An Exploration of In-service Teachers' Understanding of the Teaching of Mathematics/Numeracy in Grade R Class. The case of Grade R in Lesotho

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Abstract

Research have indicated that young learners are capable to learn mathematics because they are born with innate core of mathematical knowledge. Teachers of young learners are therefore, expected to offer mathematical curriculum which exposes learners to deep and explicit knowledge of high mathematics which embraces all five major content areas of mathematics in order to lay a solid foundation of the learning of mathematics in the future grades.

This study focuses on in-service teachers teaching Mathematics in Grade R classes. The dissertation is aspired to explore their understanding of the teaching of Mathematics in Grade R class. Shulman's theoretical framework of seven domains of knowledge that teachers must have in order to be able to teach any subject, guided this study. The objectives of this study were to understand in-service teachers' understanding of the teaching of Mathematics in Grade R class and to examine how in-service teachers' understanding of the teaching of Mathematics influences their teaching of Mathematics in Grade R class.

To explore this, a qualitative approach and case study design were employed. I sampled five in-service teachers from four districts of Lesotho namely Maseru, Berea, Mohale's hoek and Leribe. Data sources included teachers' interviews, classroom observations, and analysis of documents such as teachers' lesson plans, Grade R curriculum for mathematics and course outline of the mathematics course offered to in-service teachers during their training at the Lesotho College of Education.

The findings were analysed and discussed according to themes. The findings revealed that in-service teachers had an inadequate understanding of the teaching of mathematics and that has a negative influence on the teaching of mathematics in Grade R class.

Declaration

I, Mamasiphole Josephine Setoromo, declare that

i. The research report in this dissertation, except where otherwise indicated, is my original work.
ii. This dissertation has not been submitted for any degree or examination at any other university.
iii. This dissertation does not contain other persons' data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons.
iv. This dissertation does not contain other persons' writing, unless specifically acknowledged as being sourced from other researchers. Where other written sources have been quoted, then:
    a) Their words have been re-written but the general information attributed to them has been referenced;
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Signed: _____ 18th March 2015

Mamasiphole Josephine Setoromo Date

Ethical Clearance Certificate

Statement by the Supervisor

This dissertation is submitted with / without my approval.

Signed _____ 18th March 2015

Ms. Blanche' Hadebe-Ndlovu Date

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Acronyms

CCK	Common Content Knowledge
CECE	Certificate in Early Childhood Education
COSC	Cambridge Overseas School Certificate
ECE	Early Childhood Education
ECD	Early Childhood Development
HIV AIDS	Human Infectious Virus Acquired Immune Deficiency Syndrome
IECCD	Intergraded Early Childhood Care and Development
ISSA	International Step by Step Association
JC	Junior Certificate
LCE	Lesotho College of Education
MoET	Ministry of Education and Training
MDG	Millennium Development Goal
MLSC	Mathematics Learning Study Committee
NGO	Non-Governmental Organizations
NTT	National Teacher Trainers
PCK	Pedagogical Content Knowledge
PSLC	Primary School Leaving Certificate
UNICEF	United Nations International Children Emergency Fund

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CHAPTER ONE
INTRODUCTION TO THE STUDY

1.1 Introduction

This study explored how in-service teachers understood the teaching of mathematics in Grade R. The investigation comprised a case study of five Grade R classes located in three districts of Lesotho, namely Maseru, Berea and Mohale's Hoek. This chapter discusses the background of the study which includes an elaboration on how Early Childhood Education (ECE), which is pertinent to the understanding of the present study, is administered in Lesotho. The problem statement is presented in this chapter, followed by a brief review of related literature which is succeeded by a discussion of the rationale for the study. The research objectives and questions are stated. Moreover, the theoretical framework underpinning this study, as well as the research methods, is addressed. Finally, the chapter defines terms and briefly outlines the structure of the study.

1.2 Background: Physical Features of the Country and the Lesotho Educational System

Lesotho is a mountainous country and is divided into ten districts, with Maseru being the capital of the country. It is landlocked by the Republic of South Africa. The country is divided into four ecological zones: the highlands, lowlands, the foothills and the Senqu River Valley. The highlands are very cold with snow in the winter, which makes some locations very difficult to reach, while the lowlands and foothills are warm in summer. In the latter areas most places are easily accessible. Weather conditions affect school going days during winter seasons in the highlands (National Policy for Integrated Early Childhood Care and Development, 2013). This study was conducted in three physically diverse but readily accessible educational districts of Lesotho, namely Maseru, Berea and Mohale's Hoek.

The Education Statistics Bulletin (2012) reports that the Lesotho education system is structured into different levels, with learners spending a designated number of years in each level before they qualify to proceed to the next level. The first level consists of seven years of primary school education, at the end of which learners are awarded the Primary School Leaving Certificate (PSLC). From 2007 this level was allocated an additional time period during which learners, aged between 4 and 5 years, spend one year in Reception class (Grade R) before they are enrolled in Grade 1. This study focused on the Grade R year and explored

how in-service teachers understood the teaching of mathematics in this particular phase of primary school education.

The second level of Lesotho education is secondary education which begins at Form 1 (Form A) and continues to Form 3 (Form C). Upon the completion of this level, which takes three years, learners are awarded the Junior Certificate (JC). The third level is the high school/senior secondary education level. It comprises Form 4 (Form D) and Form 5 (Form E) and lasts for two years, after which learners who have successfully completed this phase are awarded the Cambridge Overseas School Certificate (COSC). In Lesotho, junior and senior secondary schools are inseparable in terms of facilities and teaching staff and are commonly called high schools (Education Statistics Bulletin, 2012).

It is imperative to elaborate on how Early Childhood Education (ECE) is being administered in Lesotho because Grade R is an important phase in the provision of ECE to children.

In Lesotho, ECE started as a project supported by Bernard Van Leer and the United Nations International Children Emergency Fund (UNICEF) way back in the 1970s when women associations still took care of the children in their communities. It became a priority after the declaration of the first Millennium Development Goal (MDG), the slogan of which was “Education for All”. This slogan expresses the paramount importance of Early Childhood Care and Development (ECCD) and therefore calls on governments to expand and improve a comprehensive Early Childhood Care and Education (ECCE) system, especially for the most vulnerable and disadvantaged children in their societies. It is against this background that the government of Lesotho, through the Ministry of Education and Training (MoET), established the Intergraded Early Childhood Care and Development unit (IECCD) in 1995. This unit became part of the mainstream in the MoET. The IECCD unit has its own mandates to fulfil, some of which are to expand and promote early childhood programmes countrywide, to coordinate and supervise provision of services at ministerial level, to provide equitable access to IECCD facilities, to improve the quality of IECCD programmes, and to mainstream all children into the IECCD programme regardless of their HIV/AIDS status and their gender during the early years (National Policy for Integrated Early Childhood Care and Development, 2013).

Two approaches were used to access, promote and expand early childhood education before the declaration of the first MDGs. The first approach was the provision of centre-based facilities for children from 0-5 years. These centers could be individually owned, cooperatively owned or church owned. Fees were charged at the discretion of the owner, and also according to the availability of teaching and learning materials which were provided by the owner of the centre. The second approach was the provision of home-based centres. These centres admitted children of different vulnerabilities; i.e., children from poor families or children who were orphans. The latter approach involved no fees because parents volunteered and took turns to look after the children on a daily basis at these centres.

After the "Education for All" approach had been launched by the MDG declaration, a third approach was introduced which is called the Reception class which caters for Grade R learners. This approach was established to fast track the implementation of the MDGs in answer to the call for "Education for All". The Lesotho government, through the MoET, prioritised ECE and, in 2007, embarked on the process of attaching Grade R classes to government, community and church registered primary schools. Currently there are 220 Grade R classes in the entire country with attachments of 32 classes in the district of Maseru, 25 classes in Berea and 25 classes in Mohale's Hoek (Educational Statistics Bulletin, 2012). It is in these three districts where the schools, which comprised the research sites for this study, are found. The backgrounds of the five schools are discussed in cf.3.5.

With the Grade R approach five-year-old learners are enrolled. Since primary school education is free in Lesotho, Grade R classes are also free and parents do not pay school fees or for meals that are provided through a school feeding programme. The main purposes of Grade R in Lesotho are: (1) to prepare learners for a smooth transition to Grade 1 when they turn six years of age, and (2) to increase access to and expand early childhood education in the country in order to reach every Mosotho child (Education Sector Strategic Plan for 2005-2015, 2005).

However, now that ECE has been formalised in Lesotho, there is some concern regarding the quality of education provided by caregivers to learners in Grade R. As a result the Lesotho government, through the Ministry of Education, communicated with the Lesotho College of Education (LCE), where teachers are trained, in order to launch a two-year in-service training programme at the college. This programme aims at training and capacitating all caregivers

working at the various ECE centres, with preference to those who teach Grade R classes. In 2007 a Certificate in Early Childhood Education (CECE) was established and the first intake was in June 2007. Since then, admissions have been undertaken every year in this programme (Educational Statistics Bulletin, 2012).

This study focused on the teachers who are enrolled as second year students in this programme and who are teachers of Grade R classes. The study explored their understanding of the teaching of mathematics in Grade R.

1.3 Statement of the Research Problem

Notari-Syverson and Sadler (2008) state that in order to prepare children for more formal mathematics instruction in the later grades, teachers need to expose them to deep and explicit knowledge of high quality mathematics education at pre-school level. McGuire, Kinze and Berch, (2011) in cognisance with Notari-Syverson and Sadler (2008), emphasise the importance of age 0-8 in the development of the child and therefore suggest that teachers, parents and researchers should recognise and embrace this development, particularly in the mathematics area. The International Step-by-Step Association (ISSA) (2010) indicates that there is a growing awareness of the importance of ECE globally. As a result, early years education is receiving unique attention from the research community, the public and political bodies. Different countries have established determined goals to increase the quantity and quality of ECD and ECE.

The Lesotho government is not an exception in this issue. Through the MoET, it has formalised the training of caregivers and has increased access of ECE to learners by attaching Grade R classes to primary schools as discussed above (cf.1.2). However, the Education Statistics Bulletin report (2012) illustrates that learners' performance in mathematics and science is still not satisfactory in Grade R and at the primary school level of education, although learners display an interest in, and a love and enjoyment of mathematical games, songs, and activities like counting and sorting. This poses a question: do in-service teachers understand the manner in which Grade R learners need to acquire the mathematical skills which should form a sound foundation for formal learning of mathematics in later grades (Notari-Syverson & Sadler, 2008)? It is on this basis that this study explored in-service teachers' understanding of the teaching of mathematics in Grade R.

1.4 Literature Review

In their study entitled "Big Math for Little Kids", Greenes, Ginsburg and Balfanz (2004) conclude that there is the possibility that all learners from different backgrounds and socio-economic status can achieve substantial mathematics learning at a young age. Ginsburg and Amit (2008) accord with Greenes *et al*. (2004) that young learners' thoughts differ from those of adults; however, young learners have the opportunity to deal with mathematical ideas on a daily basis through play that arouses their curiosity about mathematical concepts. For this reason they can easily learn interesting mathematical skills when they are exposed to games. Ginsburg and Amit (2008) argue that young learners are capable of learning mathematical skills at concrete as well as at abstract levels. Therefore teachers of young learners are advised to know mathematics content, to use appropriate pedagogical content knowledge, and to motivate learners through games and activities. Ginsburg and Amit (2008, p. 284) emphasise that "teaching math is teaching math, almost regardless of the age level". This statement demands a shift from how teachers of young learners have been teaching mathematics. They are challenged to participate in improving learners' mathematics results by engaging learners in explicit and deep learning of mathematical, and not just counting, skills (National Association for the Education of Young Children [NAEYC] and National Council of Teachers of Mathematics [NCTM], 2002).

Benner and Hatch (2009) state that teachers of young learners have a critical role to play to improve the academic mathematics results of learners; as a result, there is a need to be capacitated so that they are competent to teach mathematics. Jung and Conderman (2013) emphasise that ongoing professional training will assist teachers in improving their teaching and in engaging in intentional teaching of mathematics. Jung and Conderman (2013) insist that this kind of teaching suits the developmental level of learners. Moreover, it encourages learners to learn independently and therefore teachers are required to be creative and purposeful in all aspects of teaching mathematics in Grade R. For instance, they should plan lessons with learning objectives, employ effective teaching strategies to help learners achieve the set objectives, interact with learners, assess their progress, and modify lessons based on assessment results.

1.5 Rationale for and Purpose of the Study

I have chosen this field of study because of personal experience as a lecturer at LCE for six years where I trained, monitored and supervised ECD in-service student teachers enrolled in

the CECE programme. I have observed that most teachers teach basic counting skills, ignoring other major content areas of mathematics.

I discussed the matter with my colleagues in the department and they acknowledged that they were aware of the issue. I started to check teachers' planning documents and it was evident in their schemes of work and their previously taught lesson plans that they would spend most of the teaching time on numbers and operations and ignore other content areas of mathematics. This raised concerns which prompted me to conduct a study that would explore teachers' understanding of the teaching of mathematics in Grade R. To my knowledge, there is no study which addresses in-service teachers' understanding of the teaching of mathematics in Grade R in the Lesotho context. Hence this study will contribute significantly to knowledge in the field.

Notari-Syverson and Sadler (2008, p. 149) state that pre-school years aim to achieve different goals in the life and development of a child than schooling in the later years. Forming a solid and a broad mathematical foundation such as understanding numbers and operations, geometry, and developing a spatial sense and measurement abilities with algebra and data analysis playing supporting roles, is one of the goals of ECE. These ideals were contrary to my impressions while conducting teaching practice observations.

As a researcher, I will seek to share the findings of my study with policy makers at ministerial level and with other stakeholders who have a role to play in the training of in-service teachers working in Grade R classes, such as non-governmental organisations (NGOs) and teacher training institutions like the Lesotho College of Education. The purpose of sharing the findings of this study is for the enrichment of mathematics workshops and training which are being offered to these teachers.

1.6 Objectives

This study intended to achieve the following objectives:

- to evaluate in-service teachers' understanding of the teaching of mathematics in Grade R;

- to examine how in-service teachers' understanding of the teaching of mathematics influences their teaching of mathematics in Grade R.

1.7 Research Questions

My study was guided by the following research questions:

- What understanding do in-service teachers have of the teaching of mathematics in Grade R?
- How does in-service teachers' understanding of the teaching of mathematics influence their teaching of mathematics in Grade R?

1.8 Theoretical Framework

This study was guided by Shulman's theoretical framework of teacher knowledge. Shulman (1987) argues that teaching is crucial because it develops the cognitive, physical and emotional skills of learners; therefore it is imperative to know what is in teachers' minds and how they carry out their duties. Morrow (2007), in agreement with Shulman, clarifies the fundamental duty of a teacher as to teach a child based on knowledge of what to teach and how to teach it. The seven knowledge bases which Shulman (1987) identified are regarded as the minimum knowledge required for teaching; these were used in this study to generate and analyse data regarding in-service teachers' understanding of the teaching of mathematics in Grade R. The seven knowledge bases are as follows: content knowledge; general pedagogical knowledge; curriculum knowledge; pedagogical content knowledge; knowledge of learners and their characteristics; knowledge of educational contexts; and knowledge of educational purposes and values as well as of philosophical and historical influences.

1.9 Research Design and Methodology

1.9.1 Research paradigm

This study was underpinned by the interpretive paradigm. The interpretive paradigm aims at understanding the social behavior of people and how they make meaning of their experiences (Bertram & Christiansen, 2014, p. 35). This paradigm afforded me the opportunity to visit teachers in their schools in order to explore and interpret, firstly, the understanding which they had of the teaching of mathematics in Grade R, and secondly how they understood the influence of their teaching of mathematics in Grade R. The interpretive paradigm further

allowed me to facilitate the generation of data by asking open-ended questions and engaging with teachers by asking them probing questions and digging for deeper meaning in order to gain an intensive understanding of teachers' understanding of mathematics teaching and to facilitate the interpretation of the data.

1.9.2 Research approach

A qualitative research approach was employed for this study. Maree (2009, p. 78-79) states that "qualitative research is based on a naturalistic approach that seeks to understand phenomena in real-life situations." The study aimed at achieving an in-depth understanding of teachers' understanding of the teaching of mathematics in Grade R; hence the qualitative approach allowed me to interact intensively with the participants by engaging in face-to-face interactions with them, and by talking to and seeing them behaving in their real-life context (Creswell, 2011, p. 45). The identified participants were visited at the schools where they worked in order to observe them while they were teaching mathematics in Grade R classes.

1.9.3 Case study

A case study design was employed for this study. Yin (2009) clarifies that a case study helps the researcher to be engaged in a study and to systematically explore and gain in-depth understanding of a particular case in its context. Therefore, this design allowed me to embark on a multiple case study where I originally selected four schools as my research sites from four different districts in Lesotho (Leribe, Berea, Maseru and Mohale's Hoek). Owing to the withdrawal of one participant because of his personal experiences regarding audio taping, I had to replace him. I decided to replace him with two participants for stronger back-up in case another participant withdrew. The sample size for the case study approach I adopted was therefore five schools and five in-service teachers in three districts of the country, namely Berea, Maseru and Mohale's Hoek.

1.9.4 Sampling

I used purposive sampling because it afforded me an opportunity to select participants who qualified to be holders of the required data (Maree, 2009). I coupled purposive sampling with convenience sampling which allowed me to choose individuals nearest to the purposes of my investigation to serve as respondents, as suggested by Cohen, Manion and Morrison (2011).

Data were generated through the use of semi-structured interviews, structured observations and analysis of documents such as teachers' lesson plans, the Mathematics Curriculum for Grade R, and course outline material of mathematics offered to in-service teachers during their training at LCE. The use of multiple data generation tools added trustworthiness to the findings of this study, as purported by Maree (2009). Triangulation of data was not used because Maree (2009) pointed out that triangulation is used in quantitative studies to confirm and generalise research findings.

1.9.5 Data analysis

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*., 2011).

1.10 Definition of Terms

- **In-service teachers** is a term that refers to teachers who are "enrolled in distance education programmes [and who] are usually already involved in teaching in their own classrooms" (Aldridge, Fraser & Ntuli, 2009, p. 147).
- **Grade R** is the class prior to Grade 1 which admits learners who are 4 to 5 years of age. This class prepares learners by equipping them with the necessary academic skills in the junior education phase (Education Statistics Bulletin, 2012).
- **Mathematics** has been defined by a large number of scholars, but for the purposes of this study the definition by Brown, Askew, Baker, Denvir and Millett (2010, p. 365) was adopted: "Mathematics is the ability to process, communicate, and interpret numerical information in a variety of contexts".

