional development designed programmes to assist Mathematics teachers in rural areas. However, the HSRC (2005) confirms that the teaching and learning resources issue in rural areas is still not being attended to and this creates a disconnect between what happens in some rural/township and urban schools. It is disturbing that many schools in the rural context are still struggling in terms of development after twenty years of democracy, which is confirmed by Gardiner (2008a, p. 13) who argues that many schools in rural communities are still difficult to reach and that "the physical situations in these schools are dilapidated". Another factor is that the resources for teaching and learning are unsatisfactory in many rural schools. There are teachers who rarely receive support in their teaching and learning.

Recent literature on rural education has also been proactive about redressing educational issues in rural areas for global changes, such as International Research and Training Centre for Rural Education INRULED (2001). Therefore, learner performance especially in Mathematics in rural schools compared to schools elsewhere (urban schools) is not progressing at all. This was evident in the school in the rural area where I did my research. Referring to the issue of insufficient resources, **Batha-Phumeza, research participant No. 4,** explained that teaching and learning in the rural areas were still big challenges. This confirmed Setati and Adler's (2000) argument that teaching and learning in rural areas are inadequate which affects them achieving their goals.

The four research participants from both urban and rural contexts were not able to display the sub-topic of knowing their pedagogical knowledge. This was confirmed by research participant No. 4 Batha-Phumeza when she said:

> My practice is always encouraging learners to work in groups, think around the things they do in their everyday life because that is where even the slower learners will learn from the faster one, I want the learners to learn from each other.

The research focused on Grade 1 and learners at this stage depend on the teacher to see and understand the value of education. This does not only refer to Mathematics but to how significant education is in the lives of learners. According to Shulman (1987), the concept of understanding pedagogical knowledge is referred to as "the practicalities of information" and it is related to the value of education. There is variety of understanding that is vital for the effective teaching of Mathematics. Teachers of Mathematics may show effective skills in the content and pedagogical knowledge of Mathematics, but they need to realize the value of being able to transfer that knowledge to the learners.

The following response was surprising, but it was what a teacher experienced in a rural context:

> Learners in Grade 1 are sometimes not ready to deal with what is required in the curriculum; as a result, you as a teacher are forced to lower the standards and in this case it becomes Grade R work.

This response does not imply that teachers in the rural areas do not understand their pedagogical practice, but it relates to the support needed for these teachers to perform optimally. The understanding here refers the argument back to what Shulman (1987) refers to as the educational context and the roles teachers play in their practice. In this context, **Batha-Phumeza, research participant No. 4,** demonstrated that she understood the nature of her pedagogical practice and responsibilities as she taught learners who had not been afforded the opportunity to learn Grade R Mathematics.

Mtha-Anelia, research participant No. 1, had also taught in a rural area before moving to an urban area. When asked about teaching in a rural context, she responded as follows:

> I have taught in both rural and urban contexts. Rural areas are still struggling in terms of developmental workshops; as a result, teachers struggle with a lot of things, especially resources, in [such] a way that the teaching skills are compromised. But I have belief in the teacher-centred approach, as I understand teachers' need to teach".

Mtha-Zumile, research participant No. 2, responded as follows to the same question:

> It matters most where my school's context is learners need to be taught in ways that suit them. Some learners learn easily by visualising, some gain more knowledge by playing whilst learning, so I structure my teaching according to that, especially Mathematics as a challenging Learning Area. Sometimes I feel I need to play with them [to help them] understand the concepts. Well … that allows me to take advantages as they play to ask them questions about what they are playing so that they unconsciously learn mathematical concepts.

These responses clearly showed that these teachers understood the educational context of their learners and the expectations thereof. Mukeredzi (2009) argues that teachers in rural schools want to deliver quality education, but that they are limited by inadequate resources, particularly those which relate to the learners' context; as a result, effective teaching is compromised. This is confirmed by Shulman (1987) who states that, in order to choose appropriate Mathematics teaching strategies, teachers need to understand the context of the learners they teach and that learning should be enjoyable for the learners. Furthermore, teaching should include different types of knowledge that epitomize teachers' accumulated understanding of their pedagogic practices in terms of content knowledge, learners, and the curriculum (Shulman, 1987). Ball (2000) asserts that both mathematical knowledge and pedagogical knowledge for Mathematics teachers seem to be intertwined in as much as the curriculum and assessment are significant; but that alone cannot improve learner competence.

Mtha-Anelia, research participant No. 1 and **Mtha-Zumile, research participant No. 2** were aware of Vygotsky's (1978) social theory that refers to how learners learn and that claims that social activities are the basis for complex cognitive processes. In this context, the teaching and learning

strategies that these teachers claimed they had would play a significant role in the classroom because they showed that they had an understanding of the learners they taught.

Teachers with more than ten years' experience seemed to know what was expected of them when teaching Grade 1 learners. These research participants showed knowledge on how learners in Grade 1 were taught that is why I felt they had an understanding of what they were doing in the classrooms. The concepts of number operations in Mathematics refers to teachers teaching data handling as a topic. This is the reason why I specified that the teachers will more experience in the Foundation phase were able to explain concerns to learners for understanding.

The examples that they used were unfamiliar with the leaners' context. However, it became clear that such experience did not assist them in the rural context. **Mtha-Anelia, research participant No. 1,** stated the following regarding the lessons she felt compelled to design for her Grade 1 learners in a rural context:

> Mmm … rigid lessons, dominated by what I have to say to the learners for them to know, concentrating mainly on memorizing numbers. It was a one-way teaching approach. I was not integrating the related topics as there were no resources.

In some instances Mtha-Anelia, research participant No. 1 as an experience teacher and also with 29 years of experience seems to understand the different teaching approaches for the unique learners in Grade 1 yet she appears to be struggling at some point. This is said because of the response given when she felt the rigid lessons and sometimes her lessons would be dominated by what she wanted to achieve. There was no room for creativity in this classroom. Self-understanding of the curriculum involves the profound and vital understanding of mathematics thinking which is connected to how the teacher uses her skills to construct the knowledge in order for learners to interact with it (Sadovnik, 1991). Qualifications in the teaching profession seemed to be ineffective in assisting Mtha-Anelia research participant No. 1 in any way, because the conditions in the rural school where she taught mitigated against sound teaching and learning practices.

There is a perception that the Department of Basic Education is not providing resources for all the schools at the same time. This oversight challenges teachers, particularly in rural schools where, in my own experiences and based on personal observations, the situation is often dire. Mathematical knowledge for teaching is observed as teachers develop with their learners in understanding Mathematics (Powell, 2006). When learners' performance is very poor, this may be due to a number of reasons, as claimed by the National Education Infrastructure Management Systems (2009) report and the National Assessment Report published by the Department of Education in 2007. One reason given for the underachievement in many rural schools is that they still lack the required infrastructure. As far back as 1990, Bernstein (1990) remarked that the learners of the underprivileged were being doubly disadvantaged by the current structure of the educational edifice that supported mostly the elite. Sadly, this situation has not improved much in rural schools, as demonstrated by various studies in recent years (Morrow, 2007; Balfour, et al., 2008).

Responding to a question about her views of teaching Mathematics in a rural school and how this impacted on her teaching of Mathematics in Grade 1, **Batha-Phumeza, research participant No. 4,** responded as follows:

> As a teacher in a rural area, everything happened to be a struggle. Resources! As a result, I will only convey what I know. [There was a lack of] developmental workshops and developmental support, and this impacted badly on my teaching of Mathematics.

Balfour, et al. (2008) argue that the lack of resources in the rural schools challenges teachers in terms of performing their duties. Shalem and Slonimsky (2010) and Darling-Hammond (2000) assert that teachers have to be well versed in the content they are teaching. Hoadley (2012) argues that teaching and learning in South African primary schools has been dominated by the teacher-centered approach, and that teachers have adopted an authoritarian approach because of the inactivity of learners. Alienating learners from participation results in an increasing number of drop-outs. As far as Batha-Phumeza was concerned, teachers in rural areas had to work ten times harder to catch up with the teachers in urban schools. She argued that learner development in the rural areas was difficult due to the unavailability of teaching and learning resources.

During our conversations she said that there had been a need for her to improve her qualifications as she felt that this would make her a better teacher. In terms of teaching and learning, she was therefore aware of what was required to teach effectively, but the issue of inadequate resources seemed to be holding her back. Gardiner (2008b) argues that it is the lack of qualified teachers that tends to slow down the education in rural areas, but this study revealed that a teacher who was more than adequately qualified was being let down by systemic problems such as insufficient resources, which had a negative effect on her teaching of Mathematics.

5.2 Understanding of curriculum knowledge by Mathematics teachers

Mtha-Zumile, research participant No. 2, stated**:**

> I was very selective with the content I would teach before I started with Mathematics workshops. Learners listened to what I knew and would memorize the sums throughout the year, then they were tested at the end of the year through examinations.

The curriculum is supposed to be about what is to be taught and why it should be taught to learners. Furthermore, Turner-Bisset (2001, p. 14), alluding to Shulman (1987), refers to the curriculum as "… the tools of the trade for teachers". Knowledge of the curriculum is a key element that Shulman (1987) describes as a requirement for Mathematics teachers. This means that they need to know and understand the subject content and the topics and programmes as stipulated in the curriculum of the subject they teach. Kennedy (1997, p. 6) focuses on teachers' conceptual understanding of Mathematics and argues that the main aim of teaching Mathematics is to instill a deeper understanding of the central idea and issues in various subjects in learners and to enable learners to see how these ideas connect to, and can be applied in the real world. It therefore makes sense to require that teachers themselves also understand the central concepts of their subjects and recognise these relationships.

The issue of singing or recite counting using songs and rhymes allowed learners to memorise the sums and this showed the lack of curriculum knowledge on the side of the teachers. This lack of knowledge is essential in content and subject as it affect the teachers' teaching of mathematics and it deprives learners of an opportunity to be exposed to explicit mathematics that will lay a solid foundation for the Learning Area in the following grades (NAEYC & NCTM, 2002). Also Shulman (1987) suggests that the teacher knowledge needed for effective teaching are subject matter knowledge, pedagogical content knowledge, and general pedagogical knowledge. The memorisation of sums does not meet these criteria.

The response by **Mtha-Anelia, research participant No. 1,** was very powerful in terms of how she related to teaching Mathematics:

> Understanding my practice means the approach I use and how I deal with learners' problems to teach Mathematics to the Grade 1 and that it is based on my understanding of the learners and how they receive the content taught. This has been my philosophy.

As teachers are exposed to new challenges in teaching Mathematics, they also engage their learners in tasks that allow them to understand mathematical perspectives and content (Powell, 2006). Simon (1995) argues exactly what Mtha-Anelia refers to, namely that the constructivist theory cannot teach teachers the approach to use when teaching Mathematics, but that teachers have to understand the learners they teach in order for them to know which practice to employ and to apply such practice. Simon further refers to constructivism as a way of knowledge development; not as some kind of pedagogy, but as how learners would learn being assisted by teachers. Learners in Grade 1 are dependent on what the teacher does and says, and this is the reason that teachers of learners in this grade should be able to impart important skills to them. The pedagogical knowledge of the teacher in Grade 1 is significant as the content knowledge will be what the teacher will arm him/herself with to make an impact in the teaching of Mathematics. According to the central idea of constructivist theory, mathematical knowledge cannot be transferred ready-made from person to person, but is reconstructed by each individual learner (Von Glasersfeld, 1990).

In response to a question pertaining to the first research question, **Batha-Phumeza, research participant No. 4,** stated:

> I use different approaches because learners are different; as a result, they learn differently. Some learn through touching, others by just looking and listening, but most of my learners learn best when they use their bodies since they are young. I have also noticed that some learners differ from their peers due to poverty at their homes, so they need special attention because the resources are unfamiliar to them.

The above response revealed that a teacher in an urban school experienced different challenges to those experienced by teachers in the rural areas. In this context, **Mtha-Zumile, research participant No. 2,** responded about teaching in an urban school as follows:

> I acquired a vast knowledge during the workshops that were organised by the Department of Education, but as I mentioned, these learners are too young to think for themselves. When I started teaching in Grade 1 that allowed me to see modern ways of teaching and that is now the order of the day in my classroom.

This response was different from that of the teachers who taught in the rural schools. It was clear that the urban teachers were not left to fend for themselves, as was the case in the rural areas. It appeared that teaching and learning in the urban schools were significantly supported by the Department of Basic Education compared with the rural areas.

Mtha-Zumile also made the following comment:

> After workshops that had been organised by the Mathematics committee, my teaching had to involve learners more, whereas before I had taught in a very rigid way, where I was the only person with the chalk in the classroom. In fact, [before], as a Mathematics teacher, I couldn't escape the teacher-centered approach.

Moving away from a teacher-centered approach seemed to be working for this teacher who had been 'workshopped' on approaches that are successful in the Mathematics classroom. The National Council of Teachers of Mathematics (NCTM) (1991), as a body of Mathematics teachers of all grades, has provided teachers with constructivist approaches on how to teach Mathematics, and the learner-centered approach became one approach that was recommended (Brown, 2003).

It is the learner-centered approach that provides Mathematics teachers with useful ways to understand learning and learners. Wood, et al. (1995) argue that it is the responsibility of teachers to construct a practice that works for the learners they teach. Also, such an approach is centralised in the curriculum that applies to South African schools. It is an approach that is popular also with constructivist theorists. "Let learners work in groups to communicate as they solve mathematical problems" is one suggestion by Collins, Brown and Holum, (1991). Such an approach assists teachers in urban areas to teach Mathematics successfully in Grade 1. This was confirmed by **Mtha-Anelia, research participant No. 1,** who also supported this approach:

> The teacher-centred approach was what I thought worked for learners, but now all approaches in teaching Mathematics are important. But since learners are unique in each classroom, they also grasp information in different ways: some visualize, or work hands-on, and some memorize information.

The National Curriculum Statement (2011) acknowledges that learners understand the content taught in each subject in different ways. This implies that teachers should employ different teaching approaches that will cater for all their learners. The teacher-centered approach does not allow learners to learn in different ways and the teacher is not aware of the shortcomings associated with them being the only supplier of knowledge. The NCTM (1991) allows teachers to use the constructivist theory in order to let learners be the drivers of knowledge in the classroom. When learners are allowed to think, they develop their own learning and creative thinking and that is what enables them to learn.

Here, the teacher encourages the learners to discuss their creations and this allows learners to learn in their own space where they will show their understanding and use of mathematical ideas in different situations other than in the classroom. Carpenter and Lehrer (1999) believe that learners have to construct their own thinking when taught Mathematics, as this is the way that encourages them to think critically. Moreover, it is the way that impacts on the strategies that teachers use in the classroom.

In response to a question to determine how effective assessment strategies are, **Mtha-Zumile, research participant No. 2,** commented as follows:

> The approaches I use for teaching have to be coupled with meaningful feedback on assessment. This happens after each and every activity done, when the learners have an assessment to do. As I teach I know that continuous assessment is an integral facet of instruction.

The implications of this response were that, as Mtha-Zumile planned her teaching, she was also able to incorporate different assessment strategies to determine if her learners had understood and mastered the concepts. The Curriculum Assessment Policy Statement (2011) guidelines refer to the need for teachers to assess as they teach. This was also apparent in the lesson plans of **Mtha-Zumile, research participant No. 2,** where she specifically stated the lesson for the day (fractions) and her plan stated that, as the lesson progressed, she would continuously ask questions to make sure whether her learners coped. **Batha-Phumeza, research participant No. 4,** stated the following:

> I understand that learners in my Mathematics classroom are different; as a result they require different stimulations, and using relevant resources allows learners in their unique spaces to develop at their own pace.

When using different types of teaching approaches, the assessment strategies should cater for the exceptional learners in the classroom. Different teachers in different contexts do things differently as they teach different learners. When responding to a question on the effectiveness of her teaching and assessment strategies, **Mtha-Anelia, research participant No. 1,** stated:

> All approaches are important as the learners grasp information in different ways. Some learners learn easily by visualising, some gain more knowledge by being hands-on (practical activities), etc. That is also how assessment should be. It was not useful to most of the learners as they were given only one method, it was very difficult for a learner to showcase his/her outcomes, except when they are being tested, or memorizing numbers.

In this regard, Bernstein (1990, p. 75) argues that "learners who meet the requirements of the sequencing rules will eventually have access to the principles of their own discourse". The reality, however, is that learners from underprivileged communities are destined never to meet these stringent requirements because they are not given access to the language of power. At the most basic level, they do not have access to, say, any form of reading at home in Grade 1, while educational institutions assume that every learner who starts school is able to learn from reading.

Bernstein's (1990; 2000) pedagogic device theory attests to the claim that by focusing on horizontal knowledge, teachers develop new skills and knowledge. This is the importance of a horizontal discourse in Grade 1, namely that learning is facilitated by the utilization of this knowledge given to solve a problem, which is consistent with the learning objective. This theory highlights the importance of social activity in understanding how teachers understand their pedagogical practices to influence their teaching of Mathematics in Grade 1. The teacher is also involved in resolving problems by facilitating learning: whilst learners are working in groups, the teacher continuously asks appropriate leading questions. This is what assists learners to learn. The learners are further required to reflect, discuss and defend the application of their knowledge or skills. Horizontal discourse thus consists of "culturally specialised segments", embedded in a specific context, that are of particular relevance to the acquirer's everyday life (Bernstein, 1990).

Before the teacher can introduce anything new in a lesson, he/she has to find out how much the learners know. This pedagogic device acts as a communication tool that is available for knowledge acquisition and transmission.

Darling-Hammond and Goodwin (1993) argue that it is a requirement that teachers know their content before they can teach any Learning Area. **Phumeza-Batha, research participant No. 4, suggested** that teachers in the rural areas were still not being supported like the teachers in urban areas in terms of their teaching and learning and that, as result, this affected the way they taught, especially in Grade 1. The South African Curriculum Assessment Policy Statement regards the construction of knowledge as being socially rather than individually constructed, and Vygotsky (1978) holds the view that it is, in fact, adults and the wider society that create those experiences that facilitate learning. He argues that abstract knowledge is constrained or guided, or even structured, by the environment where the learning takes place, and in his words "semiotically mediated" (p. 118). In effect, Vygotsky argues that this implies the indispensability of the "more knowledgeable other" (Vygotsky, 1978, p. 18).

Furthermore, the constructivist theory refers to knowledge construction as a process designed in association with the environment and the learner, and that is how development is perceived in learning. In this context, the responses of teachers in the rural area were different from those of the teachers from the urban area. **Mtha-Zumile, research participant No. 2,** responded as follows:

> I have never taken teaching in Grade 1 Mathematics lightly. I used to research more on what and how to teach in Grade 1 as there were no prescriptions in our curriculum. The approach that I use to teach them comes from my understanding of what they can conceptualise; as a result, I knew that I had to register to further my studies for me to understand my teaching.

What Mtha-Anelia was arguing here is that the potential for development in rural schools exists. Turner-Bisset (2001, p. 110) refers to the "tools of the trade for teachers". Bernstein's (1990) pedagogic device theory supports the notion that teachers have to possess content knowledge to be able to teach effectively, which is derived from Shulman (1986, 1987). As she wanted to be relevant in her teaching, **Mtha-Zumile, research participant No. 2** furthered her studies in order to improve her learners' knowledge in Mathematics. Pointe and Marques (2011) state that teachers can promote their professional abilities in teaching Mathematics by promoting the learners' needs, because the teaching experience does not equate to their expertise. Grossman (1990) refers to teachers' knowledge of the curriculum as having an impact on their teaching in Grade 1.

5.3 Teachers' understanding of concepts of the Grade 1 Mathematics

Shulman's question (1986, 1987): "What do teachers know?" was relevant to this study. He states that, as teachers are supposed to be knowledge bearers, they should know the curriculum of the Learning Area that they teach. Furthermore, the Department of Education (2003, p. 2) enlightened teachers on how to construct lesson plans and how they should be used together with concrete resources; that is, the construction of a detailed teaching and learning plan that includes the assessment activities that are to be implemented. Shulman (1987) insists that teachers should know and understand topics and programmes as stipulated in the curriculum and they should also understand the variety of instructional materials available for the programme. The Department of Basic Education has recently put in place attractive workshop developments for teachers, particularly for Mathematics, but teachers seemed to experience problems in accessing these programmes. **Batha-Buyile, research participant No. 3,** stated:

> The curriculum gives us guidelines on how to teach, but the Department of Basic Education takes away what we desperately need: resources to assist us with our teaching. Young learners require more resources [that they can use] to understand the concepts well; they learn by touching, feeling and seeing things.

The South African Curriculum Statement regards the prominence of knowledge as being socially rather than individually constructed. Moreover, Vygotsky (1978) refers to knowledge construction as a process designed in association with the environment and the learner, and that is how development is perceived in learning. Furthermore, the teacher's lesson plans should include the use of activities that are in line with educational theories such as those of Vygotsky, Bruner and constructivism. Such a situation should encourage teachers to plan their lessons for knowledge construction. **Mtha-Anelia, research participant No. 1,** described her Mathematics lesson as follows:

> … An unintegrated, rigid Mathematics lesson where I will do all the activities in the text book, focusing on what I know but not on the learners.