1.11 Brief Overview of the Study Report

This study report is divided into five chapters. In this section the structure of each chapter is briefly outlined.

Chapter One is an introductory chapter which provides a discussion on the following: the background to the study, the Lesotho education system, and ECE in Lesotho. The chapter also presents the statement of the problem, the rationale for the study, the research questions and objectives, the theoretical location of the study, research design and methodology, definition of terms, and the structure of the study report.

Chapter Two reviews relevant literature to explore in-service teachers' understanding of the teaching of mathematics in Grade R. The literature reviewed included relevant academic articles, research reports and books. The theoretical framework which guided this study is also discussed in this chapter.

Chapter Three provides an account of how the study was designed and conducted. In a nutshell, it unpacks the research design and methodology which I embarked on to address the paradigm and approach underpinning the study.

Chapter Four presents the data related to my research questions and analysed findings. The chapter contains transcriptions of relevant verbatim discourses by the participants as part of the data selected. Four major themes that emerged from the data are presented, discussed, and analysed.

Chapter Five concludes the study report with recommendations with regard to the findings of this study.

1.12 Conclusion

This chapter provided background information on Lesotho and its education system in order to contextualise this study. The chapter addressed the problem that prompted the need for this study to be undertaken. It briefly reviewed related literature, followed by a discussion of the rationale behind this study. The research objectives and questions of this study were also stated. The theoretical location of the study was briefly outlined. The research design and methodology, definition of terms and the structure of the study report were presented.

The next chapter presents a review of literature from various publications. The literature reviewed focused on relevant information for the exploration of in-service teachers' understanding of the teaching of mathematics in Grade R.

CHAPTER TWO

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Introduction

This chapter presents a review of various publications which were found to be relevant to an exploration of in-service teachers' understanding of the teaching of mathematics in Grade R. The review of the literature focuses on the following: First, a discussion on major content areas of mathematics for Grade R learners is presented. Second, a discussion on how learners learn follows. In this context the following sub-themes are discussed: psychological perspectives on learners' learning of mathematics; different kinds of knowledge; conceptual learning; experiential learning; and factors that contribute to effective learning. Third, the literature review incorporates a brief elaboration of the theoretical framework of Shulman (1987) who proposes that each teacher must possess seven domains of knowledge in order to be able to teach any subject. Fourth, the review explores the teaching of mathematics which entails the following sub-themes: prior knowledge; intentional teaching of mathematics; strategies for the teaching of mathematics; use of concrete objects; learning styles; assessment; and barriers to the effective teaching of mathematics. Further discussions include: reasons for teaching mathematics to Grade R learners; planning to teach; teachers' documents for teaching; and training of teachers.

2.2 Major Content Areas of Mathematics for Grade R

The awareness of and the need to teach mathematics to Grade R learners captured various researchers' attention, who then embarked on conducting different studies focusing on various major content areas of mathematics which Grade R learners need to learn and master. Numbers and operations seem to have attracted many researchers such as McGuire *et al*. (2011), who conducted a study on developing number sense in Pre-K with Five-Frames. Jordan, Kaplan and Locuniak (2009) conducted a study which explored learners' number competence and later mathematical skills. They concluded that it is important for learners in Grade R to develop number competence because it forms a good basis for their development in elementary school mathematics, as being competent in numbers and operations forms a solid foundation for the learning of other domains of mathematics. Moreover, Van de Rijt and Van Luit (1999) outline that there are different mathematical concepts involved in counting

situations such as cardinal counting and situations that relate to the sequence of cardinal numbers, measurement, ordinal situations, symbolic situations and non-numerical situations that contribute to the development of counting for learners. As a result, they also form a solid foundation for the later learning of mathematical skills. Grade R learners should therefore be exposed to all number situations so that a solid foundation for mathematics is laid.

The Community Learner Care of Victoria (2011, p. 8) states that classroom activities should involve mathematical concepts which lead to "numerical reasoning, classifying, grouping, sorting, recognising, distinguishing, symbolising and representing". Missall, Mercer, Martínez and Casebeer (2012) indicate that learners develop mathematics concurrently across five major content areas of mathematics, namely: numbers and operations; geometry; algebra; measurement; and data analysis. These major content areas of mathematics exist and are further cultivated as learners grow, but occur at different levels of sophistication.

Greenes *et al*. (2004) points out that teachers should avoid limiting major content areas of mathematics to counting, shape identification, the identification and completion of repeating patterns and to an introduction to measurement comparisons. Teachers should teach all major content areas of mathematics as stipulated in the curriculum. However, they should not only introduce mathematical concepts and skills, but they should also expose learners to explicit mathematical knowledge by maintaining and enriching mathematical ideas in a playful manner through a variety of activities as the policy stated.

Missall, *et al*. (2012, p. 96) contextualise mathematics for Grade R by explaining it as follows: "…numbers and numbers operations encompass the skills of number knowledge, verbal counting, basic calculation and quantity comparisons; geometry is defined by identifying shapes and describing spatial relations; measurement skills include identifying quantifiable attributes and comparing objects using the attributes; algebra translates to skills related to identifying patterns and bringing organisation and predictability to unorganised situations; and data analysis concerns classifying and ordering information to ask and answer questions." Missall *et al.* (2012) conclude that the mathematical skills detailed above indicate the basis upon which further education and real-life functioning are grounded.

2.3 How Learners Learn

2.3.1 Psychological perspectives on the way learners learn mathematics

This section reviews literature on how different theorists view the learning of mathematics by young learners. The review focuses on the psychological point of view of three theorists, namely Piaget, Vygotsky and Bruner, and explores the constructivism philosophy of learning.

2.3.1.1 Piaget

Piaget (1973) notes that learners are able to create their own ideas and that the knowledge they receive from parents or teachers is not limited. He also observes that learners construct their own knowledge and as they do so, learning occurs whereby they create products or artefacts which become more meaningful when they are related to their personal experiences. Piaget identified four major stages of cognitive development of learners and adolescents, namely: sensor motor; preoperational; concrete operational; and formal operational. He believes that all learners pass through all these stages without skipping any, and as they progress through each stage they show intellectual abilities and their understanding of the world around them increases. Piaget further observes that factors like the environment and background of each learner affect the level at which they progress throughout each stage.

Piaget describes the characteristics of the four stages as follows: The first stage is the sensor motor stage. This stage begins from birth to 2 years of age. During this stage learners are involved in motor activities but there is limited knowledge because it is based mainly on physical interactions and experiences. Learners at this stage learn through trial and error. Piaget says that as learners become stronger and more mobile, their ability to develop cognitively increases, and they also develop language (Piaget, 1973).

The second stage is called the preoperational stage which occurs between toddlerhood (18-24 months) and early childhood (7 years). At this stage young children use language, memory and imagination to learn and develop. They learn as they are involved in different kinds of play, like make-believe (fantasy play). Through play, learners may understand and express relationships between the past and the future. They are egocentric, meaning that they look at things from their own perspective. This study focused on learners who are at this stage of development or being.

The third stage is the concrete operational stage which ranges from 7 to 11years. At this stage learners demonstrate their intellectual development through the use of logic and systematic manipulation of symbols related to concrete objects. They are less egocentric now (Piaget, 1973).

The formal operational stage is the period from adolescence to adulthood. At this stage, learners use symbols related to abstract concepts. Learners at this stage can form hypotheses and can also think about abstract concepts. Piaget believes that intellectual development is a lifelong process which develops more complex schema through the addition of knowledge. Piaget's theory insists that the learning content offered to learners should be developmentally appropriate to their age. The teacher must be creative while facilitating learning by providing a variety of experiences. Learners should be engaged in learning that creates opportunities to discover things by themselves, because discovery provides them with opportunities to explore and experiment and thereby encourage new understanding and learning of things (Piaget, 1973).

Piaget (1973) suggests that teachers should provide learners with concrete materials, visual aids and models and also use familiar examples. Teachers should also provide opportunities to discuss different cultural, political or social issues at an appropriate level. Piaget emphasises that teachers should, as far as possible, contextualise concepts and facts that they teach learners so that learners make meaning of them.

2.3.1.2 Vygotsky

Taylor (2013) states that theorists like Vygotsky, who is a social constructivist, argue that learners need guidance from more knowledgeable adults and that they need opportunities to interact socially with peers as a means of learning. Vygotsky proposed the idea of the "Zone of Proximal Development", which simply means that a learner needs to work with another person in order to achieve something that is impossible for them to achieve on their own, thereby learning through this process of guidance so that eventually they are able to perform the task alone. This process is sometimes called scaffolding.

Teachers need to have knowledge and understanding of Vygotsky's theory because it clarifies that each learner has the potential to successfully learn new knowledge, provided they s/he is offered the needed support by a more knowledgeable person. This theory again insists that

learning is a process; as a result, it takes time to acquire new knowledge but it becomes easier if the existing knowledge of a learner is connected to the new one (Taylor, 2013).

2.3.1.3 Bruner

Bruner (1965) advocates that cumulative learning is important in the learning process because it affords learners an opportunity to build their learning on previously learnt ideas. Bruner suggests that learners undergo three phases during the learning process.

The first phase is termed the inactive phase. This is when learners are engaged with something concrete in order to explore and manipulate ideas. This kind of learning involves the use of the whole body, so it is related to kinaesthetic learning. The second phase is called the iconic phase. In this phase learners begin to represent ideas in a more abstract way. This is the time when models and images are used to support and assist learners' thinking during the teaching of mathematics so that learners are able to visualise some of the mathematical concepts that they have to master. At this stage learners begin to represent ideas in more abstract ways. The third phase is termed the symbolic phase. This is when learners can use abstract ideas to represent mathematics (Bruner, 1965).

In terms of Bruner's theory, the first phase is relevant to how Grade R learners learn mathematics. It is therefore important that teachers have the knowledge and understanding of this phase so that they are equipped with appropriate classroom instructions that they need to employ in mathematics lessons.

2.3.1.4 Constructivism

Fosnot (1996) states that constructivist learning takes place when knowledge is constructed physically by learners as active participants during the teaching and learning process. This occurs symbolically as learners represent their own actions, socially as they convey their understanding to other people and things around them, and theoretically as they try to explain things they do not understand. Stiff (2001) asserts that constructivism addresses the role of the teacher and of the learner in order for learning to take place. During the facilitation of teaching and learning, teachers are expected to provide the necessary support by fostering integration in the classroom and extending knowledge among learners so that they acquire deep understanding of the subject matter.

Stiff (2001) points out that constructivism requires learners to be actively involved to build their knowledge. Moreover, they should be free to use their own strategies to learn. Learners construct their knowledge best when it is socially embedded in their social contexts. Different forms of interactions should exist in the classroom, such as teacher and learner interactions or learners working together either in pairs or small groups. Stiff (2001) emphasises that these interactions are useful in mathematics education because mathematics emphasises problem solving; thus, during the interactions, learners create their own strategies for solving problem tasks. ISSA (2010) proposes that, through interactions, learners develop a sense self. They acquire a sense of being a community member with knowledge of the world around them. Another important factor of constructivism is that it focuses what learners can do by integrating new knowledge with existing knowledge so that they create deeper understanding of, for example, mathematics.

As illuminated above, various psychologists have elaborated on how learners acquire new knowledge. The following section will discuss the different knowledge bases that learners need in order to comprehend mathematical concepts and acquire mathematical skills.

2.3.2 Different kinds of knowledge

There are three kinds of knowledge which are important to the development of all learners, but specifically for the development of mathematical skills (Department of Basic Education, 2012). These are physical, social and conceptual knowledge.

2.3.2.1 Physical knowledge

Learners construct physical knowledge by touching, using, playing with and acting on concrete materials. Teachers should therefore enhance acquisition of physical knowledge by creating opportunities for learners to play, handle and explore with concrete materials (Department of Basic Education, 2012).

2.3.2.2 Social knowledge

Learners acquire social knowledge by being told and the expectation is that they should remember that knowledge. Examples of social knowledge are number names and names of shapes (Department of Basic Education, 2012).

2.3.2.3 Conceptual knowledge

Long (2005) highlights that conceptual and procedural knowledge are important knowledge bases in the learning process; therefore teachers should develop their lessons and present them in a manner that allows learners to develop such knowledge. Long (2005) further explains that conceptual knowledge is obtained by constructing the relationship of two pieces of information or by creating relationships between the existing knowledge and the new one.

2.3.3 Conceptual learning

Rusznyak and Walton (2011) indicate 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 easily.

2.3.4 Experiential learning

Hartshorn, Robert-Boren and Sue (1990) postulate that experiential learning is based on the idea that when learners are actively involved in the learning of any subject matter, it is then when learning takes place. Hartshorn *et al*. (1990) insist that mathematics is abstract, so in order to make it understandable, the use of concrete materials is recommended. The manipulation of concrete materials is useful because it assists learners to move from the concrete to the abstract level; however, teachers must be careful when selecting manipulative activities because they have to ensure that such activities are appropriate for the developmental level of the learners they teach, as discussed above under Piaget's theory.

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 real objects to solve the problem; the semi concrete level is when they use pictures of real objects; and the semi abstract level is when learners use symbols that represent concrete objects, but the pictures do not look the same as the real objects they are representing. This therefore implies that Grade R teachers should engage learners in the manipulation of concrete materials because they are, according to Piaget, in the second stage of development (Piaget, 1973).

2.3.5 Factors that contribute to the effective learning of mathematics in Grade R

2.3.5.1 Learning environment

It is stated in section 2.3.1.1 that learners in the preoperational stage learn by manipulating concrete materials; hence, during the teaching and learning of mathematics, teachers need to create a classroom environment which will enable learners to manipulate concrete materials. This process will enable learners to have unlimited access to challenging mathematics learning (Varol & Farran, 2006). Teachers should provide a favourable learning (i.e., classroom) environment which motivates learners to learn mathematics spontaneously. For instance, Ginsburg, Lee and Boyd (2008) state that physical classroom environments differ in terms of quality. Where the existing physical classroom environment is unattractive and unappealing, it needs to be improved, because a classroom environment that is conducive for the learning of mathematics is one that has a variety of objects and materials that enrich and arouse learners' curiosity to learn mathematics. In the case of Grade R, such materials could be blocks, puzzles, and a fantasy area. Clement (2001) adds that although high quality learning in Grade R is sometimes incidental or informal, it still has to be planned and prepared for all the time. Teachers are expected to organise the learning environment in a manner that creates opportunities for learners to explore mathematical concepts. The class environment could include, for example, unit blocks and a "shopping centre", as these will expose learners to a variety of mathematical concepts while they play.

Varol and Farran (2006) suggest that the classroom should have external and internal characteristics. By external characteristics, they mean things like the arrangement of the furniture in the classroom and the additional materials and their display to arouse learners' interest and maintain learners' acceptable social behaviours. By internal characteristics, they refer to the internal characteristics of teachers, which are their personal qualities such as their attitudes and beliefs regarding mathematics, and learners' attitude to and knowledge of mathematics. Varol and Farran (2006) indicate that these characteristics are essential because they are capable of transforming a classroom into a learning environment that advances learners' ability to learn mathematics. However, Ginsburg *et al*. (2008) point out that teachers should be aware that a rich environment alone does not guarantee effective learning of mathematics; the most important thing is what learners are doing in that classroom. Therefore, teachers should provide the necessary support to all learners so that they learn mathematics effectively. ISSA (2010) adds that the learning environment greatly influences in learners different developmental aspects; as a result, learners should be provided with safe

and stimulating environments that afford them with different developmentally appropriate materials, tasks and situations. Teachers should also create an environment which promotes independent learning, group exploration, play, and interaction with both the teacher and among learners themselves.

2.3.5.2 Play

Wood (2013) postulates that in early childhood education, play is considered essential for learning and development to take place. Wood (2013) argues that works of philosophers like Piaget have influenced early childhood education. For instance, Piaget identified three categories and stages of play (Piaget, 1973). The first is practice play. This category of play caters for learners who are at the sensory motor stage. Learners at this stage enjoy exploring physical activities. The second, namely symbolic and construction play, is normally enjoyed by learners at the pre-operational stage. Learners at this stage enjoy, pretend, fantasise and enjoy socio-dramatic play which involves the use of mental representation. The third category of play is games with rules. This category caters for learners who are at the concrete operational stage. At this stage learners enjoy a game with predetermined rules. I have also observed that at this stage children make up the rules of a game as they go along.

The report of the Foundation Phase Conference (2008) points out that the indigenous games that learners play in their communities possess different concepts of mathematics which learners enjoy enormously. Therefore, the report maintains that teachers should incorporate those games in their teaching. Ginsburg *et al*. (2008, p. 7) contend that play "provides valuable opportunities to explore and undertake activities that can be surprisingly sophisticated from a mathematical point of view". For instance, while learners are playing with puzzles they learn patterns, shapes and symmetries. However, Ginsburg *et al.* (2008) highlight that play alone is not enough to explicitly teach mathematics to learners; as a result teachers' support is still needed during play in order to assist learners to connect their play experiences with the formal learning of mathematics.

2.3.5.3 Valuable moments to teach mathematics

Ginsburg *et al.* (2008) assert that there are teachable moments which teachers should be intelligent enough to identify. These moments allow and accept the presence of the teacher during free play to guide and unconsciously facilitate learning to take place. Teachers are expected to carefully observe learners as they play in order to identify activities and moments

that promote the learning of mathematical concepts. If those moments are addressed opportunely, learners will have opportunities to experience excellent learning (Ginsburg *et al*., 2008). Teachers should therefore not focus only on managing the behaviours of learners, but they should pay more attention to and be knowledgeable of identifying moments to teach mathematical concepts during play.

Daily activities in schools have mathematical features that can be emphasised to create opportunities for the exploration of and conversation about key mathematical ideas, or the application of mathematical ideas in new contexts (Greenes *et al*, 2004). For instance, during sand or water play, teachers may enrich the play by providing a variety of containers. As learners play, the teacher utilises educational moments to teach concepts such as mass, volume and capacity. Instructing or asking questions such as, "Bring an empty container", or "Which container is half full?" and "Which one holds more water?" are effective in instilling mathematical concepts. Klibanoff, Levine, Huttenlocher, Vasilyeva and Hedges (2006, p. 61) suggest that "teachers should incorporate math talk naturally into their daily routines and create opportunities within the classroom that engage learners into conversations that include mathematical concepts". This is because practices like these enhance the growth of learners in acquiring mathematical knowledge (Klibanoff *et al*., 2006).

2.3.5.4 Projects

Teachers need to involve learners in projects that require them to learn and experience mathematical concepts in a practical manner. For instance, learners can be involved in a project of making their own table. This project will expose them to measurement, counting, height and space. Teachers need to assist learners to make sense of real-life problems through the use of projects and this will add fun and stimulate learners to learn mathematics in a relaxed manner (Ginsburg *et al*, 2008). Effective mathematics instruction requires teachers to possess sound content knowledge and pedagogical content knowledge (Shulman, 1986). It is crucial for teachers to be competent to interpret learners' thinking and to integrate their actual teaching with learners' experiences, interest, and needs.

This study explored in-service teachers' understanding of the teaching of mathematics in Grade R. To undertake this task, Lee Shulman's theoretical framework was employed. The following section discusses the theoretical framework that guided this study.

2.4 Theoretical Framework

The theoretical framework for this research was drawn from the work of Lee Shulman (1987). Shulman stipulates seven domains of professional knowledge required for effective teaching, namely: subject matter content knowledge; pedagogical content knowledge (PCK); curricular knowledge; general pedagogical knowledge; knowledge of learners; knowledge of educational contexts; and knowledge of educational aims, goals and purposes. I therefore used Shulman's knowledge domains to explore teachers' understanding of teaching and learning of mathematics in Grade R.

Shulman (1987) indicates that teachers must possess and demonstrate subject matter content knowledge. This means that they should know the facts, concepts, organisation, principles and structures of the subject they teach. Shulman argues that the teacher must show an understanding in terms of why a particular topic is essential to a discipline while another may be somewhat minor. The author asserts that teachers must be knowledgeable and have an understanding of the subject matter themselves. They should demonstrate competences regarding the use of rules and laws that govern the subject matter. Shulman (1987, p. 9) further points out that "content knowledge requires going beyond knowledge of the facts or concepts of a domain; instead, it requires understanding the structures of the subject matter." Ball, Thames and Phelps (2008) accord with Shulman (1987) that teachers themselves should know the subject matter in order to be able to help learners to learn the content.

Shulman (1987, 1986) refers to pedagogical content knowledge as the representation and formulation of subject matter in such a way that it is understandable to others. Shulman points out that to enable learners to understand the subject matter, teaching strategies such as analogies, illustrations, discussions, examples and explanations can be used to present the content and ideas in a lesson. Hurrell (2013, p. 55) adds that teachers' ability to employ those strategies requires "a practical knowledge of teaching and learning guided through a contextualised knowledge of a particular classroom setting".

Curricular knowledge is another domain which Shulman describes as a requirement for teachers' knowledge. This means that they need to know and understand the subject content, the topics and programmes as stipulated in the curriculum of the subject they teach.

Moreover, they need to know and understand the variety of instructional materials available for the programme. Chukwbikem (2014) insists that those resources provided by the curriculum should be informative and practical, and must suit a range of early childhood settings. The curriculum should provide examples of how teachers can create a stimulating environment for their learners in order to make use of the most critical period of rapid development in learning. Seo and Ginsburg (2004) also suggest that teachers should be able to implement the Grade R Mathematics curriculum in an effective and developmentally appropriate manner. It is therefore important for teachers to understand all the topics in the curriculum; that is its depth, breadth and sequence. Understanding of the topic should enable teachers to connect their knowledge of the subject with the topics they are to teach in Grade R in a harmonious manner. They should work towards teaching all the stipulated topics in the curriculum and be creative in altering the curriculum if the need arises.

Shulman (1987) defines general pedagogical knowledge as teachers' knowledge and understanding of broad principles and strategies of classroom management and organisation that apply to the subject to be taught. NAEYC and NCTM (2002) suggest that within the classroom, teachers should enrich learners' natural interest in mathematics as well as create a favourable classroom environment that helps learners to develop characters like curiosity, imagination, persistence and flexibility. Teachers are therefore expected to arrange the classroom in a manner that will display different learning and discussion areas. There has to be a display of learners' work regarding mathematics and posters that spontaneously enhance learning of mathematics.

Shulman (1987) defines that knowledge of learners refers to the knowledge and understanding that teachers should have about the learners that they teach. They should know their characteristics, cognition, motivation, developmental abilities, interests, and their cognitive development. NAEYC and NCTM (2002) postulate that teachers should know learners' different learning styles, their needs, their interests and their potential for cognitive and conceptual development. Hollins (2011) postulates that teachers should know learners as unique individuals who belong to different social and cultural groups and who have specific characteristics. Teachers should know learners' emotional, psychological and social needs in order for them to develop. Seo and Ginsburg (2004) argue that learners bring different types of informal mathematical knowledge to the classroom. For this reason teachers should be able to integrate their subject matter and the strategies they use to teach mathematics with the

knowledge that learners have acquired informally from their different backgrounds. Also, activities in class should cater for all learners' learning styles. Hollins (2011) agrees with Seo and Ginsburg (2004), but expresses the concern that teachers are not properly trained in skills to link previous knowledge with new knowledge.

Knowledge of educational contexts refers to teachers' understanding and knowledge of learners' backgrounds, their culture, and the community surrounding the school (Shulman, 1987). NAEYC and NCTM (2002) emphasise that teachers should demonstrate knowledge and understanding of the differences that exist among learners such as their cultural backgrounds. This kind of knowledge will help teachers to select appropriate teaching materials that are familiar to learners and to use examples that are relevant to the learners' social contexts. For example, when teaching about money, learners in Lesotho will understand it better if the teacher talks about Maluti, and not dollars.

Shulman (1987) posits that teachers should possess knowledge of educational aims, goals and purposes. In this context he refers to teachers' understanding and knowledge of the long and short term goals of education and of the subject(s) they teach, as spelled out by educational authorities in government. The NAEYC and NCTM (2002) suggest that teaching that promotes problem solving, reasoning and many other mathematical concepts is consistent with the national reports on mathematics education. This knowledge will also assist teachers in knowing the purpose of teaching mathematics to Grade R learners. Moreover, through such knowledge they become aware of their contribution to the growth of the economy of the country and the development of valuable human resources.

In a nut shell, Shulman (1987) stresses that all domains of knowledge are vital and need to be known and practised by all teachers in order to execute effective teaching that benefits all learners. Therefore, to address the aims and objectives of the study, Shulman's seven domains of professional knowledge for effective teaching were incorporated in the study design in order to gain insight into teachers' understanding of teaching mathematics in Grade R. The following section discusses the effective teaching of mathematics in Grade R.

2.5 The Teaching of Mathematics in Grade R

Hollins (2011, p. 395) explains that teaching "is a complex and multidimensional process that requires deep knowledge and understanding about a wide range of ideas and the ability to synthesise, integrate and apply this knowledge in different situations, under varying conditions and with a wide diversity of groups and individuals". This definition is applicable to the early childhood education context because teachers need to possess adequate knowledge of mathematics in order to demonstrate their competences in facilitating learning. Moreover, teachers need to employ effective teaching strategies and methods that hold learners to positively learn mathematics, and they also need to creatively arrange and create a positive atmosphere in the classroom that enhances and motivates learners to learn mathematics spontaneously (Young & Stuart, 2011). The joint position statement entitled "Early childhood maths: promoting good beginnings" by NCTM and NAEYC (2002, p. 1), outlines that "high quality, challenging and accessible mathematics education for 3 to 6 year old learners is a vital foundation for future mathematics learning". It recommends that in every early childhood setting, learners should be involved in a well-informed curriculum and teaching practices so that they could be helped to learn mathematics effectively.

The Mathematics Learning Study Committee [MLSC] (2001) defines the effective teaching of mathematics as "…teaching that fosters the development of mathematical proficiency over time". The MLSC (2001) further points out that this kind of teaching occurs when there is interaction between the three vital entities in education, namely the teacher, learner and content, in an appropriate context that promotes teaching and learning. The MLSC (2001) also asserts that effective teaching rests on teachers' knowledge, their use of mathematical content, and their attention to learners. Teachers with these competences are able to select tasks that engage learners in critical thinking and are able to plan lessons that build new knowledge on the learners' existing knowledge. Teachers will therefore relate tasks or activities to learners' life experiences and allow learners enough time to work on any assigned tasks (MLSC, 2001; Mewborn, 2003; Grossman, 1990).

NAEYC and NCTM (2002) add that teachers should learn mathematics content which is directly relevant to their professional role and should show competence in planning mathematics activities that will engage learners in a deep and sustainable interaction with key mathematical ideas or major content areas which are: numbers and operations; geometry;

measurement; algebra (including patterns); and data analysis. It is therefore important that teachers master mathematics as a subject because their expertise regarding the subject matter is expected during the teaching and learning process. Seo and Ginsburg (2004) point out that early childhood mathematics entails broad and deep mathematical ideas. For instance, geometry is broad because it includes subtopics like shape and spatial reasoning. Shape involves two dimensional figures like square, circle and rectangle as well as three dimensional figures like cubes, octagons and cylinders. Spatial reasoning involves position (e.g., between, in front) and direction (e.g., left and right). Early childhood mathematics is also deep; for instance, for algebraic thinking, learners are being prepared to organise data and make predictions and generalisations and they also learn basics for linear function. These examples show that teachers need to master the subject matter for effective teaching of mathematics in Grade R.

As discussed above, effective teaching is influenced by different aspects, but for the purpose of this study only the following aspects will be discussed: prior knowledge, intentional teaching, strategies for effective teaching of mathematics, uses of concrete objects (i.e., teaching aids); learning styles; assessment; and barriers to effective teaching of mathematics.

2.5.1 Prior knowledge

Learners enter formal schooling with different types of informal mathematical knowledge, such as number and geometry, which they developed informally during their different everyday life experiences such as counting and sharing sweets with friends and family members (Seo & Ginsburg, 2004; Clement, 2001). Hollins (2011, p. 397) further adds that teachers should know the learners that they teach “as individuals, as members of social and cultural groups, as learners with particular characteristics and as learners at a particular point in their academic, emotional, psychological and social development”. Hollins (2011) insists that this knowledge plays a vital role in the teaching and learning process because, while teachers prepare and plan the lessons, their facilitation and support of the learning process depend on their understanding of learning strategies, knowledge of learners’ previous experiences, their values, attitudes, and cultures.

2.5.2 Intentional teaching of mathematics

Notari-Syverson and Sadler (2008) argue that early childhood learners need to be prepared for more formal mathematics instruction in the later grades. Hence they should be exposed to deep and explicit knowledge of high quality mathematics education at preschool level. MLSC (2001) states that the quality of instruction is determined by the engagement of the learner, therefore instruction should help learners to connect their informal knowledge of mathematics with their experiences of formal mathematics. This connection can be done through manipulation of physical objects. However, teachers need to be clever enough to use them well because, if they do not, learners will fail to connect their use with new knowledge.

The ECE guidelines for teacher preparation, developed by NAEYC (2003), emphasise that teachers need to recognise the concepts and skills that are developmentally appropriate for young learners. More important, they must know what is essential in each content area and they also have to determine why these content areas are crucial. They should employ good strategies to simplify crucial parts of the content in order for learners to comprehend them easily. Teachers' knowledge of learners' developmental levels is very important because the teacher will recognise the impact of cognitive, language, social and emotional development on learners' understanding of topics presented to them (NAEYC, 2003). The MLSC (2001) insists that teachers should demonstrate proficiency when teaching mathematics by possessing conceptual understanding. This means that they should understand the core knowledge of mathematics, the students, and instructional practices needed for teaching. They should demonstrate an understanding of procedural fluency by carrying out basic instructional routines such as introducing the lesson and engaging learners in class activities. Teachers could as well demonstrate proficiency by being strategic when planning effective instruction and solving problems that arise while teaching.

It is stated in the theoretical framework that teachers' knowledge of teaching strategies is important in the teaching process; therefore the next section discusses different strategies for teaching mathematics in Grade R.

2.5.3 Teaching strategies for the teaching of mathematics in Grade R

Teachers are advised that when selecting teaching strategies, they must consider learners' differences such as their developmental stages, interests, abilities and background (Shulman, 1987; Varol & Farran, 2006). Teachers should also use mathematical language throughout the

day and incorporate it within the learners' daily routine (Seo & Ginsburg, 2004). ISSA (2010) adds that teachers should use teaching strategies that promote learning which reflects freedom of cognitive development and academic achievement. ISSA insists that those strategies should help learners to develop the skills that will model them to become responsible members of the community and the nation, by instilling dispositions like a sense of empathy, concern for others, openness and respect for diversity. Teachers should provide learners with opportunities to form, express, and justify their opinions, as well as to make choices and intelligent decisions and to reach consensus.

2.5.3.1 Group work

Varol and Farran (2006) state that teachers should create learner-centred classrooms that help learners to learn mathematics through the use of interesting classroom discussions and group work. Such strategies create an opportunity for learners to share ideas about and find solutions for the given problems. Varol and Farran (2006) insist that group work is a good strategy to use in order to help learners to learn mathematics effectively. During group work, learners share ideas and are able to apply previously learned knowledge and, as a result, they learn from one another. However, teachers need to be careful when they form groups in order to avoid anti-social behaviours that may occur and thereby hinder the intended learning process for some learners.

2.5.3.2 Projects

Clement (2001, p. 274) suggests that teachers should use projects as a teaching approach because it caters for learners of all different levels of readiness "…to become involved meaningfully with mathematics". For instance, the teacher can engage learners in a project where they will be making a table. Learners will be involved in measuring the length, width, and height of the table using arbitrary units like boxes of matches, sticks, strings, their hands or feet. As these units are not accurate, through the guidance and support of the teacher, learners will resort to the process of making their own rulers. During these processes a number of mathematical concepts will be learned and applied such as counting, measuring, and mathematical language will be used such as small, big, short, long and tall. Clement (2001) also suggests that teachers should help learners develop mathematical concepts by planning and introducing activities that deal with mathematics. For instance, games that use numbers and card and board games will provide experiences with counting, matching and comparing.

2.5.3.3. Exploration

Henning (2014) suggests that teachers can assist learners to make world mathematics by engaging them in different situations such as inspiring learners to explore the natural world and its processes. Teachers should understand that Grade R learners need to experience mathematics physically rather than to be hurried to work on paper in order to express their ideas.

2.5.3.4 Integration of mathematics with other subjects

Henning (2014) indicates that teachers need to engage all the senses as much as possible so as to help learners experience mathematics at first hand. Teachers also need to integrate mathematics with other subjects. For instance, to integrate concepts such as time, space and number, the teacher could take learners outside during summer and show them a tree that bears fruit and ask them questions like: "How many fruit do you see on this branch?" (number) or: "How far apart are these fruit on the branch?"

2.5.3.5 Integrating mathematics within daily routine

Greenes *et al*. (2004) also suggest that teachers should make use of stories and songs to teach mathematical concepts because narratives are a major component of Grade R programs and are useful for developing mathematical skills. However, Greenes *et al*. (2004, p. 160) caution that "integrating mathematics within daily routine activities is not sufficient because building on those activities does not provide systematic and sustained mathematical experiences that can lead to integrated learning and retention". This implies that it is important for teachers to understand and be knowledgeable about mathematical topics that are stipulated in the curriculum. This knowledge will help them to plan logical and appropriate lesson plans that will expose learners to mathematical concepts in all major content areas of mathematics.

NAEYC and NCTM (2002) outline learning paths and teaching strategies to be employed in order to promote effective learning of mathematics. For number and operation, the teacher could demonstrate counting of small collections, then guide learners to count in everyday situations stressing that we use one counting word for each object. The teacher can further help learners to count in twos, fives and tens. The teacher can also challenge learners by giving them a brief glimpse of a small collection of items like stones, and then ask how many

there are. Teachers may tell real-life stories involving numbers problems and then ask questions like: “How many are there?” and “How many were added?”

NAEYC and NCTM (2002) maintain that for the teaching of geometry and spatial awareness, teachers can use strategies like introducing and labelling a wide variety of shapes such as a fat triangle and a slim rectangle. The teacher should create a situation where a variety of shapes are placed in different positions, for example a cylinder standing upright in the corner of the classroom. Teachers should also create opportunities for learners to construct their own shapes and make pictures or models using shapes, after which they are encouraged to talk about their creations. NAEYC and NCTM (2002) suggest that, to facilitate effective learning of measurement, teachers should use comparing words such as: “This lunch box is heavier than that block”. Teachers are encouraged to create situations that capture learners’ interest in measuring, for example marking a garden row using various units such as a pair of shoes. For effective teaching of patterns, algebra teachers should demonstrate and encourage learners to create patterns and ask questions like: “What is missing?” Learners should then be encouraged to discuss their patterns. Teachers should encourage learners to find colour and shape patterns in the environment, and number patterns on calendars and number charts.

NAEYC and NCTM (2002) indicate that for effective learning of data analysis and display, teachers should invite learners to collect and sort materials by colour and size and then encourage them to discuss and compare categories. Teachers should also work with learners to make simple numerical summaries such as bar graphs to compare data.

2.5.4 Use of concrete objects

Varol and Farran (2006) emphasise that teachers need to create opportunities that engage learners in the acquisition of mathematical skills through the use of different resources like computers, calculators, other forms of technology, and concrete materials such as models, pictures, diagrams, tables and graphs. Varol and Farran (2006, p. 384) posit that teachers should note that the use of different materials during the teaching and learning of mathematics is essential but may be useless if teachers fail to connect the used teaching and learning materials with effective and developmentally appropriate mathematical tasks in which learners are engaged.

To introduce Grade R learners to mathematics, teachers should engage them in the manipulation of concrete materials, as discussed in section.2.3.4. Varol and Farran (2006) claim that the use of concrete materials during the teaching of mathematics has advantages such as enabling learners to develop imaginary pictures in their minds, thereby helping them to increase their computational fluency in the future. The use of concrete objects also adds fun and enjoyment to the activity. The report of the Foundation Phase Conference (2008) reports that, as learners are born with mathematical minds which enable them to think mathematically, teachers need to expose them to play and manipulation of concrete objects. The manipulation of concrete objects will provide opportunities for learners to sort and match, count freely, sing or recite counting songs or rhymes, play freely with 3D objects, and to have a sense of mass and volume while playing in planned sand and water activities.