What was evident from this response was that this teacher from a rural area only focused on what mattered to her and not what mattered to the learners. Approaches that do not cater for all the learners in the classroom hinder the acquisition of mathematical skills because the learners fail to adopt certain competencies. When learners are in the process of learning, they seem to engage in a learning process that allows them to engage with the teacher's knowledge together with their own innate mathematical knowledge in a way that enables the learning and teaching space to function in the Mathematics classroom. This study focused on the constructivist theory where learning is much more than a memory exercise and teachers also learn from their teaching. As far back as 1990, Bernstein remarked that it appeared as if learners were disadvantaged by the structure of the curriculum. **Batha-Phumeza, research participant No. 4,** suggested that this shortcoming had not changed at all:

> My understanding was that direct teaching was going to assist the learners to listen because the books I used did not give out the how the activity needed to be done. That means I use my own opinions and learners have to listen.

The rules of "sequencing" and "pacing" (Rose, 2004) of the curriculum remain two fundamental opposites of the culture that seems to dominate teaching and learning. If anything, they are being used as excuses to continue educational injustices against those who come from the submissive classes. Bernstein (1990, p. 75) argues that the learners who can meet the standards and requirements of these sequencing rules will eventually have access to the principles of their own discourse.

What was clearly revealed in this study was that the research participants understood that the lesson plans they formulated needed to be effective. However, they encountered difficulties such as the lack of resources for Mathematics teaching in Grade 1. As effective teaching requires teachers to have subject matter knowledge, **Batha-Phumeza, research participant No. 4,** responded as follows on the effective lesson planning for Mathematics:

> The telling method using the chalkboard, demonstrations, examples and recitation methods … the learners … as they were given only one method, it was very difficult for the learners to showcase their skills, except when they were being tested, or [when] memorizing numbers.

This comment implies that the reality is that learners from underprivileged communities, particularly those from rural areas, are destined never to meet these stringent requirements because they are not given access to the language of power. At the most basic level, they do not have access to, for example, any form of learning at home in Grade 1, while educational institutions assume that every learner who starts school is able to learn Mathematics. No real effort is made to 'bring on board' these learners and to bridge the gap that this type of learner brings to school. Vygotsky's theory of social learning seems to offer a persuasive way out of this dilemma. Also, Ball, et al. (2008, p. 399) describe teachers' knowledge as "the mathematical knowledge and skill used in settings other than teaching", which appears to be lacking when teachers plan their lessons for effective teaching. Shulman (1987) insists that Mathematics teachers should be knowledgeable in order to be competent in the subjects they teach. This requires them to go beyond the knowledge of facts or concepts of a main content area and to also understand the structures of the Learning Area and how those structures need to be taught.

Balasubramanian (2006) focuses on the teacher's role in teaching mathematics, and it is clear that it is the responsibility of the teacher to ensure the learners achieve understanding in Mathematics. Her arguments are based on teachers' challenges in teaching Mathematics, but she excludes teachers' skills and competencies in terms of content knowledge. The findings of this study were relevant to what Baker and Chick (2006) refer to as challenges with content knowledge and the pedagogical knowledge that teachers of Mathematics should able to teach, which occurs especially in primary schools. According to the latter researchers, both content knowledge and pedagogical knowledge are significant for teaching a Learning Area. **Batha Phumeza** commented on not being fully prepared to teach Mathematics in Grade 1 when she stated:

> I learnt this the hard way, when I thought learners will listen to what I have to say and do as I say without designing different strategies for their uniqueness. It's important to think of a strategy because learners learn differently; as a result, I think deeply about the strategies that work.

Shalem and Slonimsky (2010) and Darling-Hammond (2000) concur that teaching and learning is a socialisation profession. There are broad concepts between what the teacher believes and what the teacher thinks. Before the teaching and learning processes commence, teachers decide on different issues based on the theory, only then should they embark on the approach to be used. These two aspects influence what the teacher does during teaching and learning activities. The teacher makes decisions at the time of preparation, which requires an understanding of what the learners are supposed to know. There is also a requirement for closing the gap between theory and practice, because often teachers understand the theory but lack the knowledge of the required practice in some topics/content. The gap between theory and practice leads teachers to be driven by the practice when choosing the content/topic to teach. These researchers refer to teaching and learning of Mathematics as culturally orientated because of the unchanging traditions which have been in place for many years. For Mathematics teaching, these traditions could be used to fabricate ideas, beliefs and skills that teachers could use to teach in a way that will achieve optimal results.

Although Bernstein's pedagogic discourse theory supports the hierarchical order of a class-based society, this study revealed that teachers used the curriculum as their foundation for teaching and learning. When they were faced with the situation where theory did not serve their purpose of teaching, they reverted directly to the curriculum, which is where their knowledge and skills came into play. Three of the research participants mentioned that they selected a methodology that worked for them in class. When that happened, their understanding of the concepts was lost because they also looked at how they could teach without leaving the learners behind. This is where the learners' learning pace came into play. Bernstein (1996, 1999) differentiation between "horizontal discourse" and "vertical discourse" specifies that horizontal discourse may be compared to everyday or "common-sense" knowledge that can be acquired orally and is localised, context-specific and context-dependent. So horizontal discourse is like a conversation where the knowledge is segmented and related not by integration of the meanings, but by some functional relations of segments to everyday life (Bernstein, 1999, p. 160). This s becomes significant in teaching where the teacher has divided the learners into groups (i.e., peer teaching).

The importance of a horizontal discourse in Grade 1 is that learning is facilitated by the utilization of the knowledge given to solve the problem, which is consistent with the learning objective. The teacher is also involved in resolving problems by facilitating learning while asking appropriate leading questions while learners are working in groups or pairs. This assists learners to learn as they are required to reflect, discuss and defend the application of his or her knowledge or skills. Teachers must use the appropriate teaching strategies to enable learners to achieve satisfactory results (Anderson & Helms, 2001; Mendro, 1998; Powell & Anderson & Helms 2001,Strong & Tucker, 2000). It is also necessary to equip teachers with the latest information to improve their practice.

The same sentiments are shared by Grossman (1989) and Ball, Hill & Bass (2005) who argue that that the quality of teaching depends entirely on the teachers' knowledge of the content. Grossman (1989) particularly states that teachers combine different types of knowledge(s) to teach, and they look at the knowledge of the Learning Area, the content knowledge, and the understanding and potential of teachers to devise appropriate instructional strategies. Windschitl (2002) considered teachers' constructivist ways of teaching and found that it was difficult for teachers to subscribe to this theory. The significance of this research was the understanding of teachers' pedagogical knowledge in teaching Mathematical concepts. Teachers found it difficult to allow learners to learn from each other hence they were very quick to employ teacher-centered approaches. Although t learners were given group work and worked on their own, the teachers seemed to be very concerned and wanted to help even if learners made small mistakes that they could learn from and rectify. Research participant No. 2 Mtha-Zumile and research participant No. 3 Batha-Buyile's responses indicated that they were familiar with their practice though their learners were memorising the sums more than understanding what was required in order to be able to do some of the sums.

Powell and Anderson (2008) suggest that there is a divide in teachers' thinking compared to their practice, a notion guided by the theories and beliefs that teachers use to teach. Teachers tend to resort to teacher-centred methodologies although learners also have knowledge that they want to share with the teachers. That is where constructivist theories come into play, as this allows teachers to evaluate learners' knowledge of, for example, the Mathematics content, hence allowing teachers to also conceptualise their knowledge on all their practices.

Schon (1983p. 28) describes this as "the reflection in action" as teachers rarely attend conferences where they share knowledge. In Mathematics there have been platforms for teacher collaboration such as AMESA, but this has been implemented for teachers to share common challenges and different practices in different phases so that they can assist one another. This initiative resulted from the learners' difficulties with Mathematics. The expectations of teachers are that they must come to the classroom with the required knowledge to teach. This was stated by research participant No. 3 Batha-Buyile when she was asked about her pedagogical knowledge for teaching Mathematics in Grade 1.

> I started teaching Grade 1 before I could finish my PGCE as a result I found teaching in this phase very challenging. There is much of problem solving that is needed in Mathematics as a result I decided to further my studies. By so doing I learnt to teach using different approaches and understood what the curriculum was about.

5.4 Teachers understanding of content knowledge

Ball, et al. (2005) are in agreement with Shulman (1978) that Mathematics teachers should have subject knowledge that goes beyond the knowledge of simply teaching Mathematics. Whilst teachers are in a position of engaging with learners in terms of their understanding of mathematical concepts, they also have to communicate their skills to build new mathematical knowledge for learners. It was evident that **Mtha-Anelia, research participant No. 1,** had attended a workshop where her confidence in teaching Mathematics was boosted. She mentioned the following:

> After the workshops that I attended I have made sure thereafter that the lessons are interactive, learners have activities to do, and I have acquired vast knowledge on the Mathematics for Grade 1.

This comment revealed that an in-service initiative provided by the Department of Basic Education assisted in elevating Mtha-Anelia's confidence in her teaching of Mathematics. Bernstein's (1990, 1996) theory of pedagogic discourse reveals that power and control relations are manifest in the manner that pedagogies are configured. Bernstein (1999, p. 159) explains that the dominant function of pedagogic discourse is not so much transmission of skills and knowledge, which is what we generally assume as teaching and learning, but rather that it is a system of "order, relations and identity". Teaching and learning should be about learners acquiring knowledge and attention has to be given to the value of special pedagogic content knowledge and knowledge of general pedagogy that a teacher needs to teach such a specific Learning Area as Mathematics. That the Department of Basic Education takes the initiative in this regard by organising effective and informative workshops for Mathematics teachers is a step in the right direction; however, such training initiatives should clearly be extended to rural areas as well.

Shulman (1987), Darling-Hammond (2000), Ball, et al. (2008) and Milner (2003) all agree that teachers teach differently in different contexts and that learners behave differently in different contexts. Hill, et al. (2005) state that teachers' preparation to teach Grade 1 learners is significant if they want to achieve better results in Mathematics. Teachers' competencies at different levels play a crucial role in teaching learners in Grade 1. In this regard, the two research participants from the urban schools had different views and knowledge on how a Mathematics lesson should be presented in the classroom. Their comments not only referred to the use of resources, but also to how the teachers should interact with the learners. Also, the use of interactive whiteboards by the teachers influenced how the learners were learning. This presented the view that teachers in rural areas taught differently from those in urban areas. **Mtha-Zumile, research participant No. 2,** commented as follows:

> The kind of a Mathematics lesson I normally do is the one where I first think about the learners I am teaching and know exactly what their needs are, then design the lesson according to their needs and where I make sure that the activities are suitable for learners for them to enjoy the lesson.

There are many implications inherent in this response. **Mtha-Zumile** seemed conscious of how the learners in her classroom needed to learn. She used this knowledge before starting her lesson. She thus interacted with the context of her learners by placing herself in the right mind and understanding the content she had to teach. She made sure that all the learners were 'with her'. She was crucially aware of the fact that the learners came from different contexts. **Mtha-Anelia, research participant No. 1,** presented the following argument:

> I make sure of the teaching approach which should be suitable for the learners where they will acquire knowledge. The changing curriculum allows me to focus more on how learners will understand the concepts I am teaching.

These two urban school teachers concurred with Vygotsky's (1978) theory that a lesson should be designed in such a manner that it differentiates between tasks that are relevant to learners' contexts, which is a process aimed at maximizing each learner's developmental potential.

The emphasis here is on differentiated instruction and learning, which deviates from the more 'traditional' or 'progressive' pedagogies. This has been referred to in academic circles as the "scaffolding" approach (Bliss, Askew & Macra,1996). Its purpose is always guided by support learning in order to bolster the developmental capacity of learners. The reality is that social interaction, particularly among very young learners, plays a key role in their cognitive growth and remains unquestioned in scholarly research.

Two primary concepts, namely the 'More knowledgeable other' and the 'Zone of proximal development', are central to Vygotsky's theory. These concepts are presented in Figure 4.1 below:

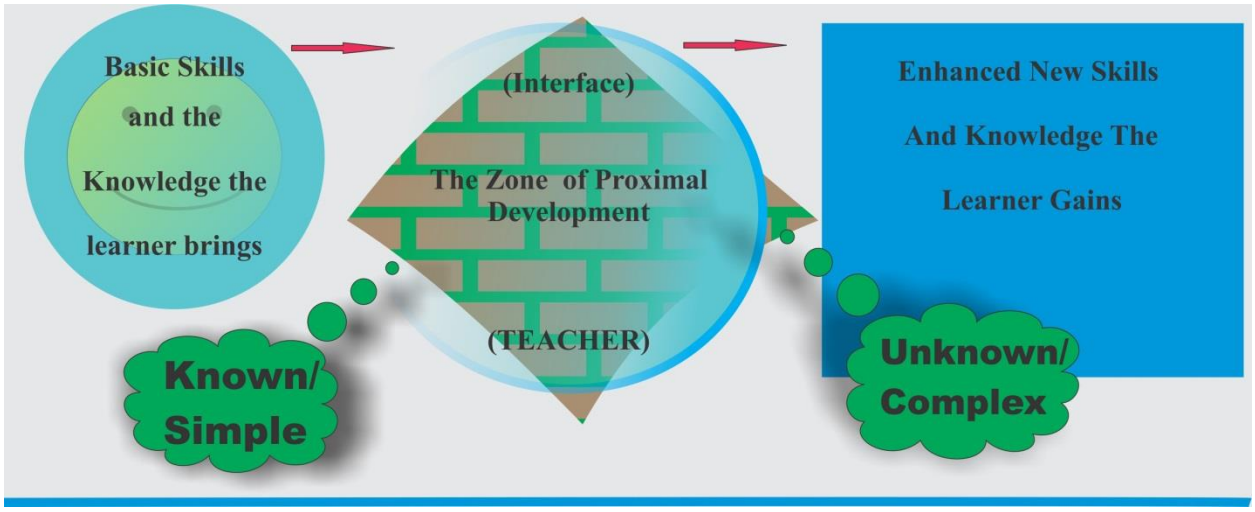


Figure 4.1: Combined More knowledgeable other and Zone of proximal development diagram. Source: Vygotsky (1978).

Figure 4.1 presents a diagram that demonstrates how a learner brings basic (or prior) knowledge to the learning environment where it is enriched by the teacher in the Zone of proximal development. Chamber (2008) suggests that activities that involves partnership between the teacher and the learner are encouraged in Mathematics where the learner brings the simple understanding of concerts. Cengiz,

Kline and Grant (2011) state that Mathematics tasks emphasise high level cognitive processes which is memorising and recalling facts and procedures than reasoning about and connecting ideas or solving complex problems that require learners to think with the assistance of the teachers understanding of mathematics ideas rarely asking for explanations using physical modes or calling for connection to real world situation (Silver et al., 2009). From here prior knowledge or the basic skills that learners have are enhanced and understood through scaffolding by the teacher in order to move to newly gained knowledge. Therefore teachers allowing the use of their teaching knowledge and understanding of the curriculum which involves written questionnaires interviews and draw exercises to get indications of what is going on in the mind of the learner (Radford, 2008).

The teachers' understanding of the curriculum brings in the facts about Mathematics that allows how teaching and learning within the community affects and shape the content. This implies that learners come to school with a basic knowledge of different mathematical concepts and the teacher has the responsibility to explain this basic knowledge to the learners so that they understand what is being taught. Vygotsky defines the Zone of proximal development as a 'space' where the learner and the teacher meet each other halfway. The learner brings to the 'zone' what he or she is able to do independently as well as what he or she has learned, and the teacher brings, inter alia, support by means of content and pedagogical knowledge, so that what the learner is able to do beyond the 'zone' is supplemented and 'boosted' by the support and knowledge of the teacher.

The lessons teachers teach are affected by the different theories they choose; when teachers are deciding on the lesson, they aspire to what Bernstein (1999) refers to as different knowledges. The teaching should never be about what works but it should be about what learners understand as part of the curriculum. The response by research participant No. 4 Batha-Phumeza was that she understood the content which was problem solving but it became tricky when she stated that she would use what works:

> I will definitely have activities with a lot of problem-solving. I am mostly driven by the content to choose the practice and I try different types before I get what works.

This is significant in classrooms where the teacher realises that learners are different and have to be taught differently. Baker and Chick's (2006) study used questionnaires as a data generation method and found that the teachers' pedagogical content knowledge differed from teacher to teacher. This was due to the different activities teachers employed in the classroom when they concentrated on the different abilities and contexts of their learners. Teaching and learning in Grade 1 require teachers to instill the following Mathematical skills in the learners: the development of computation skills; problem solving; the ability to think rationally; reasoning skills; critical thinking skills; and the ability to justify and prove (Goodell, 2006, p. 201). Blumberg (2008) recommends the learner-centered approach as he states that it is vital for the teacher to disengage from learning activities so that learners, even those as young as in Grade 1, can take responsibility for their learning. The teacher's knowledge of the curriculum was also tested as one of the research participants No .4 Batha-Phumeza stated that her practice of the curriculum was informed by what she wanted to achieve at the end of the lesson.

> The pedagogical practice choice is based on what I want to achieve at the end of the lesson that I am teaching. It also depends on the subject being taught, so it means if I want to achieve problem solving skills.

In terms of knowledge about the curriculum, teachers need to demonstrate knowledge of content and learners (KCS) because they need to understand learners' behaviour, their thinking abilities, and interests, and they need to interpret their incomplete thinking (Ball, et al., 2008). The research showed that this kind of knowledge was a challenge for teachers, especially when it came to understanding the learners they were working with. The observations that took place with research participant No. 4 Batha-Phumeza showed that she was had problems dealing with the knowledge of the learners. She could have let the learners learn in their own way rather than limiting learners and blaming it on overcrowding. As a result, this led to teachers thinking and answering questions for learners in the classroom as they really could not understand their behaviour and interests.

5.5 Understanding of pedagogical knowledge

Shulman (1987) states that it is clear that teachers need to embrace both theory learned during teacher preparation as well as experiences gained from their professional activities, as content knowledge is deeply embedded in a teacher's experiences. This implies that development of pedagogical content knowledge is influenced by factors relating to teachers' personal backgrounds and the context in which they work. Teachers' knowledge that will contribute to their ability to select and sequence appropriate activities will take learners further in their mathematical exploration (Hill, 2010).

In this context **Mtha-Zumile, research participant No. 2,** focused on general pedagogical knowledge when she made it clear that she had confidence in her Mathematics teaching. She stated:

> What I learnt when teaching Mathematics is that learners have to be part of what I teach by doing examples and that is how they learn. I then promote learner-centeredness in my classroom.

Using a learner-centered approach is what **Mtha-Zumile** argued helped her to master her teaching of Mathematics. She mentioned that the workshops she had attended had taught her how to manage teaching in Grade 1. Also, the fact that she had furthered her studies assisted her in teaching Mathematics. This corroborates Bernstein's (1990, p. 211) argument that teaching is supposed to be practically implemented and learners are supposed to be observed so that they can create their own knowledge. For teachers to understand how they teach, they also have to understand the knowledge and skills of the Learning Area they are teaching. The pedagogical discourse refers to the instructional discourse as always being embedded within the regulative discourse, which means that the hierarchical relationships between the acquirer (learners) and the transmitter (teachers) regulate the selection, sequencing, pacing and evaluation criteria of knowledge. This was problematic for the teachers in the rural area, as **Batha-Buyile research participant No. 3** commented:

> My practice was related to what the topic for the day was about. I would only select topics that suited my understanding since there was no clarity on how to teach the whole Mathematics program, especially for the young learners.

Batha-Buyile research participant No. 3 showed that self-understanding of the teacher's approach played a significant role in her practice. This refers to how this particular teacher was taught and it had nothing to do with the learners. Khoza (2015) argues that this kind of knowledge is what is unique to the individual and it is as a result of the experiences of the teacher.

As pedagogy consists of a social relation between the transmitter and acquirer, where the rules of evaluation always lie with the transmitter, it appeared that the teaching of Mathematics in these schools did not form part of a social relationship. In this sense the social relation of pedagogy is always asymmetrical; thus the relations between the transmitter and acquirer are always unequal (Bernstein, 1996). Vygotsky's (1978) theory takes a social constructivist approach and stresses the pivotal role of social relations in the process of learning. He believes in the centrality of community in the 'meaning-making' process and that culture is a prime determinant of individual learning. As far as Bernstein is concerned, social activities are the basis for complex cognitive processes.

The findings that are presented in Darling-Hammond's (2000) article reveal that very little is done for teacher efficiency and for preparing them for the professional world. In the South African context, researchers like Anderson, Case and Lam (2001) found that there is an adequate number of primary school trained teachers, though they found that the numbers did not represent the learners who were doing well in Mathematics; hence the many shortages in the field of Mathematics in the country. General pedagogic knowledge is vital if mathematical content is to be converted for learner communication and learning. Teachers' understanding of how they are expected to teach Mathematics, and what they are expected to teach in Grade 1, will have an effect on how these learners learn and understand Mathematics.

In some instances Mtha-Anelia, research participant No. 1 as an experience teacher and also with 29 years of experience would seem to be understanding the different teaching approaches required to cater for unique learners in Grade 1. This is said because of the response given when she felt the rigid lessons and sometimes her lessons would be dominated by what she wanted to achieve. There was no room for creativity in this classroom at some point.

This problem is not peculiar to South Africa, as there are similar concerns in other countries like Lesotho (Setoromo, 2014), Nigeria (Tella, 2007) and Namibia (Saito, Imansyah, Kubok, Hendayana, 2007) where learners perform poorly in Mathematics and the teachers seem to be unprepared for teaching learners, (Ball, et al. 2005). Teachers in rural areas have pointed out the problem of not having access to resources. The Department of Basic Education should see to it that these teachers in the rural areas are not left without any development opportunities. Teachers are expected to continue to educate and empower themselves (Hindle, 1997; Polk, 2006; Rose, 2004) and to update their own content knowledge in accordance with curriculum changes and amendments. Gill and Dalgarno (2008, p. 331) refer to the idea of teacher preparedness as a "state or condition of being equipped and ready" and emphasise the attitudinal aspect of being prepared to teach.

New content knowledge may be linked to alternative approaches and strategies to teaching new concepts and ideas. Teachers ought to be proficient in their content knowledge and they should know which methods and strategies are most effective in delivering the content and that is why it is significant for teachers to know the content and have pedagogical knowledge before attempting to teach in any classroom (Goodell, 2006).

The teacher-centred approach appeared to be very dominant in the classrooms. As I observed activities in the classrooms, the teachers wanted to explain concepts to the learners without giving them a chance to air their views. **Batha-Phumeza, research participant No. 4,** stated the following regarding measuring the effectiveness of her teaching approaches:

> Mathematics is a dynamic, a practical and a life subject. Surely if learners were exposed to play, songs, games and discovery, these are good strategies to employ in teaching Mathematics and exposing learners to their daily life activities in Mathematics. In this way they gain more on basic quality teaching and learning.

There is a belief that such strategies allow learners to learn together while sharing ideas and they also provide learners with a lot of fun and enjoyment. The teachers understood that assessment should be undertaken during the processes of teaching and learning of Mathematics and also after the lesson. Thus, one way that would assist learners to learn is by means of assessment. Vygotsky (1978) attests that a pedagogy that supports learners includes assessment, learners' potential level of performance is enhanced, which makes learning easier and progress possible (Johns, 2002, p. 56).

Questioning was found to be a commonly used assessment method amongst the teachers. Mathematics is referred to as a highly complex Learning Area, and therefore the teachers who are responsible for teaching Mathematics are crucial implementers. There is evidence in the literature that the way Mathematics teachers teach can contribute to learners either failing or passing Mathematics.

In response to a question to determine how teachers measured the effectiveness of their teaching approaches, **Mtha-Anelia, research participant No. 1,** commented:

> My teaching approach is more learner-centred to promote learners' participation in Mathematics. I do this to promote creative thinking for the learners in my classroom. I don't want [them] to be dependent on the teacher all the time.

This respondent argued that it was the learner-centred approach that seemed to be effective in her teaching. The learner-centred approach seemed to be popular as an effective strategy, as **Batha-Phumeza, research participant No. 4,** also stated:

> My teaching approach has much to do with what learners know and I build on that. I encourage group work, I do not make all the decisions and it is important to model in order to promote learning.

Simon (1995) argues that using the constructivist approach in teaching Mathematics cannot be the only approach teachers rely on as their practice. Van de Walle and Lovin (2007, p. 14) argue that in the constructivism mathematics class, teachers encourage learners to "work in groups, in pairs or individually" to share numeracy ideas. Teachers' practice refers to all the activities that take place in the classroom while teaching and learning are taking place (e.g., learners' contributions, use of resources, reference to the curriculum, and the teacher's actions and behaviour). The links between these elements make up the practice teachers want to master. The constructivist approach has been widely used but is not recommended for all teaching practice, especially when teaching Mathematics. For such an approach to be successful, it would have to make sense of peoples' perceptions. Von Glasersfeld (1990) refers to social constructivism as "…having no way of knowing whether a concept matches an objective reality".

5.6 Teachers' documents

During lessons, I obtained evidence from the teacher's files which contained the lesson plans and the work schedule, as well as a copy of the Curriculum Assessment Policy Statement for Mathematics (Curriculum Assessment Policy Statement) (DoBE, 2011). The learners' work books were also available. These were the documents that reflected what the teacher was teaching and how she was able to teach a specific topic/content. The Curriculum Assessment Policy Statement (2011) was also there as a guide to what was to be taught at that particular time, how it should be managed, and what the assessment activities should be. Mathematics specifies detailed aims for Mathematics in the Foundation Phase. The teachers' work started with the Curriculum Assessment Policy Statement document where the topic was specified for the particular term.

The learner-centered approach was evident in the topic about fractions. Different learners were catered for in this lesson where the teacher used group teaching and where learners were divided according to different capabilities to work on the task to master fractions. Cole (2008) refers to group teaching as a high opportunity for learning where learners are given a chance to showcase their learning skills.

The use of Vygotsky's (1978) Zone of proximal development is important for the teacher to understand the process of knowledge acquisition and knowledge transfer and not to be merely concerned with the construction of meaning and understanding. During the process of both knowledge acquisition and knowledge transfer, social interaction can play a major role where the teacher has to scaffold knowledge for the learners. In more general terms, the ZPD brings to the fore the issues of effective mediation of scientific concepts, the scaffolding of educated discourse, and the 'learning to talk' in the manner of the practice of school Mathematics.

The Curriculum and Assessment Policy Statement's (DoBE, 2011) contribution is regarded to be knowledge, skills and values worth learning; therefore its purpose is to ensure that learners acquire and apply knowledge and skills in ways that are meaningful to their own lives. The teachers have no choice but to follow these guidelines, as abiding by these rules assists the teacher in meeting the goals. In the process of transmitting knowledge, teachers and learners are at the mercy of curriculum planners. Bernstein (1999) refers to curriculum and pedagogy as message systems that include assessment as the transmission of school knowledge. When such activities take place in the classroom, the teachers are focusing on what the outcomes are in order to determine what to transmit.

There is evidence that teachers acquire knowledge in the classroom whilst they are teaching, and that this is the kind of knowledge that informs them how to use certain strategies, procedures and practices that can be employed to deliver content in the classroom (Calderhead, 1996; Shulman, 1986; Argyris & Schon, 1978). Feiman-Nemser and Floden (1986, p. 513) emphasise that "understanding the organisation of teachers' knowledge refines our appreciation of uses by showing how different forms of knowledge permit different kinds of performances".

In **Batha-Phumeza, research participant No. 4's** classroom learner-centered teaching was visible when she gave learners work to do in groups but this was the only time where learners were on their own. I observed three different activity corners, and each corner displayed different types of materials for the Learning Areas (i.e., a corner for Mathematics, Literacy and Life Skills). Learners could go to these corners for individual reading, colouring and art activities. In the Mathematics corner there were resources that assisted learners to learn Mathematics.

With reference to the research question that investigated whether teachers understood their practices in terms of Mathematics teaching, it was clear that the Mathematics activity corner in particular would have a real impact on the corroboration between what the teacher understood as her pedagogic practice and knowledge, and the mathematical knowledge and skills the learners had to acquire not only within a classroom context, but also within their own personal space and contexts.

On this particular day when the observations were taking place in the schools, the learners were divided into small groups of five or six. The research participant No.1 Matha-Anelia and 2, Mtha-Zumile in the urban school were able to implement the group work effectively Vygotskian scholars emphasise that both teachers and learners learn to work together to be able to transform learning from their initial level of mastery to gradual independent activity, and that together they bring the teacher to greater expertise, so that they can be of the utmost assistance. This is what is referred to as pedagogical content knowledge. While theorists like Piaget (1969) believe that learners actively construct knowledge through experiences, Vygotsky (1978) holds the view that it is, in fact, adults and the wider society that create those experiences that facilitate learning.

Vygotsky (1978) further argues that abstract knowledge is constrained or guided, or even structured, by the social environment in which learning takes place and, in his words: “semiotically mediated” (p. 229). In effect, this implies the indispensability of the “more knowledgeable other” (Vygotsky, 1978). The teachers in this study agreed that the teaching approaches that involved learners seemed to be working for Mathematics teaching.

The learner brings to the ‘zone’ what he or she is able to do independently and what he or she has learned, and the teacher provides the support so that what the learner is able to do beyond the ‘zone’ is supplemented and ‘boosted’ by the support of the teacher. The role of the teacher is neither that of an authoritarian figure nor, what Cope and Kalantzis (1993) call “well-meaning bystanders”, nor is it that of a docile observer. Rather, the teacher is a catalyst that ‘increases’ the speed and depth of the learner’s cognitive development, utilizing scaffolding as a measure to support the learner as he or she grows in confidence (Vygotsky, 1978).

According to **Mtha-Anelia, research participant No. 1,** the teaching approaches used in her teaching of Mathematics entirely depended on her planning that was guided by the National Curriculum (Curriculum Assessment Policy Statement). She strongly expressed herself as follows:

> The teaching approach depends on both planning and learners who find Mathematics difficult sometimes so that needs me to think deeply about the approach to use for them to understand the concepts in Mathematics … Mathematics is challenging for learners; as a result they need more support from me as a teacher. I decide on different techniques that work for that particular topic.

What is crucial in what she was suggesting is that because Mathematics is a challenging learning area, learners will find it difficult; it is how she chose her approaches that assisted her learners to understand the concepts she taught. The theory of pedagogic practice examines a series of rules that defines its inner logic and considers both how these rules affect the content to be transmitted and, perhaps more important, how they "act selectively on those who can successfully acquire the knowledge of what is learnt of a topic (Bernstein, 1990, p. 63).

Ramsden (2003), Brown (2002) and Mncube and Harber (2010) investigated how teachers developed curricular plans and ideals and what they translated into their classroom actions. They found that what teachers do to facilitate learning and teaching are derived from the curriculum. Through the curriculum development process, teachers plan and shape their learners' experiences in the classroom so the curriculum design provides teachers with ideas of how to deal with the content and the teachers use their designs and material to interpret what they understand about their practice in order to teach.

Teachers who use different approaches to teach Mathematics find that learners have to work in order to solve problems. Also, according to Wood, et al. (1995), teachers need to create or have an approach to their practice that will allow the learners to learn in their own way, and not according to the curriculum or any given approach.

Bernstein (1973, 1977, 1990, 1996) argues that education in societies as a whole and in the educational context in particular, the interactions between teachers and learners result in the distribution of knowledge, although this distribution of knowledge is about who has the power to do so. Traditionally, teachers were not expected to learn from learners, whereas teaching and learning are about both parties learning from each other. The pedagogic discourse is concerned with the distribution and production of knowledge and how this knowledge is to be transmitted (Bernstein, 1973, 1977, 1990, 1996) so Bernstein looks at the process and content of what occurs inside schools in terms of the learning content being dealt with and what the learning content should be.

5.7 Understanding the goals of teaching Mathematics

Understand why one teaches Mathematics is the kind of knowledge that is used to prepare learners for their careers (Feiman-Nemser, 2001). However, it seems to be lacking among teachers. Teachers who teach in the rural areas are often not from the same area as the learners so they often lack the opportunity to understand the learners' culture, the support the learners need, or the relationship the community has with the school. The respondents found questions that probed whether they fitted in with the school's context and whether they understood and instilled the purpose of education in the learners they were teaching problematic. The teachers' knowledge of the purpose of teaching has to assist learners to develop conceptual knowledge about what has to be learnt (Department of Basic Education, 2012).

The teachers' selection of appropriate teaching strategies to assist learners to understand the conceptual knowledge was another obstacle. The workshops that are provided by the Department of Basic Education assist teachers to deal with different teaching strategies in the classrooms which should help the teacher who lacks content knowledge. Being part of development initiatives like teacher support, could assist teachers to have more confidence in their teaching.

5.8 Summary

In this chapter, the data obtained from the semi-structured interviews that had been conducted with the research participants were analysed. These interviews served to respond to the first research question, namely: what pedagogic practices do teachers in Grade 1 draw upon to understand teaching Mathematics in Grade 1. The analysis revealed that teachers applied different disciplinary theoretical conceptualisations when they focused on teaching Mathematics. Some of the teachers believed in the constructivist theory as they allowed the learners to learn using play oriented activities. There are implications that relate to teachers understanding the practice, for instance understanding different approaches to teach Mathematics to different learners. Due to the demanding dynamics of teaching Mathematics, their pedagogic practice was often underpinned by scholarly theory, such as self and cultural constructivism. It was rare that teachers revealed any consideration of critical constructivism by allowing learners to engage in their own learning. The next chapter analyses how the data from the second research question was generated.

CHAPTER SIX

DATA PRESENTATION AND DISCUSSIONON MATHEMATICS TEACHERS' UNDERSTANDING OF PEDAGOGIC THEORIES

6.0 Introduction

The previous chapter focused primarily on the analysis of the data that were obtained by means of the semi-structured interviews. This chapter focuses on the data that were obtained by means of classroom observations. The semi-structured observation schedule that was used for this purpose included the following concepts that sensitized me towards purposeful observations; the type of pedagogic style the teachers used; the resources used for the teaching and learning of Mathematics; whether the concepts and theories that framed the study were evident in the teachers' pedagogic practices; what the classroom arrangements were; and what assessment strategies were employed by the teachers. I was also conscious of scrutinising the lessons for activities that catered for the different learning styles and cognitive development of the learners, and I consciously took note of whether or not the teachers used their learners' prior knowledge to build concepts.

The use of concrete, locally available materials, the contextualisation of games, songs and examples, and the engagement of learners in activities that would help them to gain a solid understanding of Mathematics by asking 'why?' and 'how?' questions were also foci of my observations. In my endeavours to do justice to the aims of the study, Bernstein's pedagogic device theory (1999) and Vygotsky's (1978) social theory underpinned my thought processes as I observed and mentally illuminated the teachers' classroom practices. The disciplinary and conceptual theories should support teachers in teaching Mathematics in Grade 1 In essence, this chapter highlights the findings pertaining to the research question: **How do Mathematics teachers' actual understanding of pedagogic theories effect the teaching and learning outcomes in Grade?**. The findings and conclusions were drawn from the concepts and themes that emerged from the main research questions, but most importantly in this chapter the analysed data will be drawn from the pedagogic and disciplinary theories teachers were observed to use in their teaching.

The analysis of the data focused on constructivist theory with reference to the physically constructed data obtained from the learners who were involved in active learning. In this context, I was sensitive to the effectiveness of the approaches towards classroom management and organisation that the teachers employed when they taught Mathematics.

For authenticity, the observations are presented in the present tense as this reflects most powerfully how I experienced and perceived the actual classroom environments. Using the present tense will also give the reader a sense of immediacy as I take him/her on this journey of each classroom with the researcher.

6.1 Classroom observations of the four respondents

The themes that emerged from the Mathematics teachers understanding of teaching Mathematics as aligned to the curricular spider web that has been used to understand teaching approaches used by teachers. These different themes as explained by (Wahyuni, 2012), were also highlighted in chapter two where literature studies were dealt with for positioning the information in the relevant for the phenomenon.

Teachers' personal rationale

This finding corroborates Khoza (2015) also corroborates this finding and states that teachers who are driven by personal rationale design assessment tasks that help learners to realise their full potential on the topics that they are assessed on. He further states that when teachers design and scaffold learners during assessment, they make subjective meanings on tasks thus support the learner in order to build and rebuild knowledge of those activities. Schiro (2013), personal rationale make up knowledge that is different to each individual that owns it. This suggests that teachers who are driven by personal rationale use their oral assessment knowledge and experience which motivates learners to enjoy oral assessment and to score good marks. Khoza (2015) further reiterate that personal rationale is the most significant rationale that drives teachers to assess orals. Therefore, teachers who hold this rationale are generally successful in their oral assessment practices.

Watt and Richardson (2007, p. 188) declare that "teachers play a fundamental role in the shaping of societies, as quality teachers and teaching are central to the development and maintenance of an intelligent, informed citizenry". This shows that teachers who are driven by a societal rationale are expected to play a vital role in transforming learners in order to address societal expectations. In societal rationale, knowledge is mostly generated horizontally from local known sources (Bernstein, 1999).

Content rationale

The teachers' comments also pointed out that their experiences of teaching Mathematics in the early grades were influenced by content rationale. Teachers who are driven by content rationale are grounded in knowledge of teaching approaches that speak to learners taught to memorise information as they use their professional knowledge experiences to assist their learners for understanding concepts, therefore allowing teachers understanding falling below certain levels to suggest their significant professional knowledge for Mathematics teaching.

6.1.1 Mtha-Anelia, research participant No. 1: Lesson Observation 1

As I approach Mtha-Anelia's classroom, I note that the paintwork is clean and there are no learners wandering outside the classrooms. The classroom is full and the young Grade 1 learners are seated in threes at each desk. There are 45 learners in the classroom and the teacher states that some might be late as it is Monday. They are all well-behaved but I can hear some chatting. The classroom looks very colourful with charts on the walls. The teacher is busy with the resources she has to use for her lesson. On the walls of this classroom are learners' birthday pictures, number charts, pictures of different kinds of food, past years' calendars, and stories and flash cards. The classroom arrangement makes provision for learners to sit in groups. There is also a big carpet in front of the class next to the teachers' table. There is an abundance of colour on the walls of this classroom. The learners' school bags are neatly packed behind the desks where they are sitting. I am allocated a small table and a chair behind the learners. As it is Monday morning, the teacher is teaching Mathematics. The school uses English as the language of learning and teaching (LoLT).

The teacher approaches the learners' desks and she asks them to stand up. They obey. She says: "Ten little pencils" and the learners' chorus after her. It is as if they are waking up from their sleep! They recite this rhyme enthusiastically. As if they were waiting for the teacher to say they should. Each learner joins in and it feels so good.

Mtha-Anelia: Ok, ok, sit down, right? What do I have in my hand?

Learners (chorusing)**:** Nothing, Ma'am.

Mtha-Anelia opens her hand and there are two ten cent coins in her hand.

Learners: Ooh, we will learn about money today!

Mtha-Anelia: No, not money, but our lesson is about fractions. Tell me, what is a fraction? Who can tell me? Let us look here (pointing at the chart with different drawings of fractions).

The teacher takes a chart from her table with different types of half-shaped pictures and she asks the learners to tell her what they see on the chart.

Mtha-Anelia takes some fruit and a knife from her bag so she can cut the fruit into halves and quarters. She instructs one boy to cut the orange into two equal parts. She shows the learners the number for the whole orange and then, when it has been divided into two equal parts, what that is called. The teacher has many objects that can be divided into halves and quarters and the learners take part enthusiastically. As the process of cutting progresses, the teacher emphasises that the two parts should be equal in size in order to make two halves.

Mtha-Anelia: Let's do this together. Look, here is a slice of bread: if I want these four boys to share this slice, what should I do?

(The learners contributions, explaining that she must cut it into two equal pieces first, and then another two equal pieces, so as to have four equal pieces.)

Mtha-Anelia: Take your time and do it properly**.** Very good, my boy!

(The activity continues until all the fruit has been divided into two equal parts and Mtha-Anelia now explains how a quarter comes from a half. As she is explaining this, she is also writing the appropriate words and letters on the chalkboard. Learners move away from the teacher's table, each with a quarter piece of an orange, an apple, a slice of bread, which they are allowed to eat.
Mtha-Anelia next asks **Sihle** (pseudonym) to come to the table to cut a slice of bread in order to give it to her four group members and she explains to the class that she has to first divide the slice into two equal parts, then the two parts into four parts. Mtha-Anelia allows **Sihle how** to do the activity according to how he understands the concepts. The teacher then calls upon another learner, **Mthanti** (pseudonym) to check whether Sihle has correctly divided the slice of bread.)

Mtha-Anelia: I have a couple of sums here that I would like you to do for me. You will have to think first before coming to the chalkboard.

(The teacher pastes a chart with different types of shapes on the board and she asks learners if it is possible to divide a circle into four equal parts. She demonstrated all the other shapes until she came to a triangle.)

Learner: We cannot divide a triangle into four equal parts because of its shape.

Mtha-Anelia: Very good, my girl.

(The learners have to write things that they can divide equally into two halves on the chalkboard. Whilst they are eating the fruit, the teacher places worksheets in the activity corners in the classroom where learners have to do a writing activity that relates to what they have just learnt (see fig. 5.2).

Mtha-Anelia: You have twenty minutes to finish that worksheet. Now go to your groups and do the activity. Please work hard.

(In the meanwhile, Mtha-Anelia is moving around the classroom, checking whether learners are doing exactly what she wants them to do. When she is satisfied with the work she moves to another group).

Mtha-Anelia: I am waiting for you, **Nothando** (pseudonym), your group is not seated as yet. (Nothando is the leader of one of the groups.)

Throughout this lesson, the LoLT was English. Research participant no.1 Mtha-Anelia stated at the beginning of her lesson that she sometimes worked with fluid groups of three of four learners as they had not yet mastered English. She had an understanding of what Mathematics teaching and learning should entail. Her way of wanting learners to do, write and talk in the classroom was impressive. This is exactly what the policy (Curriculum and Assessment Policy Statement) requires from teachers. She practically facilitated the teaching and learning in the classroom. At first she did not call the fractions by names as this was going to confuse and also discourage learners if they could not pronounce the word "fractions". The teacher wanted the learners to understand the concept "fractions". From inception she questioned the learners and forced them to participate by thinking and answering the questions. The learners' prior knowledge was reviewed where the teacher was asking questions in the classroom. In this classroom where Mtha-Anelia was teaching was favourable for the effective teaching of Mathematics because it had space for learners to move around in their groups/ activity corners. There were also support materials (LTSM) for the learners to learn, such as numbers and pictures of work previously done.