2.5.5 Learning styles

Learners are individuals with unique abilities; because of this fact teachers should remember that learners learn differently. When planning their lessons teachers should therefore cater for learners' different learning styles (Davin & Van Staden, 2005). Three learning styles are auditory, visual and kinaesthetic learning styles (Davin & Van Staden, 2005). Auditory learners learn best when they listen to words, sounds, and problems and are given opportunities to talk about them. Lessons should have activities that require learners to listen and talk about mathematical problems and concepts. Visual learners learn best when looking at things that they are learning. They think by imagining or picturing things. Teachers should plan lessons that will allow learners to look at things that are being taught. Kinaesthetic learners learn best when moving their bodies, acting out, touching and feeling things. Activities that allow learners to demonstrate what they are learning by using their bodies should therefore be included in lesson (Davin & Van Staden, 2005). ISSA (2010) emphasises that teachers should develop lesson plans based on what learners already know, can do and understand; from determining learners' prior knowledge teachers can then detect what is needed to support learners to reach their full potential.

2.5.6 Assessment

Sadler (1989) explains that assessment refers to any appraisal or judgement of learners' work or performance. Davin and Van Staden (2005, p. 225) explain that assessment as "a

systematic process of gathering information to make decisions about the learner and the information [gained] is based on daily activities done by the learner". Varol and Farran (2006) indicate that assessment is very important in the teaching and learning of mathematics in Grade R because it informs instruction. Teachers should therefore engage in assessing learners continuously and adapt instruction accordingly. This will enable teachers to provide useful feedback to learners and parents. National Council of Teachers of Mathematics [NCTM] (2003) states that learners need to be assessed so that teachers understand what learners can do or cannot do.

NCTM (2003) states that effective assessment should be practised by all teachers because it forms part of the instruction; as a result feedback has to be provided to learners because it gives them opportunities to illustrate what they know and can do. Teachers should also ensure that their assessment promotes equity by ensuring that their assessment caters for learners' differences and unique abilities. NCTM (2003) also insists that assessment criteria must be publicised so that every stakeholder involved knows the procedures used or followed to assess learners' mastery – or not – of mathematical concepts. Teachers also need to understand that assessment must promote valid conclusions about how learners learn mathematics. Teachers should also ensure that their assessment is coherent, meaning that it should match the purposes for which it is being done and also that it aligns well with both the curriculum and instruction.

Gober (2002) emphasises that teachers must understand that evaluation records of all learners must be kept and the evaluation should focus on the growth and development in all aspects of development. Gober (2002, p. 3) points out that the different assessment methods should be employed. These are: standardised tests, rating scales, check sheets, numerical grades, letter grades, portfolios, and observations. However, Gober (2002) also points out that currently assessment methods are being used which are termed by teachers as authentic assessment, meaning "the process of documenting and evaluating growth and development over time, using real-life situations" (Gober, 2002, p. 3). This assessment has an advantage such as showing things that learners can do, know and understand. It also creates an accurate picture of who the learner is. Gober (2002) asserts that it is vital to evaluate the learner holistically because all areas of development are dependent on each other. Gober (2002) proposes that learners can be assessed using six methods, namely: development of checklists; parent interviews; self- portraits; scribbling; drawing and writing samples; audio (or video) tapes;

and anecdotal records. Gober (2002) points out that not all methods can be used at the same time but that teachers should decide on one method that best suits their class.

Wortham (2012) explains one form of assessment which learners must undergo, namely diagnostic assessment. This form of assessment focuses on investigating learners' ability in terms of a specific objective, such as if the teacher wants to find out if learners have mastered colouring skills. If some learners still need assistance, they will be assigned more colouring activities. This form of assessment is continuous throughout the year. Wortham (2012) asserts that formative assessment is another form of assessment which is conducted throughout the year. This form of assessment is used to determine learners' progress regarding the objectives set to be achieved. It can be conducted every quarter or semester depending on the individual school. Wortham (2012) also indicates another form of assessment called summative assessment. This is done at the end of the year and its purpose is to grade learners.

Wortham (2012, p. 113) further asserts that classroom assessment is important and it has two main purposes. First, it encourages learners to "produce knowledge, rather than to reproduce knowledge". Second, it measures and monitors long-term development which takes its time to occur and short-term learning which is assessed normally without bearing in mind or relating it with learners' development. Observation allows the teacher to know the learner as a unique individual.

2.5.6.1 Formative assessment

Formative assessment is one type of assessment which is concerned about ways to use judgements and appraisal on learners' responses, work or performances to shape and improve their competences (Sadler, 1989). For instance, Boston (2002) expresses that in order for teachers to conduct formative assessment, they need to employ strategies like observation; classroom discussion; analysis of learners' work done during the teaching process; learners' homework; and their tests. Boston (2002) insists that feedback from learners' assessment should be used to adapt teaching and learning strategies in order to meet learners' needs. Boston (2002) further asserts that it is important that teachers know whether learners are progressing so that they are quick to note if they are encountering problems. If so, teachers

should use feedback to "beef up" their instruction, either by re-teaching, trying other teaching methods, or by engaging learners to practise the skill. Boston (2002) argues that teachers should also use questioning and discussion as techniques to increase learners' knowledge and to improve their understanding. However, they should ask thoughtful, reflective questions and give learners time to think before they are required to respond to the question.

2.6 Barriers to Effective Teaching of Mathematics

2.6.1 Teachers' lack of knowledge

Engel, Claessens and Finch (2013) point out that teachers often do not have an understanding of the fact that learners are born with the innate core mathematical knowledge which needs to be developed by exposing them to and engaging them in different domains of mathematics. Engel *et al*. (2013) assert that teachers lack the pedagogical knowledge to teach math beyond the most basic skills and, as a result, they focus on the most basic skills to avoid the discomfort of teaching more advanced mathematics. In their study, Engel *et al*. (2013, p. 158) found that "teachers spent considerably more time on basic counting, shapes and content, and the least amount of time on patterns and measurement, place value and currency, and addition and subtraction". They also found that teachers tended to concentrate on the content which learners had already mastered. They argue that this is an indication that teachers ignore important aspects of the teaching and learning process which require of them to find the prerequisite knowledge and skills learners have prior to their teaching of any new knowledge. Should teachers do this, they will know what and how to teach learners whilst employing the principle of teaching progressively from the known to the unknown or from the simple to the complex.

Benz (2012) conducted a study in German, to investigate the attitudes of ECD teachers towards mathematics. Benz's study was prompted by the fact that a new curriculum for early childhood mathematical education had been introduced without providing opportunities during pre-service, in-service or short courses training for teachers to learn the subject matter, content or pedagogy of the new curriculum. Benz (2012) concluded that the findings of the study revealed that both in-service and pre-service teachers perceived and understood that early mathematics education had significant value for learners, even though they had negative feelings towards mathematics claiming that it was confusing, boring and incomprehensible.

2.6.2 Socio economic status

Klein and Knitzer (2007) in their report entitled "Promoting Effective Early Learning" stated that a study found that learners from low-income families had lower cognitive development than their peers. This statement is supported by the example that at four years of age, learners who lived in disadvantaged families tested eighteen months below the cognitive ability of what is deemed normal for their age group. The report indicates that learners who are from advantaged families have the advantage of having educated parents who care much about their child's education. Their parents expose them to a number of educational situations which increases their vocabulary and mathematical skills at a very early stage. Similarly, Clement and Sarama (2007) conducted a study on the effects of the preschool mathematics curriculum. The purpose was to investigate if the curriculum helped learners to develop mathematical knowledge, especially learners from low-income families. Clements and Sarama (2007) found that learners from disadvantaged, low-income families had less support in their learning of mathematics at home and at school because they attended "ordinary" schools or centres without enriched learning environments, like their peers.

Klein and Knitzer (2007) suggested that to help learners from disadvantaged families so that the existing gap is closed, teachers must be provided with professional support that will equip them with the necessary knowledge and skills to effectively promote learners' learning of mathematics through the use of an intentional curriculum.

2.7 Reasons for Teaching Mathematics to Grade R Learners

Sarama and Clements (2009) synthesised relevant research on learners' learning of mathematics and they came up with eight reasons that seem to have captured global attention regarding the teaching of mathematics to young learners. First, parents are gradually becoming aware of the importance of early childhood education, so they have increased the rate of sending their learners to preschools. Second, various governments have recognised the importance of mathematics because globally there is an increasing demand for mathematical skills and knowledge in order to enhance prosperous growth of the economy of countries. Third, learners' mathematics achievement in different countries varies a great deal, and the argument is accepted that if sound, basic mathematical skills are acquired at preschool level,

learners' achievement will improve. Fourth, to address the knowledge gap that exists among learners with a low socio-economic status and culture which deprive them of opportunities later in life, such children need to be taught sound mathematical skills at an early age. Fifth, research has revealed that learners are capable of learning complex mathematical concepts at a very young age; this discovery has changed the thinking that young learners' learning of mathematics should be limited to areas like numbers and shapes. Sixth, to expose and help learners to learn mathematical concepts of all the domains of mathematics as early as in preschool, a strong foundation for the learning of mathematics in later grades is created. Seventh, mathematical skills and concepts, taught properly at an early age, alleviate the existing gap between learners' informal mathematical skills and their formal knowledge of mathematics later in life. Eighth, if the teaching of mathematics to young learners takes cognisance of their various developmental levels, it also capitalises on their socio-emotional growth by filling their days with exciting, fun and enjoyable opportunities that engage them in mathematical thinking.

2.8 Documents for Teaching

2.8.1 Curriculum

Krogh and Slentz (2001, p. 3) assert that curriculum refers to "the content that is to be taught". Shulman (1987) states that teachers must be knowledgeable and demonstrate understanding of the topics of the subject matter stipulated in the curriculum. However, they should also possess an understanding of alternative available instruction strategies that may not be stipulated in the curriculum. They need to know the learners they are planning for and should also know which appropriate materials to use for instruction**.** Shulman (1987) further argues that it is important for teachers to be cognisant of the curriculum of other subjects and of other grades of the same subject which learners will be exposed to in future grades at school, as well as the materials that embody them. NAEYC and NCTM (2002) add that teachers should understand that the curriculum should be coherent and focused across all grades; hence teachers should ensure that their planning of mathematics instruction is also coherent and compatible within known relationships and sequences of important mathematical ideas that will be taught in more depth later.

Ginsburg *et al*. (2008) state that the mathematics curriculum for Grade R 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. It

should address issues such as learners' ability to learn mathematics and the nature of the mathematics content that learners should learn. Ginsburg *et al*. (2008) further emphasise that as much as mathematics is integrated with other subjects, learners need to learn it on its own; this means that it needs to be taught as a field of study on its own. Ginsburg *et al*. (2008) clarify that the mathematics curriculum should also provide developmentally appropriate activities for parents at home in order to assist them while helping their learners. Ginsburg *et al*. (2008) also emphasise that the mathematics curriculum should stipulate the content that should be taught, such as number and operations; space; geometry; patterns; measurement; and data analysis.

NCTM (2013, p. 1) concurs largely with Ginsburg *et al*., posing a response to the question: "What is important in early childhood mathematics education programs?" According to this organisation, the curriculum for early childhood mathematics should encompass major content areas of mathematics, namely: number and operations; geometry; algebraic reasoning; and measurement. It should respond to learners' culture and language and also be aligned with the developmental level of learners. Clements *et al*. (2004) add that curriculum standards should have flexible guidelines based on available research on the developmental level of learners, as well as major content areas of mathematics.

Krogh and Slentz (2001, p. 3) point out that the curriculum has lately been underpinned by different concepts, namely: curriculum; emergent curriculum; thematic curriculum; subject- and discipline-based curriculum; and traditional curriculum. Integrated curriculum refers to the "academic subjects that are brought together to make a more meaningful learning experience". Krogh and Slentz (2001, p. 3) further explain that the integrated curriculum in early childhood years occurs during "emergent curriculum or theme-based curriculum". Emergent curriculum favours learning that takes place due to the life experiences of both teachers and learners. This curriculum requires teachers to be highly skilful in observing, documenting and reflecting on learners' practices so that they develop a lesson out of those practices.

Krogh and Slentz (2001) postulate that theme-based learning, or thematic curriculum, allows for the selection of a theme by the teacher. The teacher will then develop learning activities that are related to the theme, thereby incorporating all other subjects such as mathematics, language, science and the arts. An advantage of this curriculum is that learners are able to

connect bits of information; as a result, the development of concepts occurs. Krogh and Slentz (2001) point out that a thematic curriculum helps learners to spend ample time, such as a week or two weeks, dealing with the same theme. As a result they are able to explicitly learn the necessary content within the theme while, at the same time, their curiosity and interest to learn increase.

The subject-based, traditional curriculum focuses on individual subjects like mathematics, arts, social studies and music. These curricula promote the teacher to be an authority, so the learning is controlled by the teacher. Learners may still enjoy the learning process but they are not empowered to make their own choices, which is the core value in early childhood education to promote democracy.

A philosophically prescribed curriculum refers to the curricula that were developed by different philosophers who had an interest in early childhood and had conducted different research in this field. They subsequently used their research findings and conclusions to form the foundation for the curricula they developed. Such philosophers are Frietdrich Froebel and Montessori (Krogh & Slentz, 2001).

2.8.2 Lesson plans

The Department of Education (2003, p. 2) describes a lesson plan as a plan for "concretely and in detail teaching, learning and assessment activities that are to be implemented". Ghanaguru, Nair and Yong (2013) define a lesson plan as a "plan or design or self-contained mapping to help teachers to conduct lessons". Lesson plans should indicate objectives and content as well as detailed sequential steps to be followed when teaching. NCTM (2013) insists that to implement the lesson, teachers should be knowledgeable and creative enough to introduce mathematical concepts and methods. They should guide learners to connect ideas of mathematics with other subjects and develop their knowledge throughout the day at school.

Abdul Gafoor and Umer Farooque (2010) presented a paper entitled "Ways to improve lesson planning: a student teacher perspective", and they stated that planning a lesson is an important skill that all teachers must possess, even though to implement this skill in actual teaching needs time to practise. Above all, it needs dispositions like love and commitment. The Department of Education (2003) points out that lesson plans can be done daily, weekly

or two-weekly. A lesson plan contains information such as the topic, date, objectives, list of materials needed for the lesson, teaching approach, learners' activities written in logical steps, and evaluation strategies. Hollins (2011) points out that when teachers develop lessons, they should plan activities that will cater for learners' developmental levels and background knowledge.

The Department of Education (2003) further states that objectives should outline skills or information that learners should demonstrate after the lesson. Materials that will be needed and used should be listed and be ready at the time of teaching. The lesson should stipulate activities that will teach the learners the outlined skills and information. The activities must show logical steps that will be undertaken by learners. The Department of Education (2003) also points out that assessment of the lesson should outline questions or activities that test if learners have acquired the set objectives or skills. Assessment activities could be in the form of questions, exercises or problems assigned to learners during or at the end of the lesson. In terms of mathematics, Hollins (2011) insists that teachers should employ assessment methods that monitor learners' learning of mathematics.

Krogh and Slentz (2001) point out that a lesson is formal because it stipulates measureable objectives which learners must attain at the end of the lesson. A lesson plan therefore has to contain instructions based on the skills and knowledge that learners need to acquire. Krogh and Slentz (2001) insist that even though Grade R is the beginning of formal education, transition the lessons should be formal and there should be activities set at different centres such as fantasy, block, art and construction centres. These centres should allow learners to engage in free or structured play. Krogh and Slentz (2001) also point out that teachers should ensure that their introduction of a lesson motivates and prepares learners to be ready to learn new knowledge. Since the prior knowledge of learners is important, Krogh and Slentz (2001) state that teachers should find out what learners know regarding the topic they are intending to teach so that they identify gaps in skills and knowledge that learners lack, then address them before they teach the new knowledge. Krogh and Slentz (2001, p. 11) state that "it is good practice to identify the important skills students need in order to master new learning".

Krogh and Slentz (2001) contend that a lesson plan should include a section on materials. This part should list all materials that will be used in order to complete the assigned activities. The listing of all materials will help teachers to collect and organise all needed materials in

time, thereby preventing them from wandering about looking for some materials during the process of teaching as this can cause disciplinary problems among unsupervised learners. The plan should indicate the estimated time allocation for the lesson as a whole and for each activity specifically, as this will help teachers to time learners while doing given activities, thereby managing discipline as well.

The lesson has to show a logical sequence and clear procedures to be followed when presenting an activity. For instance, there has to be an opening of an activity. This allows teachers to introduce learners to the activity, to arouse their interest and more importantly, it gives teachers time to observe learners as they work and deal with their behaviours. The body of the activity is when learners are engaged in the actual learning of the intended knowledge and skills. During this time teachers are expected to be creative and skilful enough to present steps of the activity logically. The materials needed should be well organised and ready to be used by all learners. This highly organised selection of materials will assist in managing learners' behaviours (Krogh & Slentz, 2001).

Closing the activity is important because it allows both the teacher and the learners to review what has been learned since the beginning of the activity. The teacher could have been taking notes on important or interesting things that need to be included in the next lesson, or it could be done after the lesson as part of the teachers' review and reflection process. Therefore, assessment and reflection are crucial parts of the lesson because they give teachers a platform to check if learning has taken place. Teachers check if the lesson objectives were accomplished. First, this could be determined by assessing the lesson itself; whether it was too brief or too long in terms of the attention span of the learners. Second, teachers must reflect to check if they were not too subjective by planning a lesson which favoured their needs instead of those of the learners. They need to check if they were well prepared to present the lesson, and also if they listened to learners' views or if they were just following the lesson format. Third, teachers need to check if learners have achieved or not achieved the set objectives of the lesson. However, two factors, namely the teacher and the lesson determine learners' responses (Krogh & Slentz, 2001).

Krogh and Slentz (2001) point out that this process of assessing the lesson, the teacher and the learner can be carried out using informal observation, spot checks of on-going work, and standardised tests. Informal observation should be done continuously and daily because it

gives the teacher an opportunity to note how learners interact and participate during the activity. Formal observations are more structured and follow certain steps. The latter is done in order to record learners' progress and a checklist can be used to assess a lesson. Krogh and Slentz (2001) assert that a method of assessment that could be employed to assess learners after a lesson or activity is to place all writing and drawings in a journal. This form of assessment is relevant to older learners who begin drawing and writing. They can be assigned to draw what they have heard from the story or the poem read. Their work is kept together in a journal (or folder). This journal could include pictures made by learners. For instance, when assessing whether learners are able to count five objects, teachers can ask them to draw five things of their choice.