Teaching Mathematics to large groups in the classroom is often a serious challenge for teachers, especially in Grade 1. Innovations regarding teaching in smaller groups have been suggested by research and this kind of learning seems to be beneficial for both learners and teachers. Thus, human context and interaction are important and they require, inter alia, a process of modelling. The teaching of smaller groups has also been encouraged by the Department of Basic Education (DoBE 2009). Grade 1 teachers employ a new way of group teaching called the 'fluid group' or 'subgroup' with no more than three learners per group. This was not too much of a challenge for Mtha-Anelia as the number of learners in her classroom was manageable. Pedagogy consists of a social relation between the transmitter and acquirer where the rules of evaluation always lie with the transmitter and this is where Vygotsky's theory of learning plays a significant role. Vygotsky's social learning looks at learners transmitting their own knowledge through what the teacher is using as learners are expected to acquire new knowledge. This theory rejects passiveness and advocates activeness and maximum participation of learners in the process of learning. In **Mtha-Anelia'** classroom there was no passivity among the learners. Learners are expected to socially construct their own learning and they make their own representation of the learning action. In this sense the social relation of pedagogy is always asymmetrical, thus the relations between the transmitter and acquirer are always unequal (Bernstein, 1996). In this regard, the data analysis was based on both these theorists' views. With reference to Bernstein's (1999) theory, Mathematics is measured as a horizontal knowledge structure which consists of a set of isolated different languages in order to solve different problems**.** Mtha-Anelia facilitated different learning strategies as she used group work, questioning and answering at the initial stages of her lesson, she allowed learners to ask questions, and she used demonstrations by using a chart as feedback for learners. It was also fascinating to see Mtha-Anelia working with the two learners who were struggling in their groups as they had not managed the concept of fractions at the beginning of the lesson.

6.1.2 Mtha-Zumile, research participant No. 2: Lesson Observation 2

Semi-structured classroom observation

This classroom is more or less similar to that of her colleague Mtha-Anelia. They are in the same school. What is interesting in this classroom is how the support material is displayed. The

work displayed on the walls was created by the learners. The number of learners is the same as in Mtha-Anelia's class. The learners are seated in groups.

The classroom is arranged to make space for a Mathematics corner, a reading corner and a play corner. The activity corners are indicated as such, "library – reading; please be quiet", and contain books and exercise books for learners and big bags with colourful blocks. The teacher also has a carpet area where she works with different groups. The arrangement of the desks is different compared to Mtha-Anelia's, but they have the same furniture. I arrive whilst they are still reading the news and learners are reminiscing on what they saw on the news yesterday. It is interesting to see that they are all taking part in discussing the news and the teacher is listening as she takes down her notes. (I later asked her about this and she stated that that was how she assessed them diagnostically.) As they are still developing their minds, the use of language is important. The school uses English as the LoTL).

I am seated at the back of the class. The teacher asks me to check on her resources for the day before she starts teaching because in our initial discussion I requested that I would like to see the resources she uses for teaching Mathematics. In our discussions she explained that the kinds of resources used when teaching Mathematics have to be what learners can easily identify with. All the learners are now seated. I am then introduced to the learners and they remember me from when I first arrived when the Principal took me to Mtha-Zumile's class to meet her.

I realise that the teacher is about to start teaching because the learners move straight to the carpet area where they sit quietly, waiting for their teacher.

Mtha-Zumile has a long ruler in her hand and the learners are looking at what she is doing. She points to the numbers 2, 4, 6, 8 without saying a word. Learners look eager to hear what she will say next. They all count together, from 2, but she skips 3, then 4 and she continues up to the end of the ruler, which is 200. She then takes a tape measure and asks two boys to hold it up and all the learners count in 2's up to 200. She does the same with all the groups. Learners take out their number-boards. Everybody counts from 2 up to 200. Groups take turns to do this.

There are 5 learners in a group.I am impressed, thinking that this is a fine way of getting her learners to work. Then she claps her hands twice and everybody is quiet.)

Mtha-Zumile: Today we are writing numbers on the line. We need a very long line. (She goes to the chalkboard to draw a long line.) The only difference with this line is we will be counting backwards, taking away numbers from numbers. Let's see whether we can do this. (She calls the Zinhle Group [pseudonym]). Let's do this! Come up front.

(The five learners come up to demonstrate what Mtha-Zumile wants them to do. Forming a connected line with Mtha-Zumile at the front, they move backwards while the learners are chanting the words).

Learners (chanting)**:** We are moving backwards!

(Mtha-Zumile starts writing numbers on the long line drawn on the chalkboard and learners are working with her by counting the numbers, showing that they have mastered the skill of number chanting up to 200. The teacher then starts at the end of the line, counting backwards to the starting point.)

Mtha-Zumile: This is how we count from the back of the line towards the beginning of the line: 200, 199, 198…1.

(The learners who are already seated in groups are given work to complete in their groups. The only group on their feet is the one playing the train activity, going forward and backwards while counting. When everybody has done the counting activity, the teacher writes a sum on the chalkboard:

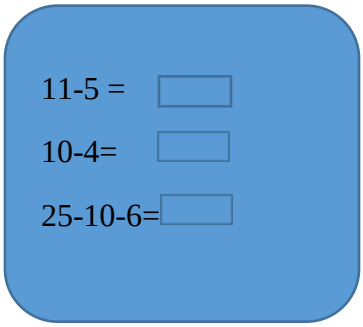


Figure 6.1.1 Learners' assessment work that was written on the chalkboard after the lesson

This was the way to get learners to work and think at the same time. She asked the learners to write this sum on their white boards. Everybody writes and gets it right.

Mtha-Zumile: You guys will have to write these sums on your white boards and then we will do the numbers line, counting backwards together.

(She then takes out the big chart with the sums on it and places it on the chalkboard and the learners start writing. She walks around the classroom checking whether everybody is writing. Every time she does this, she spends more time with a particular group. [I later asked her about this and she stated that they were the learners who always needed special attention as they sometimes did not finish the work in time. They liked to play and were struggling as they had different abilities]. I expected that if there were learners who were struggling with Mathematics, the teacher would know which resources to use for these learners. This translates to the goals and objectives that Mathematics teachers set for the learners and also herself. The teachers' understanding of the learners will also be defined by the kinds of assessments that the Mathematics teacher do.

Mtha-Zumile: Nothando's group (pseudonym), let's go to the chalkboard to write this number line.

(They then start with their number lines that correspond with the sums and the teacher is impressed)

Mtha-Zumile: Well done, Nothando's group!

(After presenting this lesson, the learners write the examples in their Mathematics exercise books. She then asks all the groups to come to the carpeted area. They all start the train game again by moving backwards and forward. There is some pushing and shoving but this is an enjoyable game for the learners.)

Mtha-Zumile's lesson was all about demonstration, play and having fun. There was no quiet time in her classroom. The group teaching enabled her to work with individuals in a short space of time. She was aware of the learners' capabilities. The social theory of implementing "scaffolding" as a measure to support learners to grow their confidence in learning (Vygotsky, 1978) was evident. This describes a process where the skills of a learner start off as elementary and as the learner interfaces with the teacher, their skills become more advanced. Darling-Hammond (2000) refers to this kind of teaching where teachers are commanders of their classrooms and where they understand learners' performance. Bandura (1986) looks at teachers' influence on bringing out the best in learner performance. To facilitate this, she employed different teaching strategies like group work, questioning and answering, discussion, free play, and demonstration by learners.

6.1.3 Batha-Buyile, research participant No. 3: Lesson Observation 3

Classroom observation

This school is located in a rural area. As I approach the classroom, **Batha-Buyile** is already waiting for me at the door. All the learners in this classroom are seated at desks. The classroom is quite full and they are noisy. They are of different ages; some look older than the others. The desks are arranged in rows in front of the teacher's table. I enter and **Batha-Buyile** introduces me. Some of the learners remember me from when I came to introduce myself to the teachers. She then explains to me that although this is a Grade 1 classroom some of the learners from the deep rural areas sometimes start school later than normal.

There are two boys of ten and eleven years of age which could cause problems for the younger learners. This is really an eye-opener as I expected to see learners of the same age in the classroom. The teacher explains that this is the norm in their school. The classroom is divided into four rows of desks and the learners are seated in the first two rows. The older learners are seated at the back of the rows. I am interested so see how **Batha-Buyile** will manage teaching and learning in this crowded classroom. The LoTL in this classroom is isiZulu, except for English First Additional Language. On the table there are two abacuses, a chart with different types of shapes, and A-4 paper.

Batha-Buyile: Let's all stand up and recite the table for 2.

(She also takes part in reciting table 2, standing closely to the older learners in the classroom. The dynamics of this classroom are very different from what I experienced in the urban classrooms. The older learners are enthusiastically reciting faster because they are familiar with the table.)

Batha-Buyile: Let's move quickly to the table for 4.

(The learners comply. One can see that some are struggling with this table but they are relying on the older learners as they catch up. Reciting and chanting tables and numbers seem to be the norm in this classroom as the learners learn from one another how to count. Also, the dynamics of the classroom allows learners to learn from one another as the teacher teaches).

Batha-Buyile: Our lesson today is "doubling" in Mathematics. If I had two oranges and I want to double them, how do I do this?

Learner: You have to have another two oranges.

Batha-Buyile: Four boys, please come to me. (Four boys go to the front of the class).

Batha-Buyile: If I want to double the number of these boys, what should I do?

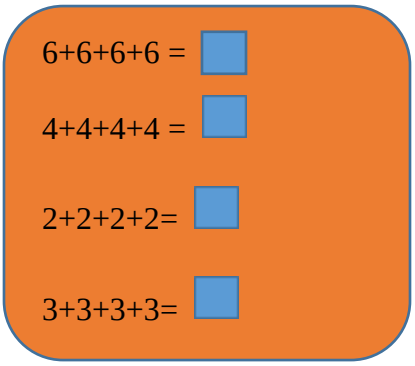


Figure 6.1.2 Learners' assessment work that was written on a chart after the lesson

Learner: Come on, guys! We need another four boys.

(The teacher starts to write on the chalkboard. These sums range from the easiest ones up to doubling ten. I become concerned as I find this problematic because there are learners in this classroom who are fully dependent on the older learners, so this exercise overshadows the teacher. The older learners are assisting young learners in scaffolded learning. Behind the cupboard there is a big box with different types of counters: buttons, sticks, pencils and some stones. Batha-Buyile instructs the learners to find the number of counters that they will be able to double. The four boys take out these counters and begin to count and also double the number. I can see that they understood what the teacher meant by 'doubling'. I realize that this is how these learners are expected to learn and that the teacher is unable to attend to each learner in her classroom, as the classroom is overcrowded).

Development in teaching and learning in rural areas has been labelled as slow and the recruitment and retention of qualified teachers is problematic in areas of high poverty.

Setati and Adler (2000) assert that there is evidence of teaching Mathematics in rural areas using code-switching as one of the resources, because the teacher and the learners share the same language.

There were a couple of code-switching incidents in Batha-Buyile's classroom as some of the Mathematical terms are not found in isiZulu.

Vygotsky's (1978) theory takes a social constructivist approach and emphasises that it is important for learners to learn in a social space where there are social relations in the process of learning. It is very clear in his social theory that the centrality of community in the 'meaning-making' is significant for the process of learning, and that culture is a prime determinant of individual learning. This seemed to be one factor that Batha-Buyile embraced in the teaching of her learners. It became a challenge to determine why her teaching focus was only on the learners who were showing enthusiasm in the classroom, and it was evident that the teacher relied on selected learners for learning to occur in her classroom. This teacher's pedagogical practice was not clear. It was not clear whether this teacher understood that possessing knowledge of facts and concepts of subject matter alone is insufficient, as posited by Shulman (1986). Teachers should retain adequate knowledge of the subject matter and be able to demonstrate an understanding on why a particular topic is central in a subject while others are not. This knowledge and understanding will help them to make informed decisions in terms of their teaching, specifically with reference to the categories of teacher knowledge required for effective teaching. During this observation I could not determine if the Grade 1 learners were actually learning. It is a basic requirement that for effective teaching, teachers require subject matter knowledge.

Hill, et al. (2005) state that teacher preparation for Grade 1 is important if the achievement of better results is a goal. Ball and Bass (2000) focused on analysing the actual teaching practice of Mathematics. Their analysis concentrated on the role played by content knowledge. Their findings revealed that their practice should entail different kinds of knowledge, which implies that teachers should be knowledgeable about and competent with content knowledge because it affords them opportunities to incorporate practices like understanding and interpreting learners' responses; anticipating uncertainties, irregularities and challenges that might occur during the teaching and learning processes; and deciding on how to present the content and to modify the curriculum, materials and instruction.

Ball and Bass (2000) emphasise that all of the above mentioned capabilities demand teachers' knowledge and competence with the content of the subject matter because that knowledge is fundamental in interpreting learners' mathematical thinking as well as in integrating it with their practice and with learners' experience, interests and needs. Most importantly, teachers' competencies at different levels play a crucial role in teaching learners Mathematics. Grossman (1990) believes that teachers' knowledge of the curriculum impacts on their teaching in Grade 1 and that it has an impact on what teachers need to assist learners with.

Bernstein's (1999) pedagogic device theory embeds the instructional discourse in the regulative discourse with the argument that the regulative discourse dominates the instructional discourse; hence, the instructional discourse is the knowledge that is selected, organised, and defined to suit either the teacher or the learners. In Batha-Buyile's case, it seemed that she was teaching for the purpose of allowing learners to understand only what she had put on the table. As her lesson progressed, she focused on who was able to respond to the questions she posed, which did not show commitment to all her learners. Such situations are illuminated by Hoadley (2012), who argues that teaching and learning in South African primary schools are still dominated by the teacher-centred approach where teachers adopt an authoritarian stance because of their inactive learners.

6.1.4 Batha-Phumeza, research participant No. 4: Classroom Observation 4

(This is another Grade 1 classroom in the same school as Research Participant No. 3 Batha-Buyile's. They teach in different classroom venues).

The classroom is crowded with Grade 1 learners who are seated in threes at each desk. There are about 50 learners in this classroom. The learners are squashed up at the desks but the arrangement of the desks makes it easier for the learners to move around.

It seems as if Batha-Phumeza is disciplined, as the learners are behaving. From the appearance of the classroom walls, it is obvious that she has a different approach from Batha-Buyile. On the walls of this classroom there are charts of the work done. I am astonished at the Mathematics

table and a reading table in this classroom. It looks very good. There are a couple of old books on the reading table.

The teacher's table is in the corner with a file, the Curriculum Assessment Policy Statement policy statement and a couple of learners' exercise books and some books on it.

There is no space for group work in this classroom. The LoLT is isiZulu. Batha-Phumeza offers me her chair and her table. I can see what happens in the front of the classroom. As I had asked for permission to browse through the documents on the table, I page through the Curriculum Assessment Policy Statement documents, her lesson plan, and the resources that are labelled "to use".

Batha-Phumeza comes back to the table, takes her cellphone and plays a song. She starts singing softly and the learners join in. There is a little pushing and shoving amongst the learners, but it lasts for only a minute and everybody is in singing and jiving mode. She didn't tell the learners to dance with her, but when she starts to sing and move her body the learners joined in.

Batha-Phumeza: Ok, everybody, let's all sit down and listen. Which part of our bodies do we use when we think?

Learner-1: Our heads.

Learner-2: Our minds.

Batha-Phumeza: Well done to both of you. We use our minds that are protected in our heads. Today we are counting backwards from 100. Let's do this … 100, 99, 98 …

(The teacher and the learners count backwards and she starts some dance steps and the learners join in. It is as if they are walking backwards and forward. It becomes a game and the learners enjoy it. Space is a problem, though, but there is much laughter.)

Batha-Phumeza: Which number comes after 65?

Learner: It's 66, Ma'am.

Batha-Phumeza: Let's see whether that is correct … 65, 66, 67… well done! Now here is what you need to think about.

(**Batha-Phumeza** pins a chart on the chalk board. Of the different activities that can be done, the learners have to fill in missing numbers. She calls them one by one to come to the chalkboard to fill in the missing numbers. After this activity, learners have to do individual work).

Batha-Phumeza: Group leaders, please distribute these worksheets to the class.

(The worksheets are distributed and the learners start working on the worksheets).

Batha-Phumeza: "Today I am working with Celani's group. Please come to my table".

(Celani's group walks up to the table where **Batha-Phumeza** takes out the worksheets with numbers counting backwards. They first chant the numbers, then each member of the group takes turns in chanting the numbers, counting backwards. In another activity, the learners fill numbers into spaces. The teacher also asks questions, e.g., "What follows after …?" (A particular number). This is an activity that the group struggles with and she answers their questions by asking them more questions so that the lesson becomes a conversation).

Batha-Phumeza: You may go back to your places and finish the work. (She calls another group and interchanges them).

This observation demonstrated to me that Batha-Phumeza had a clear idea of what teaching and learning are all about. The approaches that she used when starting her lesson could have worked for any other lesson. Research has shown that learners in Grade 1 learn through play.

The pedagogy of Mathematics is explained or defined as "… the distinct sculptured way of teaching" (Buchholtz, Leung, Ding, Kaiser, Park & Schwarz, 2012, p. 111); i.e., a demonstration of a combination of teacher knowledge and skills that becomes what teachers practice.

Such practice is supported by Shulman (1987, p. 8), who defines pedagogical content knowledge as the blending of content and pedagogy into an understanding of how particular topics, problems or issues are organised and adapted to the diverse interests and abilities of learners, and presented for instruction. Batha-Phumeza did not have many resources to support her teaching, but she was able to use what was available in her classroom and the learners were learning whilst having fun. Bandura (1977) asserts that self-efficacy is a powerful form of motivation that flows from a teacher's motivation to the learners. Important life skills flow from Mathematics as it is a subject that is necessary for effective functioning in societies (NCTM, 2002). Moreover, Mathematics is a subject that should be more enjoyable than it sometimes is. Vygotsky's (1978) social theory asserts that teachers should design differentiated tasks that are aimed at maximizing each learner's development potential. The emphasis here is on differentiated instruction and learning that are not along the lines of either the 'traditional' or 'progressive' pedagogies, but that are in line with what has been referred to in academic circles as the 'scaffolding' approach (Bruner, 1986, p. 74). Its purpose is always to guide and support learning in order to encourage the development of learners' capabilities.

It is vital that teachers of Mathematics are not only well versed in the content knowledge of Mathematics, but that they are also capable in the methods that are required to teach that content knowledge (Darling-Hammond, 2005 and Machaba, 2013). This, along with the reality that social interaction even among learners themselves plays a key role in their cognitive growth, remains unquestionable. Barnett and Hodson (2001) state that the pedagogic device theory provides teachers with specific regulative knowledge and rules on how to go about teaching the curriculum, whereas Wilson & Berne, (1999) argue that the knowledge of learning is produced in a constructivist way which could be a challenge for teachers who are still learning. Kazima and Adler (2006) are clear that it is the responsibility of teachers themselves to gain more knowledge on Mathematics.

Vygotsky's work suggests that pedagogies that are only concerned with existing independent functioning will not give the learner the chance to progress. By way of contrast, pedagogies that support learners as they progress towards their potential level of performance make genuine learning and growth possible.

Shulman (1987, p. 46) argues that the curriculum contains concepts of knowledge, educational context and the purposes of education.

The commonly and most used teaching strategies used by the teachers denied learners the opportunities to socially construct their own knowledge. Teachers tended to be more concerned about learners making mistakes as they expected them to find the correct solutions in the activities they were involved in.

6.2 Conclusions based on classroom observations

The National Council for Teaching Mathematics (1991, 2001) asserts that Mathematics teachers articulate a vision of Mathematics by engaging learners in problem solving, mathematical argument, and reflective communication.

Steinberg (1998) is in agreement with the claims by the NCTM that teachers have to be aware of learners' difficulties when posing new tasks for them. Teachers are able to learn from their teaching, but content knowledge will always vary from teacher to teacher. Significantly the understanding of the teaching and content to be taught lies with the teacher (Chisholm & Wildeman, 2013). The topic for the day might have been according to the CAPS (2011) but the teacher did not have sufficient significant knowledge about how the topic was to be taught. The teacher is the only person responsible for how the lesson develops. Therefore the commitment to the teaching and learning of the learners was not a priority. For Shulman (1987, p. 15), the definition of pedagogical content knowledge is "the ability of the teacher to transform content knowledge into forms which are pedagogically powerful and yet adaptive to the variations in ability and background presented by the learners".

Pedagogical content knowledge will then link the content, learners, and pedagogy, revealing a special kind of teacher knowledge. Also, the learners in this context design, construct, and solve problems in collaborative ways within the guidance of the teacher so as to construct their own knowledge. As Shulman (1987) explains, teachers have to merge this knowledge on teaching with knowledge about learning, which is a powerful knowledge base on which to build teaching expertise. Teachers,

especially in the rural context, find it difficult to link knowledge of the learning matter with the context of the learners. However, as teachers improve their level of education, these issues will be eliminated in their teaching.

The process of knowledge construction is impossible without the guidance of the teacher and the use of constructivism empowers people to construct their own knowledge of learning through their experiences of the world.

Bernstein's (1999; 2000) pedagogic device theory describes two models of how knowledge is recontextualised that can be seen as two opposing forms of power in the classroom (i.e., power and control). The teachers in this study lacked some of the knowledge required to facilitate learning. That is where the issue of power and control plays a role, as some teachers deliver only what is specified in the curriculum, sometimes with little consultation with the learners and awareness of their context. Learners receive instructions from teachers through classroom practices, which often contradict what teachers say they are teaching.