Follow-up activities and lessons is a form of evaluation that could be done through the use of activities based on previous lessons if they relate to or link with the one that is being taught. During oral evaluation learners are asked questions and they respond by speaking. This method is good provided that questions that require "yes" or "no" are limited or, if asked, are probed so that learners are trained to elaborate on monosyllabic answers. Demonstration is a method that requires learners to engage in action in order to portray what they have learned. It could be through dancing, miming, imitations, or they can use crayons or clay to model what they have learned (Krogh & Slentz, 2001).

2.9 Training to Capacitate Teachers to Teach Mathematics

The NCTM position statement (2013) asserts that training that is meant to capacitate teachers of Grate R learners to teach mathematics should include mathematical components that are appropriate to early childhood. The NCTM (2013) insists that training for capacity building of teachers of young learners should be a continuous process and should support high-quality mathematics education that integrates mathematical content, pedagogy, and knowledge of learner development and family relationships.

Rusznyak and Walton (2011) state that training offered to teachers should equip them with adequate knowledge and skills that will enable them to blend together content knowledge, knowledge of learners, the context, and general pedagogical knowledge (Shulman, 1987) in their lesson planning and during the actual teaching of the lesson. 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. Price

(2013) also emphasises that an outline of the course which is offered to teachers during their training should contain sections denoting the following aspects: topic areas of a subject; instructional goals; and expected outcomes.

These aspects should be aligned with course policies, curriculum design and methods of evaluation and assessment. Price (2013, p 209.) defines instructional goals as "the content of the subject that the teacher is intending to accomplish and what learners are expected to have learned at the end of the course". 'Expected outcomes' is a term that stipulates the results that are expected to be demonstrated by teachers-in-training at the end of a course. These outcomes should be measureable so that assessment methods used will assess the behavioural change of teachers in actual teaching. Price (2013) insists that the methods of teacher evaluation should spell out exercises and assignments that will be employed to evaluate teacher students. The methods of assessment should include crucial concepts of the course that teachers need to describe and apply at the conclusion of the semester and during their actual teaching.

2.10 Conclusion

This chapter has elucidated that reform in mathematics teaching in Grade R requires not only that teachers understand major content areas of mathematics, but also how learners learn and acquire mathematical skills. For this reason learning, particularly of mathematics, was discussed from the psychological perspectives of Piaget, Bruner and Vygotsky, as well as from the constructivist perspective. The review illuminated the kinds of knowledge, conceptual learning, and experiential learning which learners experience as they learn mathematics. Since teachers need to understand that their role is to facilitate learning, the discussion on effective learning of mathematics dealt with learning environment, play, valuable moments for learning, and projects. Shulman's theoretical framework which guided this study was illuminated. The seven domains of knowledge were discussed, followed by a discussion on the requirements for the effective teaching of mathematics. Aspects such as using learners' prior knowledge, intentional teaching, teaching strategies, concrete materials, learning styles, and assessment were addressed. It was illuminated that even though teaching can be facilitated, it can sometimes be impeded. It is in this regard that the review highlighted barriers to effective teaching and learning of mathematics, which were revealed to be primarily teachers' lack of knowledge and learners' socio-economic status. The literature was further reviewed regarding the predominant reasons for teaching mathematics as part of early

childhood education, teachers' documents for planning their work, and the need for effective training to capacitate ECE teachers of mathematics.

The succeeding chapter discusses explicitly the research design and the methodology employed to conduct this empirical research.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

The previous chapter reviewed related literature which formed a basis for the reasons for and the way in which data were generated while conducting this empirical research. This chapter presents the research design and the methods used for the generation of data that were targeted to provide findings that would respond to the research questions of this study. The first section addresses the research paradigm. The second section captures the research approach. The third section outlines the research design, including the sampling procedures which encompass brief descriptions of the context of the case study schools and the profiles of the participants. Data collection tools and data analysis procedures are also discussed in this chapter. The fourth section presents validity, trustworthiness and ethical clearance issues as they applied to this study. The final section summaries the chapter.

3.2 Research Paradigm

Maree (2009 p. 47) contends that "a paradigm is a set of assumptions or beliefs about fundamental aspects of reality which gives rise to a particular world-view". Basically, a paradigm is concerned with assumptions pertaining to ontology, epistemology and methodology (Neuman, 2000). Ontology relates to the facts about the nature of reality, while epistemology focuses on the nature of how knowledge is known. Methodology is concentrated on questions concerning the means of acquiring knowledge (Creswell, 2013). Creswell (2013) explains another assumption called axiology. Axiology focuses on the role of the researcher and it embraces the interpretations of both the researcher and the participants. This study was located within an interpretive paradigm. An interpretive paradigm aims at understanding the social behaviour of people and how they make meaning of their experiences (Bertram & Christiansen 2014, p. 35). I used this paradigm because I wanted to understand the world from the point of view of the people (i.e., the teachers) who lived it. I visited five in-service teachers in their respective schools in order to explore, interpret and understand their understanding of the teaching of mathematics in Grade R and

also to understand how they made meaning of the influence their understandings had on the teaching of mathematics in Grade R. Cohen *et al.* (2011) state that an interpretive paradigm rejects the idea that there is one objective reality that can be known, but its ontology takes a stance that there are multiple realities that are subjective. It is based on this assumption that I documented all the participating teachers' different responses. I expected the differences in their responses because of their different experiences and backgrounds which would naturally result in their different understandings of the teaching of mathematics. The axiology of this paradigm granted me the opportunity to facilitate the generation of data, so I visited teachers at their work place – i.e., their schools - and asked open-ended questions and further engaged them by means of probing questions in order to dig for deeper meaning regarding their understanding of the teaching of mathematics in Grade R. This process guided me towards my own interpretations in conjunction with those of my participants. The paradigm also believes that the epistemology could be reached when data are generated by a joint effort of the researcher and the participants. Consequently, the five teachers were revisited individually in their work place to discuss with them the generated data that had already been transcribed. This process is called "member checking" (Fraenkel & Wallen, 2008, p. 504). During these meetings I discussed the data that I had already interpreted with the participants to verify and clarify meaning, and consensus was reached with each participant that the knowledge I had obtained regarding their understanding of the teaching of mathematics in Grade R was clear and unambiguous and did not deviate from their perceptions and views.

3.3 Research Approach

I used a qualitative research approach for this study as purported by Maree (2009, p. 78-79), who states that "qualitative research is based on a naturalistic approach that seeks to understand phenomena in real-life situations". As the study aimed at achieving an in-depth understanding of teachers' understanding of the teaching of mathematics in Grade R, this approach allowed me as the researcher to "interact intensively with the participants by having face-to-face interactions with [them], [by] talking to them and seeing them behaving in their real context" (Creswell, 2011, p. 45). The identified participants were visited at their places of work where I could interview and observe them in their real-life contexts.

3.4 Research Design

3.4.1 Case study

This study focused on exploring teachers' understanding of the teaching of mathematics in Grade R. To theoretically frame teachers' understanding of the teaching of mathematics within an interpretive paradigm provided a useful exploratory lens for evaluating how they understood the teaching of mathematics in Grade R and how their understanding influenced their teaching of mathematics in that phase. The NCTM (2013, p. 1) suggests that teachers in different early childhood settings should "actively introduce mathematical concepts, methods and language through a variety of appropriate experiences and research-based teaching strategies", yet there is a lack of empirical research that examines what and how teachers teach mathematics in Grade R. For this reason I decided to use the case study design to explore and understand in-service teachers' understanding of the teaching of mathematics in Grade R.

Yin (2009) explains that a case study focuses on an empirical inquiry that explores an existing phenomenon within its real-life context, especially when the boundaries between the phenomenon and the context are not clearly evident. Yin (2009) emphasises that a case study assists the researcher to be engaged in a study which systematically explores and creates in-depth understanding of a particular case in its particular context. This afforded me the opportunity to embark on a multiple case study where I selected four primary schools, each with an attachment of a Grade R class or ECD centre, from four different districts in Lesotho. As each of these schools had in-service teachers teaching mathematics in Grade R, they were purposively sampled. Using the case study design granted me the opportunity to conduct an in-depth exploration of what understanding the teachers had of teaching of mathematics and how their understanding influenced their teaching of mathematics in Grade R. Four in-service teachers working in Grade R classes or in ECD centres were the cases explored in this study. The sampled participants represented in-service teachers teaching Grade R classes. They were all enrolled in the CECE programme at LCE (Cohen *et al*., 2011, p. 291).

As discussed in the literature review (Chapter Two), the theoretical framework that guided this study suggests seven domains of professional knowledge that are required for effective teaching. These seven domains are: subject matter content knowledge; pedagogical content knowledge (PCK); knowledge of the curriculum; general pedagogical knowledge; knowledge of learners; knowledge of educational contexts; and knowledge of educational aims, goals

and purposes (Shulman, 1987). I used these seven knowledge domains for the generation and analysis of data in order to explore what teachers understood of the teaching of mathematics in Grade R and how their understanding influenced their teaching of mathematics in Grade R. The interview questions (Appendix B) and the categories of observed classroom behaviours (Appendix B) reflect the seven domains of professional knowledge as purported by Shulman (1987). Table 3.1 below indicates how I used the domains of professional knowledge expounded by Shulman (1987) to develop the interview and observation schedules.

Table 3.1: Domains of Professional Knowledge for In-service Teachers' Understanding of the Teaching of Mathematics

Domains of Professional Knowledge	Interview questions	Observed classroom behaviours
Subject matter content knowledge Curriculum knowledge	• What do you understand by the effective teaching of mathematics in Grade R? • Mention major content areas of mathematics which are stipulated in the Grade R curriculum and give examples of mathematical concepts/topics under each area. • What do you understand are the differences between a triangle, square, and rectangle?	• Organisation, logic and sequencing of the presentation of mathematical concepts.
Pedagogical content knowledge (PCK)	• In your own understanding, which teaching strategies do you consider effective when teaching mathematics to Grade R learners? Why? • Do you think it is necessary to assess learners while teaching mathematics? Why? • Which assessment methods do you understand are good to be used in assessing learners?	• Effective use of different teaching methods/strategies to teach and assess mathematics.
General pedagogical knowledge	• In your own understanding, how do you think a Grade R classroom for the teaching of mathematics should be arranged and organised? • How do you understand the planning of the lesson plan/lesson activities for mathematics should be like?	• Classroom arrangement and organisation. • Integration of mathematical concepts with other subjects.

Knowledge of learners	• In your own understanding, how do you think learners in Grade R learn mathematics? Explain. • In your own understanding, what do you understand by the fact that learners are different?	• Learners' engagement in doing classroom activities. • Classroom activities cater for different learning styles and cognitive development. • Reviewing prior knowledge of learners before teaching new knowledge.
Knowledge of educational contexts Knowledge of educational aims, goals and purposes	• In your own understanding, do you think mathematics offered in Grade R is applicable in the daily life activities of learners? Support your answer.	• Use of concrete locally available materials. • Contextualisation of games, songs and examples used. • Engaging learners in activities that help them to have deep understanding of mathematics by asking why and how questions.

Source: Own illustration diagram

The following section discusses how participants were selected for this study.

3.5 Sampling

I used purposive sampling for this study. Maree (2009, p. 79) defines this type of sampling as the "selection of participants based on some defining specific characteristics that qualify them to be holders of required data for the study". I combined purposive sampling with convenience sampling which allowed me to choose respondents that would serve the purpose of the study (Cohen *et al*., 2011).

Cohen *et al*. (2011, p. 145) state that sample size might be constrained by factors such as "money, resources and time". In cognisance of the statement by Cohen *et al*. (2011), I selected four participants following the criteria for purposive sampling. First, participants were to be in-service teachers, enrolled as second year students in the CECE program at LCE. They should be in their second year of study because they would have completed the mathematics course offered to them during the second semester of the first year of study; as a result they would have had time to do the teaching practice that would require them to

practise and apply the knowledge and skills they had acquired regarding the teaching of mathematics in Grade R. Secondly, Wilkins (2008) indicates that years of teaching experience seem to have a substantial negative effect on teachers' content knowledge; therefore, it indirectly has an effect on teachers' instructional beliefs and practices. I therefore selected teachers who differed in years of teaching experience and age. Thirdly, they should work in different combined primary schools (a combination of Grade R class or ECCD centers). I sampled one teacher per school so there was a total of four in-service teachers. Fourthly, I selected the schools which were located in urban, semi-urban and semi-rural areas in four districts in Lesotho, namely: Leribe, Berea, Maseru and Mohale's Hoek. Due to time and money constrains these areas were selected for convenience (Cohen, *et al*., 2011).

The first step to recruit participants was to identify in-service teachers who were willing to participate in this study. I met with the Chief Inspector of the IECCD unit in the department of MoET in Lesotho to request permission and guidance to conduct the research. The Chief Inspector signed the consent letter and facilitated my connection with the selected schools' principals. Next, I met with the four principals to explain and discuss the purpose of the research. I then requested their permission to contact Grade R teachers who worked in their schools. Having procured their permission, I made a cellphone call to each of the four teachers and explained the purpose of the research and asked them if they were willing to participate in my study. Finally I obtained informed consent from four Grade R teachers who were willing to take part in this study. The selected participants were three females and one male from the four districts mentioned earlier. The four participants embodied characteristics that embraced different years of teaching experiences and different school certificates. These teachers allowed me to access their actual teaching of lessons in the classrooms and gave permission for me to peruse their lesson plan exercise books for analysis.

Below are descriptions of the case study schools/ECD centres and teachers' profiles. The description covers the five schools because initially I had selected four participants. Three participants were successfully interviewed but the fourth participant from Leribe district withdrew from the study because he did not want to be audio taped due to a prior personal experience. He shared that he had had a terrible experience during his previous job as a security guard when being audio taped; as a consequence he decided to withdraw from this study. I therefore had to replace him and I decided to substitute him with two participants in order to have a backup should any participant decide to withdraw. I followed the same

criteria as mentioned in the sampling section to select participants that replaced him. I also followed similar procedures to arrange an interview with them. Due to this replacement I ended up interviewing and audio recording five participants from three districts (i.e., two were from Maseru, one from Berea, and two from Mohale's Hoek).

3.5.1 Descriptions of the case study schools*

Best and Kahn (2003) contend that qualitative researchers are sensitive with regard to the study context because they place the findings of their studies in social, historical, and temporal contexts. Leedy and Ormorod (2005) assert that during the generation of data, the qualitative researcher captures data about the environment surrounding the case, like the physical environment as well as any historical, economic, and social factors.

* *For the purpose of confidentiality, all schools have been provided with a pseudonym.*

3.5.1.1 Botle ECD Centre

This school was situated in the Maseru district. It was located in an urban area, about 10 kilometers north of where I resided. It was situated within a big campus composed of a clinic, primary school buildings, and houses for employees. The classroom for the Grade R class had been constructed on the right hand side of the clinic, near the main entrance of the campus. The buildings comprised the principal's office, kitchen and three classrooms. There were other buildings like toilets, a security guard house, store room and Wendy houses for fantasy play. These buildings were built in a square-like shape. At the centre was a playground where play equipment like a see saw, jumping castle, slides, stepping ladder and old tyres were mounted on the ground. The majority of the employees were from the immediate community.

3.5.1.2 Tsépong Primary School

The school was a government school located in a semi urban area of Maseru, thirty five kilometers from my place of residence. The school was at the heart of the village where community members seemed to earn their living through rearing of animals like sheep and cattle, and crop production. Most of the families around the school hoarded heaps of maize which had been harvested from the fields just prior to my study in August of 2014. (June and July is harvesting time in Lesotho). Cattle and sheep were housed in kraals where they were fed on by-products of maize and wheat. The school yard was properly fenced. Tsépong Primary School was a combined school which means that there were primary school

buildings which housed learners ranging from Grade R to Grade 7 as well as secondary and high school buildings which housed learners from Form A to Form E respectively. The primary school buildings comprised two double storey blocks while the secondary and high school buildings comprised five single storey blocks. Within these buildings there were offices for both principals as well as staffrooms for teachers working in the primary school and teachers working in both the secondary and high schools. The Grade R class was situated on the far left of the main gate of the school yard, next to the Grade 1 class on the first floor of the second building. Both learners' and teachers' toilets were situated on the left hand side of the school yard. The school did not have play equipment like slides, a see saw, or old tyres for outdoor play.

3.5.1.3 Thakaneng Primary School

The school was thirty nine kilometers away from where I resided and was situated in the rural area of the Berea district. It was located at the end of a fairly large village along the foot hills. The villagers' main income was generated by farming, but most of the residents were unemployed. The school yard was properly fenced by wire with one main entrance gate. There were learners' and teachers' toilets as well as a water tank at the main gate. The school comprised five blocks of buildings and the Grade R class was located in the fifth block next to the main kitchen. In front of the Grade R classroom was a playground for Grade R learners with three old tyres mounted on the ground. In the block opposite were a staffroom and the office of the principal. There were eight classrooms, eight teachers and three cooks in Thakaneng Primary School.

3.5.1.4 Mohlanapeng Primary School

The school was situated in the town of Mohale's Hoek, 133.5 kilometers from where I resided. Most of the community members around the school were employed and some of them rented houses in the vicinity of the school. The school was well fenced. The school comprised five blocks of buildings and each door had a tag that labeled the classroom. There were both learners' and teachers' toilets in the vicinity of the main gate. There were also six pig sties but there were no pigs inside. The school also had a store room. Behind the fifth block there was a football pitch. The Grade R classroom was located in the first block next to the Grade 1 class. There were no outdoor play equipment such as a see saw, slides and Wendy houses on the playground. Few old tyres were kept in the store room.

3.5.1.5 Phuleng ECD Centre

Phuleng ECD centre was also located in the town of Mohale's Hoek, which was 133.5 kilometres away from where I resided. Most community members around the school were employed. Most residents stayed in rental houses while few resided in their own houses. There was a primary school and a book shop near the centre.

The centre was well fenced and the main gate was locked most of the time. There was a security guard house by the gate and every visitor had to report to the security guard before proceeding to the principal's office. The centre had six teachers. There was one block of buildings with four classrooms, one playroom, a store room, an office for the principal and a kitchen where learners' food was prepared. Learners' and teachers' toilets were at the left hand side of the building. Behind the classrooms there was a garden where vegetables like spinach and cabbage were cultivated.