Understandably in the South African context, schools in rural areas suffer from the effects of poor socio-economic conditions which differs from those in urban areas. As mentioned, resources and development is lacking in the rural areas but whether teachers understand their practice and whether the practice allows them to teach Mathematics effectively depends on the approaches and assessments used to facilitate learning. The NCTM (2000) refers to conceptual knowledge as knowledge of the underlying structure of Mathematics in terms of the relationships and interconnections among ideas that explain and give meaning to mathematical procedures. It is very difficult to rule on this conceptual knowledge in the rural areas, because the teachers often have to do what they feel will suit their context.

They experience difficulties arising from numerous contextual factors, such as the ages of their learners and limited support and resources.

In Mtha-Anelia's and Mtha-Zumile's classrooms, the learners were predominantly isiZulu speaking, yet they were able to understand the Mathematical concepts that were presented in English. It is also quite remarkable that Mtha-Anelia was able to introduce her lesson in a fun way by playing a game with the learners while they had to think hard to work out the problem. A successful strategy in Mathematics is to get learners thinking before the lesson begins.

This is exactly what Vygotsky (1978) refers to when stating that knowledge is physically created by learners who are involved in active learning. The learners in Mtha-Anelia's classroom took the initiative in their learning. Ball (1991) describes the knowledge of Mathematics as procedural and conceptual knowledge of the learning area that gives clarity to the understanding of what Mathematics is all about and how activities in Mathematics should be tackled. Therefore, teachers in Grade 1 have a responsibility to consider all these key concepts that will assist them to understand their pedagogical skills. This will allow learners at different ages to fully understand the content being taught. The product of effective pedagogy is learners' "acquisition of knowledge, skills, attitudes and dispositions, demonstrated both within and outside of the school context" (Eraut, 1994).

There seems to be a pattern of how the lessons progress. The learners taught in a group and thereafter the teacher taking it for granted that all learners were at the same level of thinking and understanding. My concern was the teachers' pedagogical knowledge of Mathematics, in the sense that although they were teaching in the same school, the approaches they used to teach Grade 1 learners were quite different. In this regard, (Zwiep & Benken, 2013) found that specialised and common knowledge in teaching Mathematics seemed to grow during teachers' training, but that the content knowledge seemed to stagnate. Such situations need to be addressed by the curriculum and workshops.

Though there are specifications in the Curriculum Assessment Policy Statement (2011) of how teachers need to attend to different topics for learners to attain certain skills, the teaching approaches in the two classrooms in the urban school were quite different. Mtha-Anelia's lesson was predominantly a group focused, learner-centred approach, whereas Mtha-Zumile had a whole-class learner-centred approach. These teachers were more concerned about how the learners were

receiving information than about how they would acquire knowledge. Also, their applications of TLSM differed. In Mtha-Anelia's classroom the learners were dependent on the available resources, whereas in research participant No. 2 Mtha-Zumile's classroom she took charge of using the resources herself. However, this was a decision that could have been influenced by her classroom space.

In the same research site research participant No. 1 Mtha-Anelia was very creative and I was able to see the integration of the lessons and learners were given an opportunity to do their work with less interference from the teacher.

The continuous assessment aspect is quite significant in teaching and learning as it is another way for learners to learn. My expectation had been that these two teachers would be vigilant in how they structured the assessment of their learners, but unfortunately it was minimal. Teachers are expected to assess learners using different assessment strategies such as observations, interviews and the collection of learners' work (NAEYC & NCTM, 2002). However, the collection of learners' work seemed to be impossible in these two classrooms. Research participants' No. 1 and 2 who happen to be in the urban school seem to be doing well.

Whilst they were teaching they paid particular attention to learners who struggled and they continued with their assessments which was commendable. It is important that teachers organise and arrange their classrooms in a manner that will facilitate a positive climate to challenge learners to spontaneously continue to explore and learn mathematical concepts in a relaxed, natural manner (NAEYC & NCTM, 2002). Moreover, Shulman (1987) adds that teachers should also possess pedagogical content knowledge which will enable them to demonstrate their competence to manage classrooms in terms of resources, the behaviour of learners, and the ability to organise and arrange a classroom in a manner that caters for the differences among learners. Fogarty (1999, p. 77) states: "Vygotsky's theory recommends that learners learn through interaction with people'; [this learning] will further be internalised through the processes of deep thinking and understanding". In the urban schools there were Mathematics corners where learners could go to in order to learn Mathematics. This was a way of attending to the learners' needs in their learning Mathematics classrooms.

Vygotsky's (1978) Zone of proximal development theory argues that if learners are not internally motivated by their teachers, their strategies of teaching have probably been inappropriate. In this study, factors such as classroom space and overcrowding could have prevented the teachers from progressing and taking the initiative in their teaching. In the urban area school, teachers seems to be understanding their pedagogical knowledge.

This was confirmed by the research participant no. 1 Mtha-Anelia when she stated:

> My understanding is … the practice is the way or method a teacher devises to teach a particular topic either in Mathematics. There is much of problem solving that is needed in Mathematics as a result I let learners work on their own. Languages or any other Learning Area. For me this will be thought of in accordance with the topic on the table.

Moreover, Curriculum Assessment Policy Statement (2011) does not indicate the sequence and depth of the mathematical concepts that should be taught. This omission allows teachers to select concepts as they wished, thereby teaching more than one concept at a time or maybe the same concept over and over again, thus confusing some learners. MacNab (2000) suggests that the use of a learner-centred developmental psychology by teachers is a fundamental requirement for the successful teaching and learning of Mathematics.

Teachers in the 21st century are aligning to the constructivist learner-centred approach to teach Mathematics (Pal, 2009). It is this learner-centred approach that provides Mathematics teachers with useful ways of understanding learning and learners. It is very useful as it teaches learners reasoning skills and critical thinking skills; in essence, the ability to think mathematically is important if learners are to be able to process mathematical knowledge. I was able to see the knowledge of research participant Mtha-Anelia as I observed the learners being given the fruit to divide accordingly to show fractions.

My visit to the school in the rural areas was a revelation as it strengthened my understanding that school and classroom dynamics are important. IsiZulu, which was the mother tongue of the learners

in Grade 1, was also the LoLT. The learners were also quite diverse as some seemed to have started school at a very advanced age. Moreover, the learners in these two classrooms were different in many ways. In Batha-Buyile's classroom the learners were of various ages, with some being quite a bit older. The seating arrangement in Batha-Buyile's classroom comprised four rows of desks and the learning space was crowded. In Batha-Phumeza's class, the learners were disciplined and attentive.

The classroom was crowded but she had arranged the desks in a way that caused the learners no discomfort. Also, the provision in terms of LTSM was quite significant in these two classrooms. There were no Mathematics corners and the teacher-learner relationship was also not the same.

The learners in research participant No. 3 Batha-Phumeza were a bit older and as a result they were able to assist the other learners. Research participant No. 4 Batha-Phumeza was teaching in her mother tongue and her use of resources was commendable when she used her cellphone (singing and playing games). In Batha-Buyile's classroom, the resources were minimal. The teachers understood their practice in this rural school differently in terms of how they should teach and how they should attend to the planning of their lessons. The planning of a lesson by Batha-Buyile was quite different as there were no activities that spoke to integrating the Mathematics lesson. Research participant No. 3 Batha-Zumile seemed to be skilled in terms of how she taught and her use of resources and her teaching showed that she had sufficient knowledge of her practice. For example this is her response:

> My choice of the practice is very much depended on the topic / content I am teaching or focusing on, on that particular day. As a teacher you always want to choose what works … eh … the learner-center approach seems to work very well.

The observations revealed that not all the teachers attempted to assess learners' prior knowledge except for research participant No. 1 Mtha-Anelia where this factor was very visible and contextualised in her teaching using fruit and bread, song and dance.

6.3 Conclusion about the documents analysed

The documents that were required for analysis were available from all the research participants and they seemed to be using the same documents for planning. When analysing the documents,

the findings showed that the lesson plans for Mathematics were the same for all the teachers. All four teachers' lesson plans adhered to the requirements as defined by the Curriculum Assessment Policy Statement (2011).

However, what struck me was the fact that the structure of the curriculum is grade specific; it thus 'assumes' that learners in Grade 1 are of the same age. However, in the rural school the learners in Grade 1 ranged in ages from 6 to 11. Economic realities prevented some children from starting school at the stipulated age. A number of requirements are significant in the format of the lesson plan, namely the lesson objectives, the lesson integration with other core Learning Areas in the Foundation Phase, the resources to be used, the activities learners have to complete, and the assessments (formal or informal).

The four lesson plans in the teachers' files were compared and analysed. There was evidence that the work had been planned according to the Curriculum Assessment Policy Statement (2011) and that it was executed following the Curriculum Assessment Policy Statement guidelines. I found that the lesson planning outline took the same format but differed in terms of the planned learning activities. The constructivist approach followed by the Department of Basic Education (1997) requires that Mathematical Literacy, Mathematics and Mathematical Sciences (MLMMS) for Grades 1 to 9 are guided by specific outcomes that direct the learners' skills, knowledge, attitudes and values. Learners are expected to apply these attributes to their learning through active involvement.

Shulman (1987) confirms that the theoretical framework of teachers' pedagogical practice needs to master two types of knowledge, namely deeper knowledge for curricular development and pedagogical knowledge for teaching practices. In the lesson plans this was quite different; these teachers had the knowledge pertaining to the application of the curriculum, but differed

in how they planned to teach. Mtha-Anelia planned to use resources successfully in her lesson. Her planning reflected teaching and learning in the Foundation Phase where learners are confined by the resources available. I also observed that Batha-Phumeza understood the use of resources for the learners to grasp a concept.

The curriculum specifies that a Learning Area cannot be taught in isolation. Teachers have to make sure that there is integration among all core Learning Areas in the Foundation Phase. Some of the observations were integrated with other learning areas and some not. Also referring to research participant No. 1 Mtha-Anelia used the learners' cultural background, prior knowledge of nutrition, and she linked the lesson with Life Orientation by using nutritious food instead of sweets. I think her skills went deeper than just teaching Mathematics. The lack of integration with other Learning Areas in the lessons, as well as a lack of knowledge about the purposes of education and understanding the learners' conceptions, was quite a concern as learners need to be taught this in Grade 1.

Mathematics is a Learning Area that is integrated in many aspects of peoples' lives, and it spans cultures, nationalities, races and religions. Duncan, Dowsett and Claessens, et al. (2007) found that the knowledge and mastery of early mathematical concepts may lead to the achievement of reading and not the other way around. The readiness of learners in Grade 1 in Mathematics reflects their success as they progress in academia. Learners need to understand that Mathematics is not a separate Learning Area, which is why it should be taught in an integrated manner.

There were times when some teachers did integrate the Mathematics lesson, for example when Batha-Phumeza referred to the part of the body we use to think with (Life Orientation) and when Mtha-Anelia used music, song and dance in her lessons to integrate Life-Skills and Literacy aspects.

I observed a number of issues that revealed inconsistencies in the teachers' knowledge regarding how the lessons should be presented. The teaching and learning attended only one Mathematics Content Area, which is addition and the counting where learners chanted numbers. Data generation was done in August, where teaching and learning of Mathematics should have been concentration on Subtraction and Data Analysis. The NCTM (2002) argues that learners in Grade 1 cannot distinguish their world as a separate entity, but that they have a holistic view of what should be in their world of knowledge. They cannot perceive Mathematics as separate from the other worlds of knowledge they are introduced to, hence the integration of Learning Areas is vital.

Learners in Grade 1 need to go beyond the Mathematics designed in the curriculum; and this pedagogy is referred to as pedagogical content knowledge which is required when teachers teach in Grade 1. Young and Stuart (2011) assert that teachers need to possess adequate knowledge of Mathematics, because they are expected to demonstrate their competencies in facilitating learning. For this reason they need to employ effective teaching strategies and methods that will empower learners to constructively acquire mathematical skills.

They also need to create a positive atmosphere in the classroom that will enhance attention and motivate learners to learn Mathematics spontaneously. Clements, Nastasi and Swaminathan, (1993) and the Conference Working Group (2004) conclude that the positive capabilities of learners assist them to develop attributes such as curiosity, imagination, flexibility, inventiveness, and persistence, which contribute to their future success in their learning. The South African curriculum was developed to ensure resonance with the current needs of societies (Msila, 2007).

Teachers, especially in the rural areas, are reliant on the use of the policy statement. Also, they blame their lack of practice on limited resources as well as on the lack of in-service development opportunities on the side of the Department of Basic Education. In the semi-structured interviews it emerged that some of the teachers found the workshops that were provided by the Department of Basic Education very helpful. Constructivists' researchers suggest that learners use their knowledge to make sense of what they understand in order to construct their own knowledge.

In many schools in the rural areas there was an expectation that teachers should do more to show that they understand their roles and support the learners in their thinking. It is understandable that learners in Grade 1 need more resources in order to understand the concepts, but in the classrooms that I visited in the rural areas resources were limited. It became obvious that where teachers worked together in teams to capacitate each other, they were better able to assist the learners, hence workshops for teachers played a significant role in teacher development.

In the semi-structured interviews I discovered that teachers in the urban areas have a group where they teach each other on some techniques and skills of teaching Mathematics and this, coupled with what the Department of Basic Education does in terms of workshops for teachers, helped improve their practice. Research participant No. 3 Batha-Phumeza stated:

> Mathematics is challenging for learners as a result they need more support from me as a teacher, I decided to join the group of Mathematics teachers in the area. This is where we teach ourselves on different techniques and skills that work for that particular topics.

6.4 Teachers understanding of assessment strategies used for Mathematics

The Curriculum Assessment Policy Statement (2011) requires learners to be continuously assessed throughout their learning. Teachers have a responsibility to provide instruction which reflects learners' informal knowledge and their daily experiences of Mathematics (Hall, 2002). During the teaching process, synthesis of new knowledge should take place; as a result, the prior knowledge of the learners needs to be integrated into what the teacher brings to the new learning activity. In Batha-Buyile's classroom the older learners assisted the young learners, and I could understand that they were scaffolding learning, as posited by Vygotsky (1978) who argues that learners learn from the 'knowledgeable other'. This implies that knowledge is socially constructed by learners who convey their meanings to others. However, it is teachers' mandate as they teach to see to it that assessment is done and that it suits all the learners in the classroom. Shulman (1987) suggests that assessment should not only include reviewing of learners' understanding during interactive teaching and at the

end of a lesson, but it should also include evaluation of the teacher's own performance and ability to make adjustments. Mostly, these fundamentals were deficient in the Mathematics lessons that I observed.

Vygotsky's (1978) Zone of proximal development suggests that learners' involuntary social interactions with the knowledgeable other will allow them to develop the problem solving skills required for Mathematics learning. Teachers have a responsibility to assemble classrooms in a manner that will provide a positive climate that challenges learners to spontaneously continue to explore and learn mathematical concepts in a relaxed, natural manner (NAEYC & NCTM, 2002). Lerman (2001) and Steffe and Thompson (2000) further argue that teachers are there to guide learners towards achieving their goals and to encourage the exploration of potential pitfalls and misconceptions with the aim of developing broader, more resilient concepts. I observed that it was a challenge for the teachers to assess learners using different strategies. It appeared that group work was the only assessment strategy that the teachers resorted to. Teachers are expected to be engaged in assessing learners using different assessment strategies such as observations, interviews and collection of learners' work (NAEYC & NCTM, 2002). The teachers did observe the learners as they worked in groups. They also attended to the struggling learners in order to assist them.

The learners' journals were also marked which was admirable considering the overcrowding. Tsangaridou (2002) and Feiman-Nemser and Floden (1986) are in agreement with how teachers should manage their pedagogical practices, stating that they change depending on what they are faced with. When teachers begin teaching, there are numerous factors to consider, like the interest of the learners, facilitating learners' understanding, and the methodology to use when teaching. Whilst they are focusing on these, their pedagogical practices change and teachers are more likely to focus on what works, as one of the research participants stated in the interview.

The Curriculum Assessment Policy Statement (2011) for Mathematics seemed to impact negatively on the understanding of the teachers because it does not provide examples of activities that teachers may use to design their lesson plans. The teachers were able to list their teaching strategies, which is a Curriculum Assessment Policy Statement requirement, but when they were teaching it seemed as if some had forgotten that they were to implement those teaching strategies in their lessons. Batha-Buyile mentioned that she would be playing a game with the learners on "doubling". She stated that the boys would double the number of boys and the girls would double the number of girls as a game to emphasise doubling in her lesson. However, there were irregularities between what she listed and the strategies she used. When the lesson observation started, the teacher only focused on explaining terms; it seemed that the issue of floor space was the problem because the classroom was a bit overcrowded, but she could have achieved the activity by merely having learners leave the classroom in doubles.

It was difficult to assess whether the teachers in this study had the requisite knowledge to teach Mathematics which is a particularly difficult Learning Area for all learners in all Grades. Teachers who are responsible for teaching this subject should have a clear understanding of what and how they are supposed to be teaching and of the outcomes of each lesson when they plan their Mathematics lessons.

The learners' prior knowledge involves formal and informal experiences that they bring with them to the classroom; such experiences may be deep-seated or argued in the classroom. Therefore, in terms of learners' experiences, it is a requirement that teachers should teach effectively by using suitable strategies to guide prior and new knowledge simultaneously. If for any reason there is confusion regarding the learners' prior and new knowledge, this may affect learners and, as a result, effective teaching and learning may not occur (Mueller, Yankelewitz and Maher, 2014). The use of the teaching tools by research participant No. 1 Mtha-Anelia allowed learners in the classroom to have fun whilst they were learning. Also her lesson was integrative as it acknowledged the prior knowledge of the learners and included an aspect of Life-Skills in the lesson plan.

6.5 Summary

This chapter reported on the analysis of the data from the four semi-structured classroom observations and the documents that were analysed. The documents that I analysed were the teachers' lesson plans, their work files inclusive of the Curriculums Assessment Policy Statements and learners' work books. The documents available to teachers should assist in guiding teachers on how to conduct a lesson, but this is not always the case, as was seen during the lesson observations. My discussion on the semi-structured classroom observations and the document analysis was an attempt to grasp how teachers' understanding of their pedagogical and disciplinary conceptualisation(s) impacted their teaching of Mathematics in Grade 1. What emerged from this research question was that teachers have to focus on the learners' context as well as taking into consideration their objectives of teaching Mathematics to assist learners learn. The next chapter presents a discussion of the findings and conclusions.

CHAPTER SEVEN

SUMMARY, RECOMMENDATIONS AND CONCLUSIONS

7.0 Introduction

In Chapters Five and Six I presented an evaluation of the data that were obtained by means of semi-structured interviews, classroom observations and documentary analysis in two schools from different demographic contexts. This chapter explores how the data responded to the critical research questions posed in the beginning of the study. Reference is also made to the literature review in order to highlight how the concepts of the theoretical and conceptual frameworks related to the findings of the study and the teachers' understanding of their pedagogical practice. The theoretical foundations of this study were Bernstein's (1999; 2000) pedagogic device theory and Vygotsky's constructivist theory. The two critical research questions are:

- What pedagogic practices do teachers in Grade 1 draw upon to understand teaching Mathematics in Grade 1?
- How do Mathematics teachers' actual understanding of pedagogic theories effect the teaching and learning outcomes in Grade 1**?**

The findings in this study pertaining to these research questions are presented in different focus areas. Importantly the research participants taught in schools with divergent contexts. They also revealed variations in their understanding of their practice. The participants understood that the learners they taught came from a number of contexts and therefore required different approaches to their learning. It was clear that the urban and rural locations caused difficulties for the research participants. One of the challenges teachers identified was the Curriculum Assessment Policy Statement (2011) that applies to primary school learners. They questioned the effectiveness of the current curriculum as it advocates a policy of "one-size-fits-all"; that is, the learning content does not cater for learners from different contexts. This shortcoming in the curriculum affected the teachers' ability to address the needs of diverse learners in different contexts, which in turn affects the learners' understanding of what is being taught.

Teachers need to have curriculum knowledge in order to make clear judgments in terms of what learners are expected to know and what they will be assessed on, they need to know how to disperse that information in terms of teaching learners, (Darling-Hammond and LePage (2005) and Cochram-Smith & Lytle (2003). Teachers in the rural areas still rely heavily on the Department of Basic Education for guidance about what should be taught and this was revealed in the interviews where teachers spoke about the Department of Education not being accessible to them to assist with workshops on how to teach Mathematics:

> I need to know more on what to teach and sometimes how to teach a particular aspect of Mathematics as it is rarely that we are called for workshops.

Throughout the study it was revealed that after twenty one years of democracy, South African schools are still very unequal in terms of the availability of resources. Although my sample was very small, it appeared that the two study sites were still treated differently by the Department of Basic Education, particularly in terms of the provision of physical resources and LTSM.

During my investigation pertaining to the research question: **What pedagogic theories and disciplinary conceptualisation(s) do teachers in Grade 1 draw upon to teach Mathematics?** I focused on the key concepts that teachers need to have in order to be able to teach, as posited by Shulman (1987).

7.1 Findings on teachers' understanding Mathematics content knowledge in Grade 1

Regarding content knowledge, the teachers' responses showed that after graduating from their Institutions of Higher Learning, and before they were employed, they believed that they possessed appropriate knowledge in order to teach Mathematics. This perception resulted from the way in which they were taught Mathematics when they were still learners. Allowing the learners to count using the rote learning and the reciting of the numbers was part of the old competence curriculum where teachers did not pay particular attention to the knowledge and facts of the discipline but to the ability to recite numbers. They agreed that they had not been trained to understand the different contexts of the learners.

An added dilemma is that in the South African context, teachers graduate with content knowledge for a specific Learning Area, and they are supposedly knowledgeable about methods to teach that Learning Area. However the fact of the matter is that both teachers and learners find Mathematics difficult, and this is the case throughout the grades.

This is borne out by the shocking international tests results not to mention Fleisch (2008) describing primary teaching as being in crisis. Teachers remain crucial players in ensuring quality teaching and learning of Mathematics as they interpret and implement the curriculum. Ball and Cohen (1999b) argue that teachers are rarely provided with the opportunity of being mentored in terms of teaching skills, instead, they attend short courses or workshops that barely address the challenges in the classrooms. Shulman (1987) insists that teachers should have knowledge of the content of the subject they are teaching and Turnuklu and Yesildere (2007) concur, stating that the pedagogical content knowledge of Mathematics teachers in primary schools is poor. Teachers in this phase need more assistance in order to improve their competencies in teaching Mathematics in Grade 1. Such competencies allow teachers to grow in the Learning Areas they teach, and in this manner they gain confidence. In this study the teachers felt that Mathematics was a challenging Learning Area, which implies that they need support at some point. Mtha-Anelia, research participant No. 1, said:

> Mathematics is very different from the other Learning Areas because it deals with numbers. Learners struggle so we teachers sometimes need support. I decide on different techniques every day to put my message across and sometimes I do not win.

This statement implied that teachers need and expect support from the Department of Basic Education which is not forthcoming. It was evident in this study that the teachers in rural areas felt empowered after attending workshops. Even though some teachers understand their practice and know what to do in the classroom, it seemed as if it was not enough to build the necessary confidence in particularly the two rural teachers. It was evident from this study that some of the teachers understood the content knowledge for Mathematics, but this was lacking in others. These problems could be addressed earlier if the Departments of Basic Education took the initiative in the early stages before any damage is done.

After the 2013 Annual National Assessments (ANAs) where the results were poor the Department of Education attempted to address the problem by inviting teachers to various workshops. Hence some of the teachers' practices improved. Teachers have an understanding of their practice in teaching Mathematics, but they are not sufficiently trained to use different approaches for all Mathematics content, (Brodie, 2007, p. 31). In this regard, it must be reiterated that teachers' practices in Mathematics in Grade 1 have not been researched in depth; research would have shown that there is a link between the teachers' content knowledge as well as the classroom organisation and environment.

The teachers in this study were aware that they need additional training in the form of workshops to improve their teaching of Mathematics, and they expressed this need in no uncertain terms. If teachers lack content knowledge, it is up to the Department of Basic Education to intervene. My respondents were aware that Mathematics is a complex and interdisciplinary Learning Area and that, as a result, they require more knowledge of the Learning Area because they are expected to be specialists. Feeling that they did not know enough was a source of anxiety for them. Darling-Hammond (2011) argues that teachers with insufficient content knowledge will find it difficult to justify the answers given by learners, especially in Mathematics. Therefore, teachers need skills, content knowledge as well as pedagogical knowledge for effective teaching and learning to take place. I could determine that the teachers in this study based their practice on constructivist theories because they understood that learners are unique, they allowed them to develop at their own pace, and they focused on learner-centredness. The Mathematics Education of Teachers Initiative (METI) (2001) does exist as a support structure for teachers and it arranges workshops to develop teachers but operates mostly in the urban areas which leaves the rural areas without vital support.

In the South African learners struggle with Mathematics and teachers seems to be scarce and this has led to learners being on the receiving end of poor Mathematics teaching. Turner-Bisset (2001) argues that the content knowledge of teachers is "the tools of the trade", which signifies that it will be difficult for teachers to teach with any skill should this be absent.

The poor results in Mathematics in Grade 1 attest to this fact. Mathematics teachers need to acquire content knowledge either during their training or later when they are employed. The only way to ensure that teachers grow in terms of Mathematics teaching, training and workshop sessions should be provided and extended country-wide by the Department of Basic Education. The challenge seems to be in rural schools, as was also demonstrated by this study, where there are limited resources and where teachers are thus forced to focus on what they are able to teach.

Teachers of Mathematics are expected to teach what is in the curriculum, as the Curriculum Assessment Policy Statement (2011) serves as a guide to what learners need to learn to be able to progress to the next grade. However, teachers select what they are able to teach (Brodie, 2007). The National Education Infrastructure Management Systems (2009) and the National Assessment Report published by the Department of Basic Education in 2013 reported that many rural schools still lacked sufficient infrastructure, and that the schooling situation in rural areas needed to be a priority. However, the efforts that the Department of Basic Education is making to improve education in the rural context seem insufficient to rescue Mathematics teaching. The Department is offering bursaries that allow the holder to pursue Foundation Phase in-service training. These bursaries also provide funds for teachers who work in schools that are struggling with resources. Bursary holders who receive the bursary for four years will be required to work in a rural area for the same number of years. This is a well-structured intervention to assist schools in rural areas as it addresses teacher shortages. However, until the effect of this is felt, quality education and access remain problematic issues for rural schools.

Teacher education programmes at universities for pre-service teachers cater for all phases and also build on the pre-existing knowledge of the pre-service teachers. The teachers are expected to teach in a school determined by the DoBE, with the proviso that each year of bursary funding is repayable by a year of service where the teacher is placed. Such an initiative is significant in the South African education system as most schools in rural areas are dilapidated and it seems as if the teachers working in these rural areas are not hopeful that conditions will improve:

> I understand that I should do what is expected of me guided by the policy but it has been years since I attended any workshop where I need to understand new ways (strategies of teaching Mathematics. Sometimes teaching in a rural area looks like you are just forgotten by the Department of Education.

My classroom observations revealed that teachers wanted to improve their teaching, but the lack of support from the Department of Basic Education let them down to some extent. A number of studies have been carried out on the issue of up-grading schools in rural areas (Balfour, et al., 2008; Mukeredzi, 2009), however, the initiatives by the Department of Basic Education are slow. The expectation of the Department of Basic Education at the end of each calendar year is that all schools will have done well and produced the expected results, especially in the most needed skills, irrespective of where schools are situated and how much support these schools have received.

The understanding of the curriculum does not only refer to one content area of Mathematics teaching. The content areas: Measurements, number sense, data analysis, statistics and probability, algebra and functions, geometry and spatial sense need to be understood by Mathematics teachers in order to be able to teach. However I found that the teachers in the study were only focussing on one content area. (Addition-number concepts and relationships).Teaching Mathematics to the young learners especially in the Foundation phase requires the teacher to have a wider knowledge on other topics. These topics are number concepts and number sense, measurement and data handling, algebraic reasoning and geometric concepts (CAPS, 2011). Grossman (1990) argues that curriculum knowledge will assist teachers in making informed decisions in understanding their pedagogical knowledge. Knowledge of the curriculum thus assists teachers to make accurate pedagogical decisions in their teaching. Shulman (1985, p. 47) states that "… to be a teacher requires broad and highly organised understanding of knowledge", which prompted the research question on examining teachers' understanding of their pedagogical practice in Mathematics. For the teachers in this study the curriculum seemed to be the only vehicle they could hold on to.

They had an understanding of how they needed to go about planning their lessons, but this was as far as it went. The Curriculum Assessment Policy Statement has the lessons planned for teachers, the only challenge is that the learners' context were not taken into consideration. It appeared that the curriculum was used only for planning, as Batha-Buyile stated that she consulted the curriculum document before her planning. The concern was on the activities that were done. Teaching and learning in the Foundation phase has to be integrated with the other Learning Areas (Literacy, Life-Skills and the additional language). I did not see this integration in the lessons I observed.

The expectation was to see the integration in the lesson plan and perhaps the teacher using some examples including the other Learning Areas. Mtha-Anelia concurred, as she stated that when she encountered a problem with the learning content, she used the curriculum document (Curriculum Assessment Policy Statement) to assist her. Bernstein (1990; 2000) asserts that the pedagogic device is a tool to relay knowledge.

He originally distinguished three fields, each with its own rules of access, regulation privilege and specialised interest: a place where the generation of knowledge is constructed in platforms where teachers produce knowledge that could be a field of production where new knowledge is constructed; a place or an arena where teachers will produce knowledge. Pedagogic practice therefore takes place in a field between these, which is referred to as relayed pedagogy in teaching and learning. The pedagogic discourse is branded with the horizontal discourse that constitutes everyday knowledge that teachers transmit orally, which is content specific. It was difficult to recognize these three fields that Bernstein proposes in the study sites. There were expectations of collaboration between the constructivist theory of pedagogy and the Curriculum Assessment Policy Statement requirements because, during the semi-structured interviews, the teachers strongly supported the learner-centered approach. However, I observed that there was some engagement of the learners in the learning content where the teachers wanted the learners to take part in their teaching, but in terms of clearly defining the learners' roles in their lesson planning, this was not evident.

The engagement of the teachers with curriculum knowledge was a challenge as they were unable to explain the structure and how they expected the learners to follow the structure. Kennedy (1997, p. 6) focused on teachers' conceptual understanding of Mathematics and argued that the main aim of teaching Mathematics is to instill a deeper understanding in learners of the central ideas and issues in various subjects and to enable learners to see how these ideas connect and are applied to real world situations. Research participant No. 3 Batha-Buyile correctly surmised that a variety of approaches work in the classroom, as learners are different and therefore learn differently.

Some learners learn through touching and seeing and others want to experiment with what they are learning. Taking cognisance of these different learning modes does not always happen in South African classrooms, as was observed in Research participant No. 3 Mtha-Zumile's lesson. She was intimidated by the large numbers and could not take control of her overcrowded classroom. Clearly her training did not include how to manage large classes. Wood, Cobb and Wood, et al. (1995), argue that it is the responsibility of the teacher to construct a practice that works with the learners they teach. Cogill (2008) asserts that curriculum knowledge is supposed to be what the teachers knows and are able to teach so that learners achieve their full potential. However, I found that the teachers in this study were unable to assist their learners to reach their potential, as they lacked the ability to create an atmosphere suitable for learning. This lack of a suitable learning environment can be a challenge for teachers in Grade 1.

Wilson (1987) argues that knowledge of the curriculum and how it is organised will assist learners to understand their horizontal knowledge with special reference to the impact of this knowledge. This was confirmed by the types of examples that the teacher used in the classroom. I noted that there were some issues that were avoided or the teacher used everyday language instead of using the language for Mathematics. McLaughlin and Walsh (2000) assert that it is the teachers' responsibility to understand their task in the classroom. In this context, teachers should know how the constructivist theory can be applied in order to understand the diversity of the learners in each classroom.

Vygotsky (1978) refers to knowledge construction as a process designed in association with the environment and the learner, and that is how development is perceived in learning. It was difficult in this study to determine how, and whether, the teachers constructed knowledge for the benefit of the learners. It can be concluded that the theories that teachers should apply in the classroom to teach remain just theories. This was a disappointing finding, as my expectation had been that despite all the challenges in the classroom, the teachers would rise above what merely worked for them and that they would apply what would work for their learners. It appeared as if they were teaching in the midst of all the challenges irrespective of whether they would achieve their goals or not. Teachers are also expected to provide conditions that will allow their learners to learn. This did not occur in these classrooms.

Batha Phumeza, for example, focused on the teacher-centred approach without considering the learners. This illuminated her statement that she had learnt to involve learners the "hard way", which implies that she pushed the learners to learn in 'her way' instead of in 'their way'.

Carter and Dean (2006) recommend that teachers be well prepared in terms of quality education for the learners. What will assist teachers is their belief in their practice; i.e., that what they are doing is recommended for the learners they are teaching. It was noticeable that in both the areas (rural and urban) the teachers rarely aligned with the guidelines of the National Council of Teachers of Mathematics (NCTM, 2000), which is an association that guides educational leadership and provides the vision and professional development to support teachers (NCTM, 2000, p. 1). The diverse learners in the South African classroom require diverse approaches and teachers need to learn this. It is also important that teachers be given opportunities to possess knowledge of educational aims, goals and purposes in terms of the Learning Areas they teach, as they experience various challenges when working with learners. This is because the learners possess different approaches to learning and this has to be taken into consideration in the planning of each lesson. The different approaches used by teachers to teach different Learning Areas will be of no value if they do not cater for the diverse learners in the classroom. This will allow teachers to design a curriculum that will be suitable for the learners.

Another challenge for South African teachers is that they become classroom managers who do not take part in the curriculum design, which excludes them from initial planning. During Batha-Buyile's lesson the learners had to construct their own meaning, which proved difficult and seemed to be due to the manner in which the instructions were given. The constructivist theory refers to knowledge as socially constructed by learners in the classrooms. Vygotsky (1978) argues that learners are given an opportunity to learn from one another. Teachers do not believe in learners' capabilities, yet in Batha-Buyile's lesson, everything that she taught was shared with the learners. Also, the questions that she asked were mostly on how the learners had progressed from the work done on previous days. Rose (2004) argues that constructivist learning environments should be classrooms where learners are given problems to solve and where they will be supported by their teachers who would model and coach towards understanding these problems.

The challenge in the South African classrooms is that learners depend largely on teachers, and not on their own constructed knowledge. This was confirmed by what Batha-Phumeza said about her teaching approaches in Mathematics:

> My teaching approach has much to do with what learners know as I teach in their Mother Tongue (LoLT) from that I emphasise on developing their understanding. Because of huge numbers in the classrooms I encourage group work. I do not make all the decisions and it is important to model in order to promote learning. There is little emphasis in assessment practices on providing learner feedback because of the large numbers. There is limited teacher–learner interactions about learner learning. More focus is placed on the formative assessment where I can easily see how learners are learning.

For learners to develop and understand what teachers are teaching, they need what Rose (2004) refers to as coaching and modelling that do not only develop learners, but also encourage teachers' growth. From a learning perspective, the constructivist approach is based on beliefs that learners construct their own knowledge from their reality and beliefs (Fosnot, 1999, Jonassen, Peck & Wilson, 1999 & Oxford, 1997), but this is a far cry from what happens in South African classrooms as teachers believe that they need to act as a springboard for learners to understand Mathematical concepts (Anthony and Walshaw, 2007). This is the reason that some South African classrooms are still teacher-dominated.

7.2 Findings on understanding the location/groups that the Mathematics teachers teach

During my very first semi-structured interview with participant Nos. 3 and 4 Batha-Buyile and Batha-Phumeza, they specified that they would teach what would come naturally on that particular day. This had been her approach when she started teaching in a rural area as well. Batha-Buyile stated:

> I would only focus on the topics I was comfortable with and able to teach before the DoBE workshopped us. It was very difficult for me to teach Mathematics and I did only what I could with the topics given.

The research participant stated that she would trust what would come naturally to her. Meaning that she trusted the community understanding of the pedagogic practice where only her opinions about how to teach was placed at the hands of the society. Understanding the practice was not disciplinary driven where teachers focus on the cognitive domain for learners' progress.

The study focused on understanding teachers' practices in teaching of Mathematics in Grade 1. The research was done in schools in different contexts but not for reasons of comparison but to identify whether teachers understand their learners in these contexts. The four teachers in the study did mention that they were aware of the diverse contexts of learners they were teaching, but this was not evident in their practice. Notari-Syverson (2008) recommends that for teachers in Grade 1 to teach formal Mathematics in the earlier grades, they need to expose themselves to deep and explicit knowledge of high quality Mathematics education. Shulman (1987) also suggests that there are different classifications of teacher knowledge that are required for effective teaching. These are teacher knowledge of the content, and teachers' participation with learners.

Both are important if teachers want to practice effective teaching. As far back as 2005 the HSRC confirmed that the teaching and learning resources issue in rural areas were inadequate and that this created a divide between what happened in township and urban schools. In the face of many media reports recently, this issue has still not been resolved and it continues to haunt resources provision in many schools (Balfour, et al., 2008, Geldenhuys, Kruger and Moss, 2013).

Hill, et al. (2005) assert that there is a relationship between teachers' mathematical knowledge and learners' achievement. The mathematical knowledge and skills that teachers develop and use in teaching are expected and should allow learners to learn Mathematics and provide them with knowledge and mathematical skills. Mathematics teaching requires that teachers help learners to recognise and understand Mathematics. Clements (2001) supports Shulman's view that Mathematics teachers need to have more than practice as a skill in order to be able to teach Mathematics. Welch and Gultig (2002) argue that it is the duty of the teacher to develop abilities in order to teach with competency and to know the purpose of education.

There have been various debates about what to do about teachers' knowledge and skills. One proposal is that a new South African teacher education policy should be developed that will allow teachers to reflect on their understanding of the purpose of education, especially with regard to the Learning Areas they teach. In this regard, I found inconsistencies among the four teachers in this study. For example, in as much as Batha-Phumeza was able to take part in what the learners were doing, she was unable to encourage the learners to raise their own expectations in order to build their confidence and trust.

Sometimes teachers who assist learners most of the time take that confidence from them and they become fully dependent on the teacher. Teachers have a responsibility to scaffold learning without taking learners' creativity from them. Batha-Buyile is the kind of teacher who is always available to assist her learners. In terms of her teaching Mathematics, she stated that she was able to use different types of approaches as she understood that learners are unique.

However, the only teaching approaches that she was able to use were the ones that involved learners with her assistance. There were no different approaches that were significant in the lesson she was teaching. I had expectations that the teachers would articulate what the learners did not know and that they would spend time making it understandable for the learners. It seems as if the presentation of the work in the classroom and learner participation have been mastered in the South African these classrooms, but the teachers did not seem to understand the purpose of their teaching. Moreover, they appeared to be particularly ignorant of the context in which they were teaching. Teachers' understanding of their pedagogical practice in Mathematics should possess both subject matter and pedagogical knowledge, yet the teachers seemed to be unable to transfer their knowledge of Mathematics to the learners. These participating Mathematics teachers seemed to be teaching only the topics that they understood. This was evident from what the teachers did in the classrooms as the focus was only on what was suggested in the lesson plan and that was transferred from what the Curriculum Assessment Policy Statement (2011) suggested. For these teachers who are expected to follow the Curriculum Assessment Policy Statement, what they were recording as facts or the school knowledge was not significant.

7.3 Findings on understanding the location of the learners

It is important that teachers understand the learners they teach. Understanding learners' needs has to do with the context where they are, as well as their learners' competencies in order to teach them using content that is familiar and that makes learning easy. Teachers in this study rarely referred to this factor. What was taught in the classroom was in the curriculum; in the rural area specifically the teachers focused more on what learners should learn instead of concentrating on the learners' strengths. Kennedy (1998) argue that if teachers want their learners to learn, they have to understand what learners are to understand. This entails the selection of appropriate activities, asking productive questions, and also attending to learner evaluation. This was confirmed by Baker and Chick (2006) when they examined the pedagogical content knowledge of teachers teaching learners in Grade 1. It was found that teachers lacked this knowledge and did not understand the learners they were working with as they differ depending on context. The questions in the semi-structured interviews aimed, inter alia, to determine if the teachers understood the roles they should play.

This seemed to be an onerous task for the teachers in the rural areas. In Batha-Phumeza's case, for example, I could not determine if she applied different types of assessment. The limited classroom space should not have deterred her, as there were other approaches that she could employ for assessment. The manner in which she introduced her lesson encouraged her learners to interact with her. This was the time for her to show her creativity in teaching Mathematics. In as much as she understood the content of teaching Mathematics, her assessment strategies were lacking. Most research on Mathematics teaching has focused on how teachers teach Mathematics in different contexts, but these studies have neglected the issue of whether teachers knew what they were expected to teach. Understanding and knowing the facts in a Learning Area assist learners in implementing what they have leant for everyday use, to gain control over their everyday life, and to solve problems. I concluded that the teachers' lack of skills and understanding during the lessons that I observed was a result of poor planning, perhaps with the exception of Mtha-Amelia. Ginsburg, et al. (2008) argue that learners should be taught in situations that afford them opportunities to explore independently, and to interact and play. My observations therefore showed that the teachers in the rural area did not have a clear idea of subject matter knowledge as such knowledge incorporates different types of activities and planned assessment strategies that will generate more knowledge in learners. This finding contradicted what the respondents said during the interviews. For example, **Batha-Phumeza, research participant No. 4,** stated:

> I always choose activities with a lot of problem-solving. I am mostly driven by the content to choose the practice and I try different types before I get what works. I always choose what I understand because I know I will do my best in what I understand what they are learning. It is the one way that will make it easy to learn and to develop.

When teachers have limited knowledge of how their learners learn, their strengths and weaknesses become a decisive factor in how the learners actually learn. In this context, the teaching strategies used by Batha-Phumeza were insufficient for learning to take place, and there was an indication of a lack of knowledge about the learners' strengths and weaknesses that made it impossible for them to understand Mathematical concepts.

As stated earlier, the lesson plans for each day were had been constructed on topics that the teachers felt comfortable with. This inevitably means that some topics would not be attended to. The Curriculum Assessment Policy Statement (2011) document contains all the information on how to present the lessons as well as the activities to do in order to show the learners different aspects of the subject, yet some of the teachers used a particular approaches that did not even match what learners were supposed to know. The teaching strategies like cutting up fruit and bread – and being allowed to eat it for example was one of the better strategies where learners were allowed to play and at the same time learn. However in the schools in rural areas teachers are mostly struggling with different strategies and Mathematical knowledge that needs to be imparted to learners as they only relied on what was in the policy for teaching and learning. This shows that the teachers experienced problems creating a positive learning atmosphere in the classroom. The selection of appropriate teaching strategies to teach Mathematics was therefore a challenge that was highlighted by the findings of the study. Teachers seemed to rely on play as the main strategy, even though during the classroom observations it was noticed that it was not used as a teaching strategy as such, but as an introductory activity that familiarised learners with the teaching materials that they would be using during the lesson.