Having given a description of the physical context of each school under study, I briefly present the profile of each participating teacher.

3.5.2 Teachers' profiles*

** For the purpose of confidentiality, all participating teachers have been provided with a pseudonym.*

Mrs Itumeleng was in her early twenties. She had been teaching young children for five years but she was in the second year of teaching a Reception class. Her highest qualification was the COSC. During the undertaking of this study she was in her final year of the CECE programme at LCE and was still awaiting her results.

Mrs Ntsoaki was at her late forties. She had eighteen years' experience of teaching preschool children ranging from home-based centres, privately owned preschools and, most recently, Grade R. Her highest qualification was a JC but she had sat for the final examination of the CECE programme at LCE and she was awaiting her results at the time I was conducting the study at the school.

Mrs Manyai was in her early forties. She was in her fifteenth year of working with young children from two to six years. She had previously worked at home-based centres and was currently teaching Grade R learners. Her highest qualification was a COSC but she had sat

for the final examination of the CECE programme at LCE and was awaiting the results at the time I was conducting the study at the school.

Ms Moliehi was teaching at Mohlanapeng Primary School. She had four years' working experience as a teacher of Grade R learners. She was in her early thirties. Her highest qualification was a JC. She had sat for the final examination of the CECE programme at LCE and was awaiting the results at the time I was conducting the study at the school.

Ms Tselane was a teacher at Phuleng ECD centre and she had fifteen years' teaching experience in ECD centres. She had a COSC and a certificate in early childhood development. She had sat for the final examination of the CECE programme at LCE and was awaiting the results at the time I was conducting the study at the school.

3.6 Pilot Study

Yin (2009) recommends a piloting of the data generation tool because that affords the researcher an opportunity to refine the tool in order to generate rich data that respond to the research questions. While waiting for approval from authorities, the data tools - specifically the interview questions - were piloted. The pilot study was conducted among four second year students in the CECE programme and two colleagues in the CECE department.

3.7 Data Generation Procedures

Below is a brief discussion on how I entered the field to generate the data.

Upon approval to conduct the study by the Lesotho MoET, the LCE, school principals and teachers, I commenced the task of generating data by meeting with the participants at LCE because they were on campus for the winter contact session. The meeting was held in the second week of June 2014. The purpose of the meeting was two-fold. First, I had to establish time frames for interviews and observations. Second, I had to remind the participants of and clarify the following issues with them: (a) participation in my study was voluntary; (b) participants were free to withdraw any time they wanted to; (c) their participation in the study would be confidential, and as a result their names would not appear in the report (pseudonyms would be used); (d) all the recordings from either interviews or discussions would be kept confidential and would be used for research purposes only. The proposed participants and I managed to develop time frames which were intended to be flexible, more

specifically for interviews in order to avoid inconveniences with class attendance. Therefore agreed times were set for evenings or weekends. For observations, the school calendar guided us to set the dates that were preferred by each participant.

Initially I intended to use four data collection tools, namely: semi-structured interviews; nonparticipant observation; document analysis; and a focus group interview. Interviews and observations would be the main source of data collection for my two research questions. The other tools were to generate data which would supplement the data generated by the main data tools. It would also serve to increase trustworthiness of data (Maree, 2009). When all the necessary consents had been granted, I embarked on the process of data generation. The following section discusses how each data collection tool was used.

3.8 Data Generation Methods

3.8.1 Interviews

Lodico, Spaulding and Voegtle (2010, p. 119) define an interview as "a conversation with a purpose, conducted with a person or group of persons". Maree (2009, p. 87) is more elaborative, defining an interview as "a two-way conversation in which the interviewer asks the participant questions to collect data and to learn about the ideas, beliefs, views, opinions and behaviours of the participant". It is on these grounds that I decided to use semi-structured interviews to generated data. Fraenkel and Wallen (2008) emphasise that an interview is an important tool to generate data because when interviewing people (such as teachers in the case of this study), it enables the researcher to discover what is in their minds and what their feelings are about their situation.

I administered one semi-structured interview to each of the five participants before conducting the classroom observations. I decided to employ this method because it generated rich and thick data that responded to my research questions. Using semi-structured interviews aided me to engage in face-to-face interaction with the participants (Cohen *et al*., 2011). I therefore arranged the interview environment in such a manner that I sat face to face with each interviewee, as Scott and Usher (2011) argue that sitting face to face with participants enables the researcher to read non-verbal language such as facial expressions, thus allowing the interviewer to make judgements about significant signs and thereby locating authentic data from participants regarding their experiences and real-life situations.

The interviews were conducted in pre-arranged venues which were the classrooms for second year students at LCE. The participants were interviewed on different dates and at times that were convenient to them. Before the commencement of each interview, I reminded each participant once again about the purpose of the study; the issues of confidentiality and anonymity; the use of audio tape; and their voluntary withdrawal. I used open-ended questions that allowed me to use hints and prompts and to re-phrase questions in order to ensure that participants understood what was being asked (Scott & Usher, 2011), thereby generating rich data on how teachers understood their teaching of mathematics in Grade R. Maree (2009, p. 87) suggests that "a semi-structured interview defines the line of inquiry; as a result, the researcher must be alert to capture participants' responses and have [the] ability to record unexpected emerging inquiries which are related to the study". To supplement my notes and to capture all the needed information, I used an audio tape to record the interviews of five participants initially. Each interview lasted for approximately 20-30 minutes and all interviews were transcribed.

3.8.2 Observations

Creswell (2013) articulates that observation is a significant tool to generate data in qualitative research, cautioning that it involves the use of all the senses of the observer. I used observations to generate data because Fraenkel and Wallen (2008) advise that some research questions can be answered best through observing how people (in this case, teachers) act or how things look. I was a nonparticipant observer and observed all five teachers in the classroom. My observations were structured because I had planned a schedule which I used to observe teachers in order to explore their understanding of the teaching of mathematics in Grade R (Appendix B). Each participant was observed once and the observation for each participant lasted between 30 to 40 minutes. In each of the classrooms I made sure that I sat on the "sidelines and watch[ed]", as suggested for nonparticipant observers by Fraenkel and Wallen (2008, p. 441). I took notes and made audio tape recordings because it afforded me the opportunity to replay the tapes several times while transcribing and analysing the data, thereby avoiding a distortion of the authenticity of the data (Fraenkel & Wallen, 2008). After each observation I ensured that my descriptive field notes summarised what I had seen and heard in the classroom and in the school environment at large. I also wrote reflective field notes that elaborated much on my feelings and thoughts about my observations, as suggested by Lodico *et al*. (2010).

3.8.3 Document analysis

The third tool to generate data was document analysis. Maree (2009) indicates that data could be obtained by perusing published or unpublished documents, for instance documents like reports, minutes of meetings, and newspaper articles. Lodico *et al*. (2010) point out that the research questions of a study enable the researcher to decide on relevant documents to be analysed. Due to the suggestions by Maree (2009) and Lodico *et al*. (2010), I found the following documents relevant for generating data that would address my research questions: teachers' lesson plans; the Grade R Mathematics Curriculum called **Integrated Early Childhood Care and Development [IECCD] Curriculum for Reception Class;** this document is a final working draft which was developed in 2007 and the course outline for Mathematics/Numeracy course offered to teachers during their training at LCE. I found it worth clarifying that the course outline for Mathematics/Numeracy course is a document personally developed by the lecturer offering the course. It is developed through the guidance of the prescribed curriculum for CECE programme called Curriculum for the Certificate in Early Childhood Education [CECE] programme which encompasses content for all courses including Mathematics/Numeracy course. My analyses took cognisance of the following.

- Lesson plans: I looked at the general layout that the teachers had prepared; how mathematics was integrated with the theme; the logic and sequence of the presentation of activities; and the teaching methods which were used in teaching mathematics.
- Grade R Mathematics Curriculum: I analysed the five major areas of mathematical instruction in Grade R; the suggested activities which are supposed to guide teachers to plan interesting and exciting class activities; the long term goals of the curriculum; and topics which teachers are to prepare and teach learners.
- The course outline for mathematics/numeracy: I analysed the content offered to teachers during their training; the time spent on content and practical; and the materials produced to serve as teaching aids.

Finally, I documented my analysis of all the documents.

3.8.4 The focus group interview

This method was not used because of unforeseen circumstances. Personal reasons prevented three participants from participating in such a process.

3.9 Data Analysis

The data were analysed qualitatively using words to describe and interpret participants' responses. I established how my participants made meaning of their world by analysing their understanding and knowledge regarding the teaching of mathematics in Grade R (Maree, 2009). I used a content analysis plan. Cohen *et al*. (2011, p. 563) define content analysis as "the process of summarising and reporting written data, the main contents of data and their messages". This process allowed me to look for similarities and differences in my data, which supported or disproved my theory because content analysis is inductive and interactive (Maree, 2009, p. 88). I initiated my data analysis process by listening to the five audio-taped voices of my participants and also by reading the interview transcripts and reports from my observations and the data generated from analysing documents in order to understand the data that I had collected.

Creswell (2013, p. 180) states that the core elements of qualitative analysis are "coding the data, combining the codes into broader categories and displaying and making comparisons in the data graphs, tables and charts". After I had read and made sense of my data, I worked with my data following the core elements of qualitative analysis as stated by Creswell. That process led to the development of general conclusions that responded to the two critical questions of this study, therefore indicating teachers' understanding of the teaching of mathematics in Grade R. When engaging in analysing the data, I observed the ethical issue of confidentiality by using pseudonyms to refer to the schools and the participants in order to protect their identities. I therefore refer to the teachers as Mesdames Itumeleng, Ntsoaki, Manyai, Moliehi, and Tselane. The teachers' lesson plans were discussed and analysed with reference to the standard lesson plan components discussed in the literature review in order to supplement the data generated by my main data collection tools.

I analysed and discussed both the Grade R Mathematic Curriculum and the Course Outline of Mathematics/numeracy with regards to the components of the analysis schedules for both documents, with the intention of checking if they made any contribution to the understanding of the teachers in teaching mathematics in Grade R. I therefore used the data generated from these documents to supplement the data from the interviews and observations and thus enhanced the trustworthiness of the data (Maree, 2009).

3.10 Issue of Trustworthiness

Maree (2009, p. 60-80) suggests that "engaging various data collection tools leads to trustworthiness". It is for this reason that I employed three different data tools as mentioned earlier, namely structured observations; semi-structured interviews; and document analysis to add trustworthiness to my findings. I facilitated the generation and analysis of the data to explore, describe, interpret and gain in-depth understanding of the knowledge teachers had about teaching of mathematics in Grade R. I secured the trustworthiness of my data by revisiting my participants to give them a chance to read and comment on the transcribed interviews and observation reports. They agreed and accepted these transcripts as a true reflection of what had been said and what had happened during the data generation processes in which they were involved. Cohen *et al*. (2011) point out that to revisit participants is a "member check" process and it adds to the trustworthiness of the data. I also increased the trustworthiness of my data by giving my supervisor and one other person my research objectives and transcriptions of data to code and develop categories. I compared their codes and categories with mine then selected those that appeared in three of us (Maree, 2009).

3.11 Ethical Issues

Creswell (2013) posits that ethical issues occur in all the phases of a research project; i.e. prior to conducting the study; at the beginning; during data generation; and when analysing, reporting and publishing a study report. It is because of these phases mentioned by Creswell (2013) that I firstly identified gatekeepers and sought their permission to access schools and teachers (Lodico *et al*., 2010). I then applied to the University of KwaZulu-Natal, Edgewood Campus where I was pursuing my studies, for authorisation and ethical clearance to conduct the study. Secondly, I requested permission to pursue the study from the MoET in the department unit of IECCD, because I wanted to conduct my study in Grade R classes. Thirdly, I sought permission from LCE, because I wanted to analyse their mathematics activities course outline offered to in-service CECE students during their training. Fourthly, the IECCD department connected me with the principals of the selected schools and they all issued their consent. Fifthly, I met all my participants (initially four, and later five) and they all agreed to voluntarily take part in the study, except one person who withdrew. Maree (2009) stresses that protection of participants is important and the researcher must obtain letters of consent and informed permission to conduct a study. I therefore made all the participants aware of the facts and explained the contents of the consent letter to them in a

clear and unambiguous manner. All the gatekeepers and participants signed approval and consent letters respectively.

3.12 Possible Limitations to the Study

Maree (2009) suggests that possible limitations that could affect the research need to be indicated and that their resolutions should be spelled out. One limitation I envisaged was that the study participants would be intimidated by my position as their lecturer and that their responses might be clouded by my position of authority. I tried to minimise this obvious limitation by explaining to my participants that they should disregard my position as their lecturer but should see me as a person who is willing to learn how they understand the teaching of mathematics in Grade R. I clarified to them that the intention was not the awarding of marks like I used to do during their teaching practice, but that it was for my study and the completion of my university degree. Unfortunately they were still nervous during the interviews and I suspect that some of them gave answers that they hoped would please me or that they thought were correct, rather than telling me what they actually knew or did when teaching. During observations, I noticed that they did not conduct the teaching of mathematics as they would normally do when they were alone. I felt that some were acting or panicking and some appeared unsure of what they were doing. Future studies of this nature should perhaps involve a sample group that is unknown to the researcher to obviate this limitation.

A focus group interview was initially planned while teachers were on campus because I thought it would be easy to convene a meeting with them since they all resided in college residences, but the meeting could not be held due to unforeseen circumstances - mainly teachers' personal issues. To convene a meeting with all the respondents while they were back in their districts was not possible due to geographical distances, transport issues and time and money constraints (Maree, 2009).

3.13 Conclusion

This chapter dealt with the research design and the methodology underpinning this study. I presented an inclusive explanation of how the research design and methodology were employed in order to answer my research questions. The purposive and convenience sampling methods were explained and a motivation was given for using both methods. I provided a detailed description of the research sites and the selection of the participants. This

was followed by an in-depth discussion on how the following data tools were used: interviews, observations and document analysis. The data analysis was discussed, followed by an exploration of the issues of validity and trustworthiness and how they were addressed before, during and after the generation of the data. An outline of the ethical issues was important in this study because this defined how I engaged with the participants. The limitations of the study were also addressed. In the next chapter the collected data will be analysed and interpreted and the findings will be discussed.

CHAPTER FOUR
PRESENTATION AND DISCUSSION OF DATA

4.1 Introduction

The previous chapter identified and discussed the research approach and paradigm that underpinned this study. The chapter further discussed the research design and the tools that were used to generate data, namely one-on-one interviews, classroom observations, and document analysis. This chapter focuses on the analysis of the data generated through those tools. This study was aimed at exploring in-service teachers' understanding of the teaching of mathematics in Grade R. The research design comprised a case study of five in-service teachers teaching mathematics in Grade R in five different schools.

This chapter presents and discusses the findings generated by the data. The first part addresses findings from the interviews with in-service teachers. These findings were aimed at addressing the first research question of this study. The second part focuses on the observation phase of the study and encompasses a description of the schools, classroom environments and the observation process. This discussion aims at responding to the second research question of the study. The third part presents a discussion of the findings based on the analysis of documents such as lesson plans, the Grade R Mathematics Curriculum, and the Course Outline for Mathematics that is presented to teachers training at LCE. The data from the document analysis were aimed at supplementing data from the interviews and observations in an attempt to triangulate the data, which was a process that enhanced the validity and reliability of the study. The chapter is concluded by addressing issues of confidentiality. Pseudonyms were used to identify teachers, schools and learners.

The four broad themes that emerged from the data are the following:

- Effective teaching of mathematics;
- Planning teaching and learning;
- Knowing the differences among learners; and
- Strategies for teaching mathematics.

4.2 Data Presentation and Discussion

Note that for the purpose of authenticity the responses by the participating teachers are presented *verbatim* in the text and may contain linguistic inaccuracies which were not edited in the transcription process.

4.2.1 Effective teaching of mathematics

The findings revealed that the teachers from the five case study schools (teachers Itumeleng, Ntsoaki, Manyai, Moliehi and Tselane) had a similar understanding of the effective teaching of mathematics in Grade R. In this regard they all indicated that they understood that the effective teaching of mathematics in Grade R required the teaching of mathematical concepts as stipulated in the Grade R curriculum document. However, most of the respondents had difficulties mentioning the three major content areas of mathematics which are stipulated in the curriculum and they were unable to provide an example of one mathematical concept under each main idea. It was particularly teachers Itumeleng, Ntsoaki, Manyai and Moliehi who responded with uncertainty to this question.

> *They are number, measurement, sorting, and counting. Err… (pause) under number the concepts are counting, err… Classifying. I can't recall others (Teacher Itumeleng).*
>
> *I think they are sorting, matching, comparing, measuring and classifying. Ache! I remember eee..! Counting. Ache! I am not sure madam (Teacher Ntsoaki).*
>
> *Eee…! Sorting, classifying, measuring, shapes, eer…! I have forgotten other areas, but I know they are written in the curriculum. Ok I remember, counting and one-to-one correspondence, I think those are the ones that I can recall now (Teacher Manyai).*

From the above responses it was clear that some teachers confused major content areas of mathematics with mathematical concepts that appear under the main content areas of mathematics. It shows that some teachers did not know - or they had limited understanding of - the requirements of the curriculum despite the fact that they claimed to be teaching curriculum content.

Shulman's theory of the domains of teacher knowledge which guided this study states that teachers should know the curriculum of the subject that they teach, such as mathematics, languages, science and agriculture. Shulman (1987) further insist 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.

By confusing the major content areas of mathematics with mathematical concepts and being uncertain when referring to the major content areas of mathematics showed that the respondents were not familiar with the Grade R curriculum which they were supposed to use every day when planning their teaching of mathematics. Teacher Moliehi, who failed to mention major content areas of mathematics but mentioned only mathematical concepts like matching and sorting, demonstrated that some teachers might be ignorant of the requirements of the curriculum; as a result they lack the knowledge and valuable information required for teaching mathematics. However, teacher Tselane was able to mention three major content areas of mathematics and provided relevant examples underneath each major content area of mathematics.