It was also noticed that most teachers used discussion, and then asked learners recall questions. Thus the predominant strategies employed were discussion, questioning and answering, which are strategies that are not effective or sufficient for learners to learn mathematical concepts in depth (Ginsburg, et al., 2008). It is significant that teachers are expected to be knowledgeable and creative in selecting different strategies to teach Mathematics for learners in order to foster an interest in what they are learning.

7.4 Findings on understanding different Mathematics approaches

Ball and Bass (2000) analysed mathematical classroom activities to explore the challenges faced by teachers in linking their subject matter knowledge with their pedagogical content knowledge. Also Vithal (2012) states that the in South African context there is a specific level of resources and infrastructure that are required for successfully implementing new curricula.

Teachers use whatever is available to try and drive the point home and assist learners to learn. It is significant that teachers should possess both subject matter and pedagogical knowledge because the teaching of Mathematics consists of different situations. This requires that teachers possess detailed knowledge of Mathematics and the ability to use that subject matter knowledge in different contexts. The NEEDU report (2013) revealed that Mathematics teachers who were teaching in the Foundation Phase were unable to express themselves in English and reverted to code switching for some of the mathematical terms that they should have known.

Grouws and Cebulla (2000) argue that there are different types of approaches to be used in the classroom. Askew and Brown (2003), Kilpatrick, et al. (2001), Li and Ma (2010) and Ball (1988) all recommend key approaches in teaching Mathematics to develop critical thinking in learning. What are these key approaches? Schools in the 21st century require teaching in a cross-curricular fashion, as learners cannot learn Mathematics in isolation from other Learning Areas.

A cross-curricular approach to teaching refers to using several different contributions from other disciplines, the synchronisation or use of the knowledge and values from other disciplines (Siemens, 2006). The teaching and learning in the Foundation Phase involves some of the synchronization of the different knowledges and skills from the other disciplines like the integration of the language issues into what is taught in the Mathematics lessons. Teachers in the Foundation Phase know about this inter-curricular style and some are able to implement it in their teaching and learning. In the 21st century teachers have a responsibility to use improved pedagogies that will encourage the kind of learning that will also be sensitive to methods like using play as a teaching strategy in the Foundation Phase.

Moschkovich (2002, p. 38) state that there are "ways of doing things in a specific domain" that relate to how teachers would want to teach a particular concept; for example, problem solving in Mathematics teaching can be done using different approaches. It is through learning that learners are able to increase their knowledge of Mathematics for future careers and development; as a result, there is a need to be introduced to different strategies in order to grow. The problem-solving approach cannot be the only working approach in Grade 1.

Powell (2006) argues that Mathematical knowledge and the use of different teaching approaches are observed as teachers develop and grow with their learners. Although the participating teachers used different strategies in their teaching of Mathematics there were times when I felt the teacher could have done more for learners' understanding especially when teachers were using play as a teaching strategy. It had been expected that teachers in the rural schools would consider the context of the learners and integrate that with what was in the curriculum for lesson planning, but this did not happen. Teachers expect the Department of Basic Education to assist them with the content of teaching Mathematics, but they also have to make a contribution. This is the most challenging aspect, even for teachers in urban schools. Pedagogical knowledge caters for procedures to be followed when teaching a Learning Area, but it also challenges teachers in a variety of ways, as was demonstrated by this study. In one particular Grade 1 classroom where fractions had to be mastered, the learner-centred approach was noticeable when the learners were given work to do on their own after the activity and the teacher took on the role of facilitator. **Batha-Phumeza, research participant No. 4,** was a Mathematics teacher in an urban school. She specified that what worked for her was an interactive lesson where the learners were able to showcase their work.

Teachers in this study used different approaches but the learner-centred approach was one that dominated in the classrooms. The challenge was that when learners were learning, the teachers should have been able to scaffold where necessary. The concept of learner-centredness for these teachers meant that the learners could work on their own in groups. This commonly happens in large classes and all these teachers taught very large numbers of Grade 1 learners in one classroom. In most Mathematics classrooms, especially in South Africa, teachers are still dominating teaching and learning (NEEDU Report, 2013, Antón, 1999). It was hoped that the teachers would focus on modelling as one of the creative strategies that is very effective when the teacher and learners are accessing meaning during teaching and learning, but this approach was not implemented in the classrooms that I observed. Though small group teaching was emphasized, there was no cooperative learning where learners were involved in a healthy learning environment. It appeared that the belief in the teacher-centred approach prevailed, as the teachers were the 'masters' in the classroom.

It appeared that the teachers do not have the confidence to allow their learners to learn on their own. Such an approach makes it difficult for learners to grow and develop and master what the teacher does not know, as the teachers are protective of the learners.

Methodologically, learners are taught differently to achieve different results to those specified in the curriculum. Teachers should not be teaching for mere knowledge transmission, but in order to achieve certain goals; for example, the Annual National Assessments are done in schools to see how schools are performing. This has placed teachers under pressure as they want to be seen to be doing well, so they teach focusing on getting learners to 'pass' these assessments. However, the teachers in this study believed in the learner-centred approach when teaching Mathematics, which was demonstrated by Mtha-Anelia who stated the following:

> The teacher-centred approach has been what I thought worked for learners, but now all approaches in teaching Mathematics are important since learners are unique in each classroom. They also grasp information in different ways; some visualise, and work hands-on, and some memorize information.

As her teaching improved, she realised that different approaches need to be implemented in the classroom for effective teaching. Leach and Moon (1999) argue that pedagogical practice is a joint activity between the teacher and the learners. In an effective Mathematics classroom, teachers are able to organise teaching and learning activities in order for learners to learn, irrespective of the number of learners in the classroom. In two of the classrooms in this study the classrooms were overcrowded and the arrangement of learners in groups was not possible so it was difficult for the teachers to arrange their classrooms in an effective way.

Black and Atkins (1996), Dance (1997) and Ernest (1991) agree that alternative approaches used by Mathematics teachers, coupled with learners seen as active participants in the classrooms, allow teachers to have effective classrooms. Active learning encompasses and focuses more on supporting learners cognitively, emotionally and also supporting them with motivation to understand and appreciate Mathematics whilst they are young.

Bell and Kozlowski (2008) refer to the active participation of learners in the classroom as an integral part of teaching and learning. However, what was revealed by the teachers in this study was that, in the Mathematics classroom, the teachers wanted to take centre stage possibly because they felt that their learners could not manage the creative and critical thinking required for learning Mathematics.

Goodell (2006) and Witburn (2001) agree on the specifications that are required in the effective Mathematics classroom. They further state that these teachers should be selected according to their knowledge of problem solving strategies, their ability to think rationally, reason mathematically with the learners, and also their ability to justify and prove mathematical problems. This is in line with (Shulman, 1987 and Leach & Moon, 2009) who argue that there are certain Learning Areas that teachers are able to teach with confidence. It is the same with Mathematics: teachers need that confidence to be able to teach. As Mathematics teaching is dominated by teachers who believe in direct teaching, it is also imperative that they possess pedagogical content knowledge, otherwise they will lose the passion to teach this Learning Area.

It has been shown that the effective Grade 1 Mathematics classroom requires much more than a teacher talking to the learners. Mathematics teaching requires that teachers help learners to recognise and understand Mathematics. In the global context, learners are unique, and teachers of Grade 1 learners have to understand a variety of approaches to deal with their learners' uniqueness. NCTM (2013) argues that teachers have the responsibility to create an understanding atmosphere where all learners are able to learn. The lack of support in terms of how learners should be taught certain concepts relies on how much the teachers are supported and whether they will develop in similar ways as the learners in other subject areas.

Teachers' beliefs about their teaching have to do with how effective they are in providing suitable instruction that reflects learners' informal knowledge and their daily experiences of Mathematics. Greenes, Ginsburg and Balfanz (2004) suggest that during the teaching process, teachers should synthesize new knowledge that has to be integrated with prior knowledge for learners' understanding.

A learner-centered approach is associated with a less challenging approach, and in the South African classroom the direct approach is associated with a disciplinary climate in the classroom. The constructivist approach, which dictates the kind of classroom that I observed in the schools where this research was done, is associated with less discipline. It is perhaps for this reason that the teachers still seemed to believe that direct teaching would allow them to teach effectively and achieve better results.

7.5 Findings on different teaching approaches for teaching Mathematics in Grade 1

The aim of the classroom observations that were done in the four classrooms in different contexts, was for the researcher to understand the teachers' pedagogic practices in teaching Mathematics in Grade 1. As the researcher in the classroom observations, I wanted to unearth the different pedagogic styles used by the teachers in order to see how the teachers involved learners in their learning and how they were doing this. The power relations referred to by Bernstein in the pedagogic device theory can be seen in the classrooms as teachers take the centre stage in their teaching. The teaching and learning approaches were found to be teacher-centered and learners follow as guided by the teachers. This theoretical framework thus afforded the researcher the opportunity to see and investigate teaching practices in the study sites as an epistemology which assumes that learners construct their own knowledge on the basis of their interaction with their environment. The goals and objectives of knowing the Mathematics concepts are guided by the teacher and this does not take any learner or learners into consideration.

Grouws and Cebulla (2000) offer recommendations for different approaches to teaching and learning Mathematics that allow for a variety of pedagogical practices of Mathematics teaching in the classroom.

These approaches, that provide learners with meaningful learning and the development of knowledge, do not happen in the South African classroom, especially in Grade 1 (Curriculum Assessment Policy Statement 2011).

Learners do not develop the mathematical skills that provide them with growth and knowledge, as teachers focus only on the approaches suitable for their own purposes, (NEEDU Report, 2013; Hedges, 2005; Hill, Rowan & Ball, 2005). The pedagogic device determines which rules teachers and learners follow to allow learners to understand the different content knowledge from the Mathematics content areas. What I observed in the classrooms starting with the seating arrangements, determined the pedagogic approach that was decided upon.

7.6 Findings on understanding teaching Mathematics in different environments (i.e. rural and urban schools)

The location of the learners had to play a significant role in what the learners understand as teachers are expected to build from what learners know to what is unknown in terms of Mathematics. Research done by UNESCO (2003), Chisholm (2004), Jansen (2005) and Mukeredzi (2009) focused on education in the rural context. These studies made it evident that teacher development and the urgency for teaching and learning of Mathematics in rural areas happens at a very slow pace. Teachers in the rural areas know about the different types of approaches that they should employ when teaching Mathematics, but this does not happen as teachers tend to 'baby-sit' learners when they teach. In this regard, the lesson plans done by the teachers in the rural school differed significantly from those done by their counterparts in the urban school. Curriculum Assessment Policy Statement (2011) specifies clearly how these teachers are expected to teach in order to prepare for the Annual National Assessment, but the challenge the teachers, specifically in the rural area faced, was a lack of resources which hampered the development of teaching and learning in the study sites.

As mentioned in the discussion on the classroom observations, some learners in Batha-Buyile's classroom were much older than others. This teacher spent a lot of time making sure that her learners understood the concept she was teaching, but there was little in the way of resources to support teaching and learning.

This created resentment in the study participants as they felt as if they had not done what was expected of them. It appeared that the teachers could not apply different approaches because they lacked a variety of resources. The teachers in the rural school spent more time explaining concepts to the learners. This phenomenon is confirmed by Gardiner (2008) who argues that teachers in rural schools where there are fewer resources, especially relating to Mathematics, resort to explaining concepts verbally to the learners, which takes a lot of time. It was almost impossible for me to determine whether the study participants understood the pedagogic theories and disciplinary conceptualisation that they applied in their teaching, as the strategies they employed were quite different. Though the teachers used more teacher-centered approaches, it was very different in the strategies they employed.

As stated in the literature review, the findings by Baker and Chick (2006) and Machaba (2013) revealed that teachers either lacked mathematical knowledge, or struggled with the content knowledge of Mathematics. Despite the fact that the current study did not focus on the challenges but rather on an exploration of teachers' understanding of their practices in the Mathematics classroom, it became clear, as pedagogical practices were interrogated, that Mathematics teachers encountered difficulties in teaching Mathematics. It is not that they lack knowledge, but rather, it is that they are sometimes faced with socio-economic factors as well as classroom dynamics that cause problems in the South African classroom. The study concluded that teachers' understanding and knowledge of Mathematics undeniably impacted on the way they taught and on how learners learnt from these teachers. The findings revealed that, in terms of content knowledge, teachers had much to contend with; they did not focus on their learners' challenges as they came from different contexts, and this was the niche area of this study.

Another challenge that the teachers faced was that they had to teach learners of different ages in Grade 1. Moreover, learners in Grade 1 should have attended Grade-R, preferably in the same school, but this was obviously not the case with the much older learners in the Grade 1 class. Teachers in the rural schools were socialised with their learners by using the same LoTL as the learners' Home Language (isiZulu), but it became a challenge when they taught Mathematics where many concepts could not be translated into isiZulu. This meant that the teachers really needed additional resources to be able explain these concepts. It was evident that the teaching and learning of Mathematics in the rural schools was complicated and that the teachers would possibly have done better with the same support as that given to their counterparts in the urban school.

Teaching for teachers in the urban school was quite different from what the teachers experienced in the rural school. This analysis applied to learners who were catered for by the same Curriculum Assessment Policy Statement policy in Grade-R, and who were attending the same school. The issue of the LoTL played a significant role in the classrooms in the urban school because these learners had been socialised in the same language in Grade-R and in Grade 1. The two teachers in this school were able to keep to the stipulated time and were also able to teach using different resources that were readily available. It became clear that pedagogic theories and disciplinary conceptualization had very little impact on how learners learnt Mathematics in Grade 1 in the rural school.

Even after a teacher in the rural area had upgraded her teaching qualifications and aimed to be a better teacher, the teaching and learning challenges that she faced took her back to the issues of resources, overcrowding, and different ages of the learners accommodated in one Grade 1 classroom. There were other issues that challenged teachers in terms of the location of their learners as Mtha-Zumile, research participant No. 2 stated that it is through the sponsorship that was allocated to her that made her consider teaching in rural areas. Otherwise she would have looked for employment in the urban areas.

7.7 Findings on understanding assessment and administering it

Assessment is defined as a measure of performance (Gagne & Deci, 2005). It is "is primarily concerned with providing guidance and feedback to the learner" (Brown, Bull, & Pendlebury, 1997). Assessment provides the teachers and the learners with essential information about what is learnt and also about meeting teaching goals, however teachers encounter many obstacles that prevent them from understanding learners. The assessment cannot fulfill both the teachers' and learners' goals. The unique leaners in these classrooms cannot be assessed differently to show their capabilities and teachers blame this on the large numbers in their classrooms. Also learners of different ages who deserve to be assessed differently are not benefitting in the Annual National Assessments as these sometimes do not cater for these different learners. Curriculum Assessment Policy Statement (DoE, 2011) states that learners need to be assessed during and after teaching and learning processes but this situation hardly happens.

7.8 Findings on understanding the historical effects of the South African curriculum

The complexity of the language used for teaching using Outcome Based Education as well as the inadequate resources (Kenton, 2002) and the long hours of teacher preparations contributed to difficulties in using the OBE and led to teachers resorting to teacher-centered approaches that seemed ineffective for learners learning Mathematics. Hoadley and Jansen (2012, p. 188) CAPS does not have clear definitions on how teachers are expected to teach. Therefore driving them to more teachers-centered approaches that do not some of the recommendations for CAPS, the learner-centered approach curriculum.

They further stated that CAPS and the apartheid curriculum are driven by the traditional teaching strategies which focus on teacher-centred approaches. However there are concepts that influence the curriculum. The everyday knowledge that learners are expected to understand and learn suggests problems in a classroom where the teacher is the only active member doing most of the talking whilst learners are inactive.

The constructivist approach of teaching that allows learner-centred teaching that stresses strategies such as discovery-based teaching, inquiry based-learning, problem-based teaching and situated cognitive based are not part of teaching and learning in these classrooms. Such approaches allow learners to dominate in the lessons and the teacher facilitates the lessons. Learners solve problems on their own with guidance from the teacher where necessary. Boekaerts (1999) pointed out that learners differ in terms of how they learn and every learner has their own way of acquiring knowledge. Some learn best when they are listening, others when they play and as they differ they need to be taught differently. Therefore teachers are advised to make some adaptations to their teaching so that all learners benefit from their lessons.

7.9 Findings on understanding Mathematics teaching and learning activities

The findings from the interviews revealed that Mtha-Anelia, research participant No. 1, used different strategies like the discovery approach, play, discovery and games to allow learners to interact with her in the classroom but this was difficult to see in the classroom observation as she focused on one Mathematics content area. It is evident that some teaching and learning approaches that Mathematics teachers choose derive from their self-understanding, how they were taught in primary school. The subject understanding of the practice was thought of as something that would emanate from the curriculum or books that were prescribed for Mathematics teaching. Also the issue of different concepts that need to be taken into consideration when planning the lessons for Mathematics teaching lacked some of the concepts, for instance how the learners had to be assessed, and the goals of teaching and learning of Mathematics. It is important that in the lessons Mathematics teachers should take into consideration the influences of the rationale for teaching, aims and objectives not merely attend to what is in the curriculum. Keeping up with innovations in teaching Mathematics teaching would allow teachers to see other dimensions in their classrooms. To support their teaching Mathematics teachers could use the argument in a the study by Nkopodi and Mosimege (2009) that indicates that in a teacher-centred approach, the teacher can use a video recorder to record the play action, then replay and pause it so that games can be analysed.

It also reveals that the learner-centred approach can be utilised by engaging learners in constructing games like [1]morabarabara to allow learners to have fun whilst they are learning. (A morabarabara is an indigenous game played on a board or floor using stones or counters- it allow learners to be able to count the number of stones or counters they have or lost as opposed to the other player). The CAPS curriculum has some guidelines for various approaches to employ but he teachers' understandings of their practice relied on self-understanding and it proved difficult to let go of the familiar.

Figure 7.9.1 A picture of Morabaraba an indigenous game that can be played for Mathematics teaching and learning

7.10 Recommendations

It came out in this research that Mathematics teachers rely mostly on the Policy Statement (CAPS) DoBE (2011) for their teaching approaches. Their understanding of Mathematical concepts is based on what the policy stipulates. The findings revealed that teachers' assessments is through obtaining guidance from CAPS policy documents. This was seen in the assessment that was given to the learners. Mathematics teachers need to understand the location of the learners in order to be able to understand teaching and assessment.

[1] Morabaraba is a traditional game played by two players on a board, it can be played by both sexes.

Mathematics teachers play multiple of roles when they teach and conduct assessment, in some instances learners happen to be confused by these roles. It is recommended that workshops and in service trainings can inform teachers on what and how to play these multiple roles of teachers for them to understand their practice and achieve good results.

7.11 Summary

The contexts within which the schools were located resulted in different dynamics in this study. I had difficulty in pinning down an understanding of the teachers' pedagogic theories as their knowledge of the content knowledge was limited to number operations. I could also not determine how the pedagogic theories and disciplinary conceptualisation impacted their teaching of Mathematics in Grade 1, and it could only be concluded that these challenges were brought about by the different contexts of the schools.

The teachers understood what they were expected to do in the classroom when teaching Mathematics; however, ineffective planning and a lack of resources, particularly in the rural schools, affected the application of their pedagogic content knowledge for effective learning. It was difficult to isolate the culture of each school to determine how the teachers were expected to teach Mathematics. According to Epstein (2007), intentional teaching means that teachers teach with a specific goal and employ the best teaching approaches that optimise learning. As the research was on different teachers' understanding in different contexts, the study was not to compare the teachers or contexts but to understand what teachers understand as their practice where they are. What emerged very strongly was that it would depend on where the teacher is located and what that particular teacher understands in terms of the practice. Teaching learners as a group is not an indication of not understanding the practice, but rather how the teacher has thought of socialising the practice. However, the findings of this research study suggest that teachers in the South African context understand their pedagogical practices in terms of their contexts when it comes to teaching Mathematics, irrespective of the challenges they face. The teachers in rural areas were very different from the teachers in urban areas and so was their teaching.

They are committed to their teaching practice, using their own unique ways and approaches that depend on how they were taught. Jung and Conderman (2013) indicate that teachers need to apply international teaching strategies by providing authentic Mathematics instruction and designing Mathematics activities that are purposeful and meaningful to learners. Jung and Gregory (2013) argue that this can be achieved by connecting the study of Mathematics with learners' real-life experiences.

The South African curriculum (Curriculum Assessment Policy Statement, 2011) specifies clearly what teachers need to do and how, but because schools are located in different contexts and because the approaches to teaching and learning are, of necessity, so very different, there will always be problems. Teachers need to be capacitated with different approaches in teaching Mathematics but they also need to take into consideration the leaners' contexts and what the learners have been exposed to, and use that to align their teaching. This is how teachers would be able to monitor their progress in their teaching. The teachers' practice could easily be improved as it was revealed in the research that attending workshops was empowering, while some had to take control and further their studies in order to be able to reflect on and thereby improve and understand their practice.

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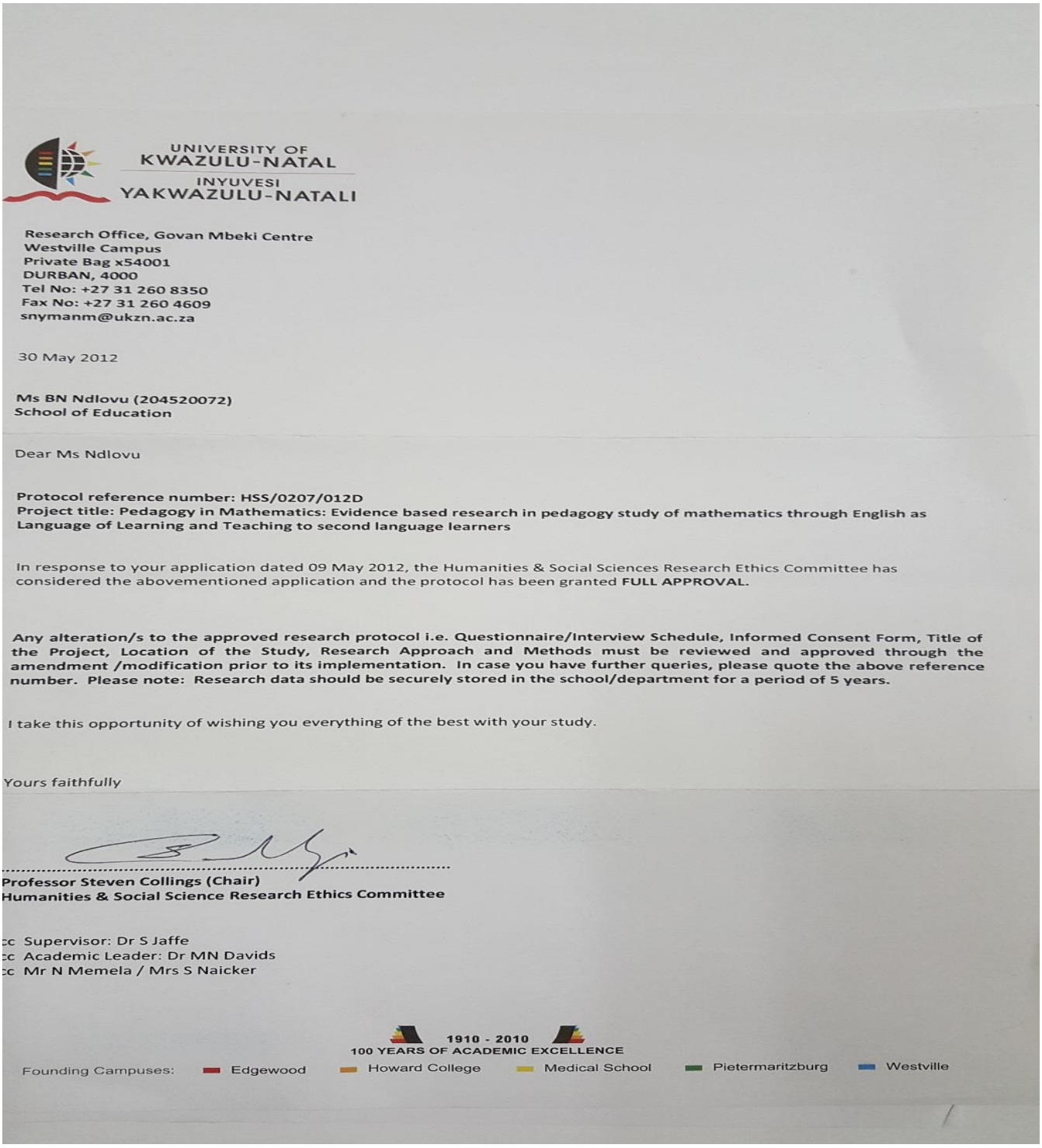
APPENDICES

Appendix-A-Ethical Clearance



UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

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Westville Campus
Private Bag x54001
DURBAN, 4000
Tel No: +27 31 260 8350
Fax No: +27 31 260 4609
snymanm@ukzn.ac.za

30 May 2012

Ms BN Ndlovu (204520072)
School of Education

Dear Ms Ndlovu

Protocol reference number: HSS/0207/012D
Project title: Pedagogy in Mathematics: Evidence based research in pedagogy study of mathematics through English as Language of Learning and Teaching to second language learners

In response to your application dated 09 May 2012, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol has 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 school/department for a period of 5 years.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

Professor Steven Collings (Chair)
Humanities & Social Science Research Ethics Committee

cc Supervisor: Dr S Jaffe
cc Academic Leader: Dr MN Davids
cc Mr N Memela / Mrs S Naicker

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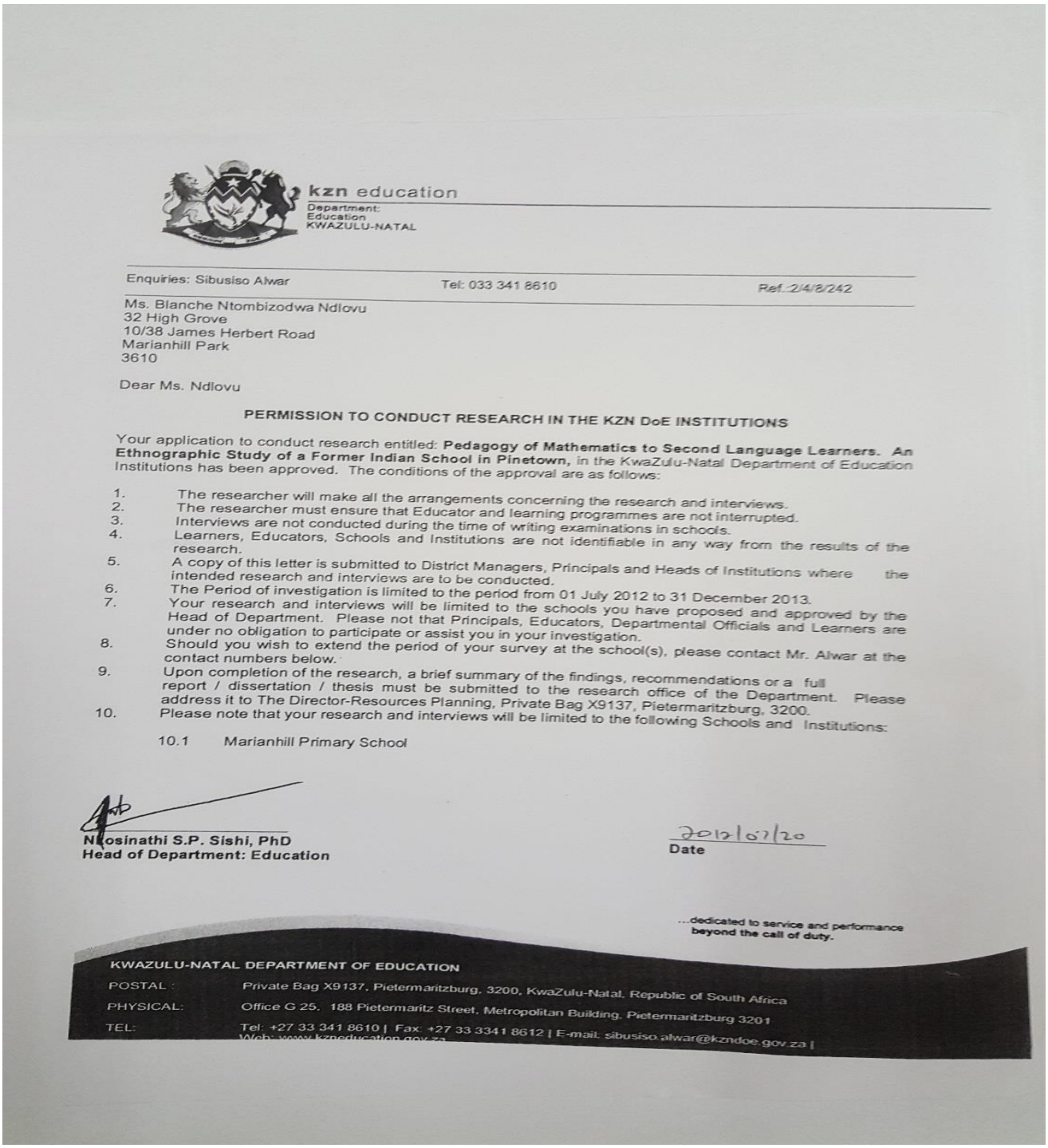
Appendix-B



kzn education
Department:
Education
KWAZULU-NATAL

Enquiries: Sibusiso Alwar | Tel: 033 341 8610 | Ref.:2/4/8/242

Ms. Blanche Ntombizodwa Ndlovu
32 High Grove
10/38 James Herbert Road
Marianhill Park
3610

Dear Ms. Ndlovu

PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS

Your application to conduct research entitled: **Pedagogy of Mathematics to Second Language Learners. An Ethnographic Study of a Former Indian School in Pinetown,** in the KwaZulu-Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the intended research and interviews are to be conducted.
6. The Period of investigation is limited to the period from 01 July 2012 to 31 December 2013.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please not that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Mr. Alwar at the contact numbers below.
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report / dissertation / thesis must be submitted to the research office of the Department. Please address it to The Director-Resources Planning, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to the following Schools and Institutions:

    10.1 Marianhill Primary School

Nkosinathi S.P. Sishi, PhD
Head of Department: Education

2012/07/20
Date

...dedicated to service and performance beyond the call of duty.

KWAZULU-NATAL DEPARTMENT OF EDUCATION
POSTAL : Private Bag X9137, Pietermaritzburg, 3200, KwaZulu-Natal. Republic of South Africa
PHYSICAL: Office G 25, 188 Pietermaritz Street, Metropolitan Building, Pietermaritzburg 3201
TEL: Tel: +27 33 341 8610 | Fax: +27 33 3341 8612 | E-mail: sibusiso.alwar@kzndoe.gov.za | Web: www.kzneducation.gov.za

Appendix-C

Letter to the School's Governing Body

Prem Mohun

University of KwaZulu-Natal

Research Office: Ethics

Govan Mbeki Centre

Tel +27312604557

Fax +27312604609

Email mohunp@ukzn.ac.za

20 February 2013

The School Governing Body

Mthandeni / Bathandenibonke Primary School

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN THE SCHOOL

I am Blanche' Ntombizodwa Hadebe-Ndlovu a Doctor of Philosophy student at the University of KwaZulu-Natal.

I hereby seek permission to conduct research at *Mthandeni / Bathandenibonke* School. My research study topic is: ***Examining teacher's understandings of pedagogic practices in teaching mathematical concepts in the Grade 1: A case study in South African Primary Schools.***

For further information on this research you may contact my supervisor, Prof. Emmanuel Mfanafuthi Mgqwashu, e.mgqwashu@ru.ac.za or Dr Simon Bheki. Khoza, khozas@ukzn.ac.za as well as Blanche Ntombizodwa Ndlovu, ndlovubl@ukzn.ac.za / 031 2603670.

Your cooperation to this regard will be highly appreciated.

Yours sincerely

……..

Appendix-D

Letters of request to Mthandeni Primary School

Prem Mohun

University of KwaZulu-Natal

Research Office: Ethics

Govan Mbeki Centre

Tel +27312604557

Fax +27312604609

Email mohunp@ukzn.ac.za

20 February 2013

The Principal

Mthandeni Primary School

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN THE SCHOOL

I am Blanche' Ntombizodwa Hadebe-Ndlovu a Doctor of Philosophy student at the University of KwaZulu-Natal.

I hereby seek permission to conduct research in your school. My research study topic is: ***Examining teacher's understandings of pedagogic practices in teaching mathematical concepts in the Grade 1: A case study in South African Primary Schools.***

Sir, may you kindly fill in the attached declaration and consent form which acknowledges the permission granted to undertake the study in your school. I also guarantee that the information gathered through research will only be used for the purposes of this research.

For further information on this research you may contact my supervisor, Prof. Emmanuel Mfanafuthi Mgqwashu, e.mgqwashu@ru.ac.za or Dr Simon Bheki. Khoza, khozas@ukzn.ac.za as well as Blanche Ntombizodwa Ndlovu, ndlovubl@ukzn.ac.za / 031 2603670.
Your cooperation to this regard will be highly appreciated.

Yours sincerely

…….

DECLARATION

As the principal of the school Mthandeni Primary School, I understand that I am not being forced to grant Blanche' Ntombizodwa Ndlovu the permission to undertake her research in my school.

……..

Signature

……..

Date

Appendix-E

Letters of request to Bathandenibonke Primary School

Prem Mohun

University of KwaZulu-Natal

Research Office: Ethics

Govan Mbeki Centre

Tel +27312604557

Fax +27312604609

Email mohunp@ukzn.ac.za

20 February 2013

The Principal

Bathandenibonke Primary School

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN THE SCHOOL

I am Blanche' Ntombizodwa Hadebe-Ndlovu a Doctor of Philosophy student at the University of KwaZulu-Natal.

I hereby seek permission to conduct research in your school. My research study topic is: ***Examining teacher's understandings of pedagogic practices in teaching mathematical concepts in the Grade 1: A case study in South African Primary Schools.***

Sir, may you kindly fill in the attached declaration and consent form which acknowledges the permission granted to undertake the study in your school. I also guarantee that the information gathered through research will only be used for the purposes of this research.

For further information on this research you may contact my supervisor, Prof. Emmanuel Mfanafuthi Mgqwashu, e.mgqwashu@ru.ac.za or Dr Simon Bheki. Khoza, khozas@ukzn.ac.za as well as Blanche Ntombizodwa Ndlovu, ndlovubl@ukzn.ac.za / 031 2603670.

Your cooperation to this regard will be highly appreciated.

Yours sincerely

…….

DECLARATION

As the principal of the school Mthandeni Primary School, I understand that I am not being forced to grant Blanche' Ntombizodwa Ndlovu the permission to undertake her research in my school.

……..

Signature

……..

Appendix-F

Letters to the research-participants in the Grade 1 participating in the study

Prem Mohun

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Research Office: Ethics

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20 February 2013

Dear Participant/ Teacher

RE: REQUEST FOR YOUR CONSERT TO PARTICIPATE IN THIS STUDY

I am Blanche' Ntombizodwa Hadebe-Ndlovu a Doctor of Philosophy student at the University of KwaZulu-Natal.

I hereby seek permission from you to be part of my study. My research study topic is: ***Examining teacher's understandings of pedagogic practices in teaching mathematical concepts in the Grade 1: A case study in South African Primary Schools.***

If you kindly agree to be participate in this study, the following will occur:

- Each participant/ teacher will be asked to take part in a semi-structured interview but this interview will take place at the time convenient for each participant.
- Each participant/ teacher will be observed whilst teaching Mathematics in the classroom, which could take 20-30 minutes.

- I will also ask to see each and every participants' file / journal that includes all the documents teachers use to teach Mathematics.
- Lastly I would like to see the work done by the learners after the classroom observation of the participants/ teacher teaching.

CONFIDENTIALITY

All records from this study will be kept as confidential as possible. I will not reveal any names no any learners' work names. As I have given your school a pseudo-name, I will also give you a code name in order to protect you and your school. The audio-tapes from the semi-structured interviews will be transcribed and summarised for this study using those code-names. All this information from this research will be kept safe by the University for about five years then discarded. I will come back with the transcript in order to verify exactly the things you said and the way you said them whilst giving you an opportunity to suggest changes if there any. Remember that participation in this study if free and voluntary, you are allowed to withdraw at any time you feel you no longer want to participate in the study. I will give you a letter of consent.

For further information on this research you may contact my supervisor, Prof. Emmanuel Mfanafuthi Mgqwashu, e.mgqwashu@ru.ac.za or Dr Simon Bheki. Khoza, khozas@ukzn.ac.za as well as Blanche Ntombizodwa Ndlovu, ndlovubl@ukzn.ac.za / 031 2603670.

Your cooperation to this regard will be highly appreciated.

Yours sincerely

…….

CONSET FORM/LETTER FOR THE PARTICIPANTS

I…….agree to take part in the research study topic: ***Examining teacher's understandings of pedagogic practices in teaching mathematical concepts in the Grade 1: A case study in South African Primary Schools*** done by Blanche' Ntombizodwa Hadebe-Ndlovu a Doctor of Philosophy learners at the University of KwaZulu-Natal.

Appendix-G

Semi-structured interview questions for the teachers

What pedagogic practices do Mathematics teachers in Grade 1 draw upon to understand teaching?

Tell me about you as a Mathematics teacher in the Grade 1.

- Describe a lesson in which you taught a specific topic, with specific reference to your teaching strategies.
- How do you measure the effectiveness of the approaches you use to teach Mathematics?
- With regards to both the teaching strategies you use to teach and assess the effectiveness of your teaching, to what extent do you feel they are effective for learners in the Grade 1?
- Which specific teaching and learning theories do you use to teach Mathematics in the Grade 1?
- Are there any other Mathematics teaching and learning theories that you know or you have used?
- Have you provided guidelines for learning outcomes and performance criteria for each of your Mathematics? Can you give me examples?
- How do you initiate and encourage classroom discussions on mathematical concepts? Can learners initiate such discussions based on learning tasks provided by you?
- How do you provide feedback to your learners?
- Do you simply mark learners' responses as incorrect, provide descriptive or numerical support for the marking or completely resolve the problem?
- Explain the different technological resources you use for interactive problem-solving and real time feedback? If yes, which one do you use?
- Which in your opinion, is a better alternative for assessment and performance evaluation: summative or formative feedback? Why?
- What formative strategies do your use in your assessment?

How do Mathematics teachers' pedagogic practices impacts on their understanding of teaching in Grade 1?

- Do you think that formative assessments are necessary?
- List and describe the assessment strategies that you use in classroom?
- What feedback strategies do you use for the above listed assessment strategies?
- Do you consider that the above feedback measures have helped your learners towards positive performance?
- How has formative feedback affected you in a professional capacity? Has it improved your own learning and delivery skills?
- Do you use the same system of formative evaluation and feedback that are compatible with the CAPS Curriculum? If so, what are the changes, both positive and negative that you have witnessed after implementation?
- In case you feel that the teaching and learning curriculum has not been altered enough to be compatible with formative evaluation, how can the situation be remedied?
- When do you give learners feedback on their work?

Appendix-H

Classroom observation Schedule for Mathematics teaching and learning in Grade 1

Semi-structured interviews Questions	**Pedagogical style – Teaching strategies**	**Theories/ concepts the teachers focused on**	**Classroom arrangements**	**Resources and Assessments**
1. Tell me about you as a Mathematics teacher in the Grade 1?	Organisation of the logic and presentation of the lesson. Learner-cantered approach	Vygotsky's Social Theory- scaffolding	The class was divided into four groups, at first the teacher used whole class approach and lastly she had groups and she worked with 1 group on the carpet area.	Worksheets/ and classwork/ charts /counters/
2. Describe a Mathematics lesson for the Grade 1.	Effective use of different strategies for Mathematics teaching	Horizontal and vertical knowledge and Scaffolding	Learners seated in rows, groups as well as individuals.	Learners working using different types of resources
3 How do you measure the effectiveness of your teaching in Mathematics?	Kinds of questions asked by the teacher to spur learners' further learning	Social knowledge- scaffolding and RD and ID	The kinds of assessment that took part in the classrooms	Reflection on the previous lessons

4 Which specific teaching and learning theories do you use for Mathematics?	Guidance and/or support to learners	Social Knowledge and Pedagogical Devise	Feedback for learners' assessments.	Games, quiz, story-books in the classrooms
5. How do you assess the effectiveness of your teaching?	Learners are taking charge for each different lessons	Scaffolding , horizontal and vertical knowledge	Feedback from learners' class work and assessments	Annual Assessment results/ tests

Appendix-I

How does the classroom look like, further semi-structured questions for the classroom observation.

1.1 Seating Arrangement:

1.2 How many desks in the classroom:

1.3 Teacher's Table:

- For assessment: what does the teacher do? Ask questions, give out assignments, homework.
- How is the lesson prepared?
- Are there any stand-out concepts in the teachers' lessons- yes learners are also asking questions of which that is very rare in regular classrooms. Learners are taking charge for each/ different lessons
- Are the goals and objectives clearly specified before the lessons?
- The kinds of teaching methods used in the classroom
- How does the teacher do reflections of the previous lesson?
- Diagnostic assessment
- How does the teacher explain the new concepts and principles?
- Lesson focus …clearly explained
- Do the learners understand the teacher when teaching using the English as the Language of learning and teaching (LoLT)?
- The interactions between the teacher and the learners….do they understand each other.
- How the teacher does involves the learners' answer the questions posed or partake in the activities given.
- Are all learners taking part in the teaching and learning?
- Are learners given times to interact with the lesson….is the time enough?
- What kinds of LTSM's were used by the teachers (chats, chalkboard, chalks, learners' exercise books/ journals, abacus, counters.

Appendix-J

The different teaching and learning approaches used by the teachers whilst observing in the classroom

- Group work, pair work, individual work
- For assessment: what does the teacher do? Ask questions, give out assignments, homework.
- The classroom observation was done to determine if the teacher/ the practice contributed to:
- Learners' understanding mathematical concepts
- Whether the teacher understood what was being done
- Classroom organisation
- Learner-Teacher Support Material (Resources) used

Learner participation in the classroom whilst observing the teachers

- Teaching approaches and strategies used to teach mathematics in the Grade 1, are these approaches aligned to the assessment for the effectiveness of teaching Mathematics in the Grade 1.
- Activities done in the classroom for both teaching and assessment focusing on theories teachers use in the classrooms for Mathematics in the Grade 1?
- What Mathematics teaching approaches do teachers used for teaching in the Grade 1?