> *Major content areas of maths that I know are shapes, measurement, and number. I think number has counting, addition; shapes has topics like square, rectangle and circle, and measurement has height, length (Teacher Tselane).*

Her response indicated that she was partly familiar with the Grade R curriculum. As stated in Chapter Three, a requirement for sound teaching is that the Grade R curriculum and the Course Outline for Mathematics were analysed to determine if they contributed to teachers' understanding of the teaching of mathematics in Grade R. Teacher Tselane's response revealed that the two documents contributed partly to her understanding of the contents of the curriculum because she mentioned only three major content areas of mathematics which appear in both the Grade R curriculum and in the Course Outline of Mathematics document that is used for the mathematics/numeracy course. Her knowledge was not comprehensive as the literature clearly states that there are five major content areas of mathematics, namely number and operations, measurement, geometry, algebra and data analysis (NAEYC & NCTM, 2002). I analysed the LCE Course Outline for Mathematics/numeracy course and found that the two major content areas are omitted. When analysing the documents, the findings showed that the Course Outline for Mathematics/Numeracy document as well as the curriculum document for Grade R used by in-service teachers at LCE offer training in only three major content areas of mathematics, namely number and operations, measurement and shapes, as mentioned by teacher Tselane. The other two major content areas algebra and data analysis are thus neglected in the training of teachers. This lack of training in essential subject content will affect their teaching of mathematics and it will deprive learners of an opportunity

to be exposed to explicit mathematics that will lay a solid foundation for the learning of the subject in the latter grades (NAEYC & NCTM, 2002).

It was apparent that all the respondents understood that the teaching of mathematics in Grade R revolved around the teaching of the contents of the curriculum only, whereas the literature revealed that to effectively teach mathematics, teachers' knowledge of the subject taught requires knowledge of the core components of competence and of effective teaching of that content (Mewborn, 2003; Gross man, 1990). In addition, Shulman (1987) suggests that the categories of teacher knowledge needed for effective teaching are subject matter knowledge, pedagogical content knowledge, and general pedagogical knowledge.

Because effective teaching requires teachers to have subject matter knowledge, I asked them to share what they understood about the differences between a triangle, a square and a rectangle. Teachers Itumeleng, Manyai and Tselane agreed that those shapes were different, even though their explanations of the differences were somewhat dissimilar. For instance,

> *Eee...! a square has four equal sides, rectangle has four sides as well and its two opposite sides are equal.(pause) a triangle has only three sides (teacher Itumeleng).*
>
> *A square has equal sides altogether. A rectangle has four sides and opposite sides are equal. Eee...! a triangle is different because it has only three sides. (teacher Manyai).*

These teachers explained the differences of the shapes in terms of their sides only. Teacher Tselane explained the differences of the shapes in more complex detail:

> *Two triangles with two equal sides, when merged together, form a square,* and *two triangles which its sides are not equal, when merged together they make a rectangle.*

Her more elaborative explanation illuminated how the shapes related because it highlighted what happens when two triangles are merged.

Teacher Ntsoaki did not notice the differences between these shapes. Her response was

> *I don't think there is much difference because they are all shapes.*

I was amazed to hear such and answer and, probing deeper, I asked, "Do you know these shapes that we are talking about?" Teacher Ntsoaki, somewhat uncertainly, responded;

Yes, I know them. Eeerrr…! (Frowning) Triangle has three sides. Yaa! I think that's how they differ.

Teacher Moliehi was also very uncertain as to how the shapes differ. She said:

They are not different. Yes, they may look different, but they are all shapes, maybe they may differ in terms of their sizes and colour.

The responses from all the teachers did not provide any satisfactory answer to the question, which revealed that the respondents had limited knowledge of the subject matter. Both teachers Ntsoaki and Moliehi lacked knowledge of the subject matter probably because of their lack of qualifications or from ignorance because the differences between those shapes are actually common content knowledge (CCK) which Ball *et al*. (2008, p.399) define as "the mathematical knowledge and skill used in settings other than teaching". This implies that people may know the differences between those shapes even if they are not teachers. I expected the teachers to describe the differences in terms of their sides, corners and angles; as explained in the Curriculum for CECE programme (2007) for instance, a square differs from these other shapes because it has four straight sides with all sides equal. It also has four corners which are all right angles. A rectangle has four straight sides with opposite sides having the same length and corners, all right angles. A triangle has three straight sides which may be of equal or unequal lengths and its angles will be right, acute or obtuse angles (Curriculum for CECE programme, 2007).

The results based on the above question regarding the differences between the triangle, square and rectangle, clearly revealed that the majority of teachers lacked basic knowledge of the subject matter they were teaching. This implies that teachers are likely to experience challenges in terms of effective teaching of mathematics in Grade R, and that these challenges are consequently transferred to the learners. Shulman (1987,1986) insists that teachers should be competent in subject matter knowledge. They are required to go beyond the knowledge of the facts or concepts of a main content area and also understand the structures of the subject matter.

4.2.2 Planning teaching and learning

Planning is an essential element of teaching. Teachers are therefore expected to develop lesson plans which are appropriate to learners' developmental level. Moreover, the lesson activities should be planned in a manner that shows clear sequence so that learners will easily comprehend the content as a result. Lessons should thus be planned to promote effective

teaching and learning of mathematics (Ginsburg *et al*., 2008). Lesson plans should indicate activities that are in line with educational theories such as those of Piaget, Vygotsky, Brunner and constructivism that describe and explain how learners learn.

To comprehend what teachers understand about the planning and teaching of mathematics in Grade R, I asked the respondents two questions. The first question asked them to share what they understood by the requirement to plan learning activities (i.e., lessons) in order to teach mathematics in Grade R. The second question required an explanation of how the classroom should be arranged in order to teach mathematics in Grade R.

The findings indicated that the teachers had similar understanding with regards to the planning of the teaching and learning of mathematics in Grade R. Teachers Itumeleng and Manyai understood that their planning had to incorporate concrete, semi-concrete and abstract materials. Teachers Ntsoaki and Tselane understood planning as incorporating sequential lesson activities that involved the use of concrete, semi-concrete and abstract materials. Teacher Moliehi understood it as planning activities that would involve all learners as well as concrete materials. For instance:

> *I plan my teaching in a way that it starts with concrete materials, then abstract like eeer… using pictures (teacher Itumeleng).*
>
> *I think I should plan in a manner that my activities will be sequential. Like I start with activities that involves use of concrete objects first then abstract follows (teacher Ntsoaki).*
>
> *I understand that activities which involve the use of concrete materials are done first, the semi abstract ones will follow. (teacher Manyai)*
>
> *Mmm…! I think activities must involve all learners and my activities should make use of concrete materials (teacher Moliehi).*
>
> *I think they should be developed sequentially and they should follow concrete and abstract level. For instance, eee…! At the beginning of the week I use concrete objects, towards the end of the week we use both concrete and semi-concrete materials (teacher Tselane).*

The responses revealed that all the teachers seemed to know and understand that learners in Grade R learn through the use of concrete materials first, followed by the use of semi-concrete materials. This understanding portrayed by the teachers showed that they had knowledge of what theorist like Piaget and Bruner discovered about how learners should

learn. Furthermore, it was revealed that the teachers had knowledge about the learners' developmental stage and characteristics, as advocated by Shulman (1987

The planning of teaching and learning extends far beyond the planning of class activities only; it also involves the organisation and arrangement of the classroom in order to create an atmosphere which provokes spontaneous learning (Ginsburg *et al.*, 2008; Clements, 2001). Shulman (1987) states that teachers should possess general pedagogical knowledge, meaning that they should be knowledgeable of the strategies of classroom management such as being able to handle discipline issues in the classroom and to manage time by allocating it to lesson activities. Teachers should be creative in organising the teaching materials that will be needed during the teaching of mathematics and they should also design or obtain various posters with mathematical concepts and paste them on the walls of the classroom or notice boards (Shulman, 1987).

I asked the respondents to share what they understood by 'arranging and organising the classroom for the teaching of mathematics'. The findings showed that all the teachers understood that the classroom has to be arranged in a manner that creates a positive teaching and learning atmosphere. They all shared that they would like to have a 'maths corner' in their classroom.

> *I do not have a special arrangement for mathematics in my class because it is too small but I understand that it should be arranged in the manner that it instil the love of mathematics in learners. There has to be a display of colourful maths posters, a beautiful counting box with colourful counters. I would love to have maths corner (teacher Itumeleng).*

> *I have arranged my classroom by partitioning it into five corners but I do not have a special arrangement for mathematics. However I would like to have maths corner amongst other corners that I already have in my classroom (teacher Ntsoaki).*

> *I believe that, eee…! The classroom should be arranged in a manner that indicates that there is mathematics lesson going on in that class. I would like to have maths corner. I have five corners in my classroom already (teacher Manyai).*

I do not have a special arrangement for mathematics but I wish to have maths corner even though my classroom is so small that it does not even allow me to accommodate even just one corner (teacher Moliehi).

To arrange a classroom is important more especially to have a maths corner where learners can do maths all the time. I like to teach maths outside at the playground where there is enough space. As a result I do not have a special arrangement for maths in my class (teacher Tselane).

From the above responses it is clear that all the teachers understood that when arranging the classroom, mathematics teaching and learning should be taken into consideration. The teachers revealed different reasons for not having such an arrangement in their classrooms. For instance, teachers Itumeleng and Moliehi claimed that their classrooms were too small to accommodate more corners. Teacher Tselane pointed out that she liked to do mathematics outside on the playground where there was enough space; as a result she did not have a special arrangement for maths in her classroom. However, all the teachers wished to have a "maths corner" in their classrooms. Teachers Ntsoaki and Manyai acknowledged that classroom arrangement is very important. They claimed that they had already arranged their classrooms by having five corners and wished to have a maths corner as well. However, they did not provide a reason why they did not have a maths corner.

4.2.3 Knowing the learners and the differences among them

From the teachers' responses it was clear that they understood that learners are different because their responses revolved around the fact that learners differ in terms of cognitive development, learning styles and the prior knowledge that they bring to class. In each teacher's response there was an indication as to how they catered for such differences in their classrooms. I asked them to share what they understood by the fact that learners are different. Teachers Itumeleng and Manyai responded as follows:

I understand that their cognitive development differs. So I plan lesson activities that suit their thinking and that help them to learn using their preferred learning styles (teacher Itumeleng).

Yes m'am , I understand that they differ, these children, they may be of the same age but at the end of the day you find that cognitively, they differ. That is the

reason I ensure that I check their prior knowledge before I teach so that I know who knows what (teacher Manyai).

From these responses, it was clear that teachers Itumeleng and Manyai knew that learners are different in terms of their cognitive development, prior knowledge and learning styles. Teachers Itumeleng and Manyai addressed the differences of cognitive development of their learners differently. Teacher Itumeleng claimed that she planned activities that were appropriate to their learning styles while teacher Manyai considered their prior knowledge so that she would know where to start her teaching. Cognitive development, learning styles and prior knowledge are important factors that teachers must consider to ensure that their teaching caters for the differences among learners (NAEYC & NCTM, 2002).

Teacher Ntsoaki also understood that learners are different. She explained this understanding as follows:

They are different because they learn differently. Some learn through touching, others by just looking and listening but most of my learners learn best when they (do), eee…! That is using their bodies. I have also noticed that some learners differ to their peers due to poverty at their homes, so they need special attention of me those ones because they are not familiar with some of the things.

Teacher Ntsoaki was more elaborative when explaining how learners learn. She even referred to socio-economic status which is a characteristic that causes learners to be different in their learning. Chapter Two of this study presents a discussion on socio-economic status as a barrier to learners' ability to learn mathematics. Learners from disadvantaged backgrounds are not exposed to mathematical concepts like those with advantaged backgrounds who come to school with knowledge of numbers because they play educational games at home. Moreover, the parents of the more advantaged learners consider education as a priority so they create time to help their children with school work (Klein & Knitzer, 2007).

Teachers Moliehi and Tselane also understood that learners are different, even though they did not specify how they differ. They indicated that they catered for learners' differences. Teacher Moliehi indicated that she ensured that learners learned through the use of concrete materials and teacher Tselane claimed to plan activities that catered for different learning styles.

I asked the teachers to share with me their understanding of how Grade R learners learn mathematics. They all responded that learners learn mathematics through play. NAEYC and

NCTM (2002, p. 8) point out that "play does not guarantee mathematical development, but it offers rich possibilities, therefore teachers are advised to help learners to reflect on their play through questions that provoke their critical thinking". Teacher Itumeleng indicated that any form of play would help learners to learn mathematics. Teachers Manyai and Moliehi added that learners would learn mathematics if teachers used teaching aids in their teaching of mathematics. These teachers understood that learners in this grade learn through the use of concrete objects, as suggested by Piaget (cf. Chapter Two). Teacher Ntsoaki also understood that learners learn mathematics through play, but she elaborated:

> *I understand that they learn mathematics by playing but I always discuss the concepts with them then assist and guide them to learn the concept by engaging them into activities.*

Teacher Ntsoaki understood that play alone cannot enhance explicit learning of mathematics, but that her support and guidance would help learners to learn new concepts, as posited by Ginsburg *et al.* (2008). Teacher Ntsoaki understood that for the effective learning of mathematics, the teacher has to play an important role to facilitate learning by explaining the mathematical concepts she wants her learners to grasp and by asking questions which will afford learners the opportunity to think critically. This practice of teacher Ntsoaki is in agreement with Vygotsky's theory as discussed in Chapter Two. Vygotsky suggests that learners learn best when guided and supported by the teacher and once they have grasped the concept, they can be left on their own to explore and learn more – but they still need to be under the close supervision of the teacher.

Teacher Tselane had a different understanding of how learners learn mathematics, but it was somewhat similar to teacher Ntsoaki's views. She stated:

> *Learners learn mathematics when they are introduced to mathematical concepts by the teacher, then the teacher explains and discusses those concepts, then allow learners freely play around the concepts and as they do so, they discover and learn by themselves. The teacher only assists and guides them here and there.*

Teacher Tselane, like teacher Ntsoaki, acknowledged the need for the presence of the teacher in order to facilitate learning by assisting and supporting learners to discover things. This practice is in cognisance with Vygotsky's idea of the 'Zone of Proximal Development' which is discussed in Chapter Two. They understand that learners are capable of learning effectively when given the necessary assistance and guidance. Constructivism also supports this notion by indicating that as a teacher facilitates learning through guidance and assistance, enhanced

interaction occurs in the classroom which in turn leads to sharing of knowledge, thereby enhancing deep understanding of the subject (Clements, 2001).

Teachers Ntsoaki and Tselane had knowledge of the learners they taught while the other teachers understood that learning of mathematics occurs through play alone; these latter teachers possessed a limited knowledge of the learners they were teaching. Possessing knowledge of the learner is one of the domains of professional knowledge of Shulman's theory. Shulman (1987) states that teachers should know their learners in order to plan teaching that suits their abilities, developmental level, interest and needs.

Teachers are expected to know and understand their learners so that their instruction caters for each learner's individual needs and differences. Chapter Two presents a discussion of aspects such as cognitive development, learning styles and prior knowledge that teachers should consider in order to teach mathematics in an effective manner that benefits all learners. Shulman's (1987) theory indicates that when teachers know the learners that they teach, they will be able to plan lessons that suit their cognitive development and their differences like learning styles and the different informal knowledge that learners bring to class.

4.2.4 Strategies for teaching mathematics

The findings from the interviews revealed that all the respondents considered play, songs, games and discovery good strategies to employ in teaching mathematics. They believed that such strategies allowed learners to learn together while sharing ideas and they also provided learners with a lot of fun and enjoyment. The teachers also understood that assessment should be undertaken during the process of teaching and learning of mathematics and also after the lesson. They indicated that assessment helped them to discover if learners had learned what was expected and to identify those learners who might experience difficulties so that extra time could be created in order to assist them. Observations and questioning were found to be commonly used assessment methods amongst the teachers. Some teachers added that they used portfolios and assessment sheets. When observing teachers, I noted that one teacher used learner demonstration and group feedback as an assessment opportunity, which could be a very effective assessment tool when utilised creatively.

Like many other subjects, mathematics is a domain of knowledge where learners learn and understand the contents if exposed to a variety of ways to understand the concepts (NAEYC & NCTM, 2002). For instance, ISSA (2010) suggests that the teaching and learning strategies employed by teachers should help students to be lifelong learners by exposing them to critical thinking and problem solving situations so that they become valuable citizens of their countries in the future. This statement agrees with Shulman (1987), who insists that teachers should possess long- and short-term goals of the subject they are teaching so that they are able to steer their teaching in a direction that enables learners to be potential holders of valuable, different professions in the their countries.

I asked the respondents to share their own understanding regarding the teaching strategies which they thought were effective when teaching mathematics in Grade R, and to support their responses. The teachers responded that both free and structured play, songs, games and discovery were appropriate strategies to employ in teaching mathematics. They further indicated that those strategies allowed learners to learn together and share ideas and that they also provided learners with a lot of fun and enjoyment. Teacher Manyai had an additional strategy which was demonstration and she pointed out that demonstration allowed learners to observe and then to imitate what they had seen. Teacher Tselane's response to the question emphasised the importance of considering how learners learn when selecting teaching strategies. She said:

> *I understand that those strategies should allow learners to learn on their own but still be guided by the teacher but they must be free and enjoy as they learn. So I normally use play either free play or structured play, song, games and discovery. Well, I sometimes take advantages as they play to ask them questions about what they are playing so that they unconsciously learn maths concepts. I do discussion every day with them.*

This response indicated that teacher Tselane understood that she should possess knowledge of her learners as posited by Shulman (1987) in order to select appropriate teaching strategies that enhance the teaching and learning of mathematics. She understood that the learning of mathematics should be enjoyable to learners. Her understanding of the choice of teaching strategies also reflected Vygotsky's theory on how learning takes place. She stated that the teacher should play her role of facilitation during the learning process by guiding learners but at the same time affording them time to learn on their own. Her unique way of taking advantage of learners' play by interrogating them with questions so that they learn from their

play is very important because, as Ginsburg *et al*. (2008) indicate, in order for play to enhance learning it has to be supplemented with other strategies like asking learners questions which engage them in critical thinking.

The other teachers' responses were as follows:

> *I consider strategies like eee…! play, songs and discovery method very important because they allow learners to enjoy and learn in a relaxed manner (teacher Itumeleng).*
>
> *I think strategies like eee…! Action songs, free play and structured play are good because learners enjoy singing and playing more especially if they are supplemented with questioning and answering method (teacher Ntsoaki).*
>
> *I think strategies like demonstration, discovery and play are good to be used because after demonstration learners are able to imitate what they have seen (teacher Manyai).*
>
> *I think songs, games and free play are very good because as they play, they learn on their own using materials. They share knowledge and ideas freely during play (teacher Moliehi).*

The teachers' responses indicated that they understood that to teach appropriately they needed to turn their classrooms into 'laboratories' where learning would be experimented, demonstrated, discussed and discovered (Shulman, 1987). Facilitating learning occurs through the use of effective teaching strategies that learners embrace to constructively learn mathematics so that learning becomes enjoyable and fun (Young & Stuart, 2011). Shulman's theory emphasises that teachers should possess pedagogical content knowledge so that they are able to teach the subject matter in such a way that it is understandable to learners. They need to use teaching strategies such as illustrations, discussions, examples and explanations in order to present the content and ideas in a lesson. When teachers decide on the teaching strategies they will use, they must consider the learners' differences such as their developmental stages, interests, abilities, learning styles, and background (Shulman, 1987).

I asked the respondents to share their understanding of assessment and to give examples of the assessment methods that they used to assess learners. All the teachers indicated that they understood that assessment should be undertaken during the process of teaching and learning of mathematics and at the end of the lesson. They indicated that assessment helped them to discover if learners had achieved the set lesson objectives and also to note learners who might experience difficulties so that they could create extra time in order to assist them. The assessment strategies most used by all the teachers were observations and oral questions.

Nevertheless, teachers Manyai, Moliehi and Tselane had additional assessment methods. The teachers stated:

> *I assess by asking questions, and observing them as they work and keep their work on portfolios which they take to their parents every month end (teacher Manyai).*
>
> *I observe and ask questions as I teach. I keep their work especially their writings in their portfolios (teacher Moliehi).*
>
> *I keep their work in their portfolios. (Pause) eee…! Again, I sometimes ask them questions and I use assessment sheet to assess skills which learners must have acquired like colour in, tracing (teacher Tselane).*

It was evident that these teachers understood the importance of assessment in their teaching of mathematics. Keeping learners' work in portfolios is good because parents will know what learners have learned, the teacher will be able to keep track of the skills which learners have acquired, and the learners will feel important as they have done so much work which they are able to show to their parents. So keeping a portfolio somehow works as a motivation for learners. Both assessment sheets and portfolios are good strategies because they keep record of the acquisition of skills and they do not only provide information that learners can simply recall. Using assessment sheets is also a good assessment strategy because such sheets record each learner's progress and the information can easily be shared with other people like parents or Class1 teachers when receiving these learners at the beginning of their Grade 1 year. Assessment sheets can provide such teachers with valuable information which will provide them with information about the skills and knowledge that the learners mastered in the previous year.

Shulman's theory which guided this study insists that teachers should know their learners in all different aspects, so through assessment teachers will be able to know learners' cognitive development, abilities, capabilities and interests. Shulman (1987) emphasises that teachers should employ assessment methods that involve testing for learners' understanding during interactive teaching and at the end of a lesson, that assess the teacher's own performance, and that allow the teacher to make adjustments. Varol and Farran (2006) add that assessment is very important in the teaching and learning of mathematics in Grade R because it informs instruction; therefore, teachers should engage in assessing learners continuously and adapt their instruction according to identified needs in order to accommodate all learners.

4.3 Classroom Observations of Five In-service Teachers Teaching Mathematics in Grade R

Research Question: *How does in-service teachers' understanding of the teaching of mathematics influence their teaching of mathematics in Grade R?*

My observation schedule included the behaviors/criteria as presented in Table 3.1 in Chapter Three. The elements that I investigated were the following: organisation; logic and sequencing of presentation of mathematical concepts; use of different teaching strategies; assessment of learners; classroom arrangement and organisation; integration of mathematical concepts with other subjects; the engagement of learners in activities that would help them gain deep understanding of mathematics; activities that would cater for different learning styles and cognitive development; taking cognisance of prior knowledge; use of concrete locally available materials; contextualisation of games, songs and examples used; and the engagement of learners in activities that would help them gain deep understanding of mathematics by asking why and how questions.

4.3.1 Lesson Observation 1

Teacher Itumeleng

Classroom Environment

It was a rectangular shaped classroom comprising forty square metres. There were forty eight learners in the classroom; twenty five were boys and twenty three were girls. The learners' desks were arranged in a manner that allowed them to sit in groups of nine or ten in a group. The inside walls of the classroom were not clean. The walls were painted with yellow paint but most of the paint on the lower part had been removed, probably by rubbing of the desks or hard objects. The walls were too crowded with a variety of dilapidated posters of numbers, pictures of people, and of different types of food. The learners' school bags, with each learner's name attached next to the bag, were hanging on pegs along the classroom walls. There were no chalk board or cupboard to store the teacher's books, chalk, pens and many other things that she might need to be kept out of reach of children. There was no desk or table for the teacher except a chair.

Classroom observation

In this section I describe the observations that I conducted. The conversations are recorded *verbatim* and may contain linguistic inaccuracies which were not corrected in the transcription process.

On my arrival to the classroom, the teacher offered me a chair which was placed behind the door and I was offered a table which was similar to the ones used by the learners.

Before the lesson began, teacher asked the learners to sing a Sesotho counting and action song:

"Ngoe ngoe o ho kae na? Ngoe ngoe o ho kae na? (One, one, where are you? One, one where are you?)

Ke 'na enoa ke 'na enoa bona ke etsa joale. (Here I am, here I am look what I am doing)."

All the learners stood up and were all singing enthusiastically. Meanwhile the teacher organised teaching and learning materials and when she completed the task, she asked the learners to stop singing and to sit down because the lesson was about to start. They ended the song and were seated.

Teacher Itumeleng: *Shhhhh!!! Keep quiet, please, everybody fold your arms. Thato, fold your arms. Okay, we have a visitor in our class today, and I am expecting you to behave well, right!*

Learners (together): *Yes, teacher.*

(Learners folded their arms and there was quiet for few seconds, then teacher Itumeleng showed them a chart with a drawn circle on it. She asked a question.)

Teacher Itumeleng: *What shape is this?*

Learners *(together): A circle.*

Teacher Itumeleng: *Well done. Today I would like us to talk about things found in our environment with a circular shape and identify them. Now! eeerrr… we will go outside to the playground to look for things which have a circular shape.*

Learners *(most of them) stood up and rushed to the door, shouting: Out, out!*

Teacher Itumeleng: *Hey! Go back to your seats, go back, go back!*

(Learners went back to their seats.)

Teacher Itumeleng: *Shhhh, quiet and listen all of you. Put your hands on your heads. Shhh. Mangoes will go out first.*

(A group of learners walked out of the classroom).

Teacher Itumeleng: *Apples, oranges, bananas and grapes will follow.*

(*Learners walked out of the classroom as the teacher had instructed the groups. I joined them on the playground. Learners stood around the teacher as she repeated the activity to be undertaken.)*

Teacher Itumeleng *(repeating the instruction): You should look around (pointing with a finger) and identify objects that have a circular shape. When you have seen it, put up your hand, then I will allow you to show the whole class what you have seen, ok?*

Learners *(together): Yes, M'am.*

Teacher Itumeleng: *Good, start looking around.*

(The learners were running around very energetically and shouting at the same time.)

Learners *(ad lib)****:*** *Teacher, teacher I have found this one…*

(*They were even pushing each other because they crowded around one object such as a drum and a slide, etc. Some learners stood still, possibly because objects on the playground were not many so those who were quick to spot them and run to cling to them survived to have objects to point out. The teacher went among the learners and asked them to show a circular shape on equipment or objects and then she would pass on to another group. She then asked the learners to come closer to where she was standing. The teacher did not attend to learners who stood aside as others were running around to look for objects or equipment with a circular shape.)*

Teacher Itumeleng: *Have you all seen objects with a circle shape?*

Learners *(together, including those who had not participated): Yes, M'am.*

Teacher Itumeleng: *Ok, good. Now, use your finger to draw a circle in the air.*

(All the learners drew a circle in the air, very excitedly.)

Teacher Itumeleng: *Good, go back to the class.*

(Learners ran back to the classroom, pushing each other in the doorway, but the teacher hurried to assist them to line up.)

Teacher Itumeleng *(shouting)****:*** *Quiet class, quiet!*

(The teacher distributed to each of the five groups a chart with a drawn circle on it. Then she asked learners to mention the shape that appeared on their chart and all the learners shouted: "A circle!" The teacher then showed learners a plastic bag full of bottle tops and plastic objects of different shapes and told learners that

she was going to distribute those bottle tops and plastic objects of different shapes to each group. After the distribution, the teacher asked learners to share materials and play with them freely before she instructed them or guided them to the intended activity. Learners were excited when playing with the materials. Some learners played in pairs while others played alone and there were those who did not play but held their bottle tops and cubes in their hands and sat quietly. Some who played built towers, houses, or a kraal, and others were sorting the tops according to colour. Meanwhile the teacher was moving around and asked learners to explain their play and she asked questions like: "What colour is this group?"; "How many blocks did you use to build the tower?" At this time she still did not attend to those few learners who did not play with their materials. After eight minutes, the teacher instructed them to stop.)

Teacher Itumeleng *(clapping her hands and singing): Clap, clap, clap, clap, clap, clap…*

(Learners joined her; they clapped hands and sang likewise: "Clap, clap, clap…").

Teacher Itumeleng: *Ok, ok, what were you doing with those materials?*

Learners *(together, shouting and putting up their hands): Madam, madam...!.*

Teacher Itumeleng: *Thato, tell us.*

Thato: *I built a house.*

Teacher Itumeleng: *Taole at the back, what did you do with your objects?*

Taole: *A snake.*

Teacher Itumeleng: *Good! Clap hands for yourselves because I know you all have built something interesting, ha kere (okay)?*

Learners *(together, clapping hands): Yes, madam!*

Teacher Itumeleng: *Now listen, put those materials that you have shared together again and I am giving each group a Bostic, which you will use to stick all objects which have a circular shape inside the big circle drawn on the chart, ok?*

Learners *(together): Yes, madam.*

Teacher Itumeleng *(giving out Bostic to groups): I repeat, you paste only objects with a circular shape inside the big circle drawn on the chart. Right! Start working.*

(Teacher Itumeleng moved from group to group to assist learners not to fight over materials and she even asked questions like: "Are you sure this bottle top has a

circular shape?" Then learners gave different answers. However, she did not ask 'why' questions. When she noticed that all the groups had completed the task, she ordered them to stop.)

Teacher Itumeleng: *Now, have you all finished?*

Learners *(together): Yes, madam.*

(The teacher then instructed other groups to listen to each group as it presented its work. The Mango group was the first to present, so they showed the whole class their work, then counted the number of bottle tops they had pasted inside the big circle that was drawn on the chart. They then counted those items that were not pasted inside the big circle because they did not have a circular shape. Other groups followed the same procedure to present their work and there was a round of applause after every presentation. Learners were unconsciously competing. They wanted to find out which group had more objects with a circular shape and which group had the fewest items with non-circular shapes.

The number of objects with circular shapes ranged from fifteen to twenty three and the number of non-circular objects ranged from seven to eleven. Providing them with more circular objects than non-circular ones gave learners the opportunity to learn more about a circle and it added more fun and enjoyment as learners discovered and pasted objects inside the drawn circle on a chart.

After all the groups had presented, the teacher assessed the lesson by asking learners to mention objects that had a circular shape. Learners responded by mentioning objects they had seen on the playground such as drums, a jumping castle, old tyres and bottle tops.

The teacher then asked them to stand up and sing an action song. They sang together with the teacher. After the song and performance of a lot of actions, the teacher instructed them to go to the toilet. They all put their hands on their heads and started to sing: "Wiwi! wiwi! wiwi!" as they marched out of the classroom.)

This observation revealed that teacher Itumeleng's understanding of the teaching of mathematics had an average good influence on her teaching of mathematics because she understood that learners learn best when they learn together. To facilitate this, she employed different teaching strategies like group work, questioning and answering, discussion and free play, demonstration by learners and feedback!!! Another strategy that made her lesson more interesting was the home groups that she had like Mangoes, Oranges and Apples. These groups made her teaching easy because she used them to assign group work or to control or

manage learners' behaviours during class activities. The counting song which she used was also good to excite learners and therefore get them ready and to stimulate them to learn. The free play in which learners were engaged was good because it afforded learners opportunities to handle materials and to explore their own ideas. The questions that she asked during this play were helpful to learners to discover some mathematical concepts that occurred during play. Teacher Itumeleng also used another strategy whereby she allowed learners to take a tour to the playground where they were afforded an opportunity to look for circular objects or equipment. This was a good plan because the classroom was too small for such an exploration. Again, learners were given an opportunity to associate a circle with real objects and also to explore their own environment. This activity had the challenge of not having enough materials on the playground so that not all learners were fully involved. Teacher Itumeleng seemed to rely on the existing play equipment which was already mounted on the ground in the play area. She could have brought along more materials. She also failed to emphasise the characteristics of a circle so that learners would understand clearly how a circle is shaped. Also, she failed to ask 'why' and 'how' questions which would have engaged learners in deep understanding of a circle.

Class activities were well presented and she was able to give learners clear instructions. She gave learners enough time to complete the assigned task. The use of group work was a good strategy for that activity because learners were sharing ideas. Also, it helped the teacher to be able to provide enough materials. The groups' presentations and an impromptu competition added a lot of fun and play to her lesson.

Although she did not overtly integrate mathematics with other subjects, I observed that teacher Itumeleng's class activities catered for three learning styles, namely: kinaesthetic, auditory and visual learning styles. The activities were also appropriate to learners' cognitive development because she taught one concept at a time and she was clear as to what learners should learn; as a result all her activities were assisting learners to identify a circle. To cater for learning styles, she had activities that allowed learners to touch objects with a circular shape on the playground, she asked them to draw a circle in the air using their fingers, she showed them a drawn circle, and made them paste objects that had a circular shape inside a big circle that was drawn on a chart paper.

Teacher Itumeleng demonstrated a positive understanding regarding the importance of prior knowledge. When reviewing the prior knowledge of learners, she briefly asked learners to mention the shape which was drawn on the chart paper Taking learners to the playground to identify objects with circular shape was a creative way of helping learners to connect their prior knowledge with their life experiences.

She took an advantage to assess learners during the lesson, when learners were working in groups to paste circular objects inside the big circle that was drawn on the chart paper. I noticed that all groups understood the concept as all groups managed to paste all circular objects inside the big circle as a result her assessment was logical and reasonable. It is therefore clear that teacher Itumeleng understood that assessment form very important part of teaching because she needed to know if learning had taken place or not. However her lesson plan did not indicate such an activity as meant for the assessment but was planned as one of the activities that afford learners an opportunity to learn the circle concept.

Teacher Itumeleng failed to assist the 'quiet', withdrawn learners and determined that all had mastered the circle. On the playground she could have called the learners together, and then sent the quiet ones back to touch the circular objects to confirm that they had mastered the concept. In the group feedback session in class she could have focused on these little ones through questions to determine if they had mastered knowledge of the circle. Instead, it seems that her focus was on the 'busy' learners who would always stand out in a group. In this regard her understanding of the differences in group and individual dynamics and learning strategies would have been useful for learning. Her failure was not so much in assessment, but in knowing and assessing all her learners.

The physical classroom situation was not favourable for the effective teaching of mathematics because it was too small for the number of learners that had to be accommodated. There was no chalkboard on which the teacher could write. Posters of numbers on the inside of the classroom walls were very old and the information was not clearly visible. Teacher Itumeleng did not have different corners or discussion areas, probably because of her small classroom. There was no space to display learners' work other than the walls, but the learners' bags took up most of the wall space. However, some attempt was made to overcome such barriers as learners' desks were arranged in a manner that allowed learners to sit in groups of ten. Teacher Itumeleng used locally available materials

creatively in her teaching. She also used concrete and abstract materials, i.e., bottle caps, and drawing circles in the air.

4.3.2 Lesson Observation 2

Teacher Ntsoaki

Classroom Environment

It was a square classroom comprising sixty four square metres. The classroom had eight windows. There were thirty two learners. Each learner was seated on a chair facing to the wall where the chalkboard was mounted. They were seated in a semi-circle with a mat at the centre. The inside walls of the classroom were clean and there were different posters pasted on the walls. Some posters had pictures of the family members of His Majesty King Letsie III, pictures of celebrations like the king's birthday, pictures of different kinds of food, and flash cards of numbers. The classroom arrangement made provision for different 'corners' where learners could play freely or where the teacher could engage them in structured play in order to reinforce any sub-themes being taught and learned. Those corners were for fantasy, books and blocks. There was a built-in locker which the teacher used to lock in important items like her handbag, her preparation books, learners' pencils, crayons, brush paints, paints, Bostic, clue and boxes of white and coloured chalk. There was a big chalkboard mounted on the wall. There was a table and a small bench placed right in front of the learners. On top of that table there was the teacher's lesson plan book which she referred to time and again as she presented the lesson. There were also a table and a chair at the door where I was seated.

I arrived at this school in the morning around 09:40 so all the learners were in their classroom. I was welcomed by the principal who was standing outside his office talking to a parent. He accompanied me straight to the Grade R classroom and told me that he knew about my visiting his school and that he fully supported what I was doing. I entered the classroom and met the teacher. She offered me a seat and she told me that she was concluding the morning presentation which was on protective food.

Classroom Observation

After she had presented the conclusion, the teacher asked the learners to sing an action song called "One little, two little, three little fingers". After the song the teacher ordered the learners to sit on the mat. When they were seated she distributed materials like blocks, playing boards and shapes of different kinds. She then ordered learners to freely play with those materials. As they played, she moved around each group which had unconsciously been formed by the learners without being instructed to do so. She observed and asked learners to describe their play. They told her that they were building houses or cars. Some were shouting that they had built nothing but had grouped shapes of the same colour together. After five minutes of free play, the teacher asked the learners to stop playing and to return all the shapes to the containers but to leave all the playing boards and slides (discs) on the mat. The learners made a lot of noise fighting over and grabbing shapes from one another.

Teacher Ntsoaki *(shouting): Hey! Hey! Quiet please, Thabo! Thabo, stop that behaviour, and everybody must go back to their seats.*

(Learners rushed from the mat to their seats.)

Teacher Ntsoaki: *Shhhhh! Please be quiet! Hey! Listen!*

(Teacher Ntsoaki then instructed leaners to work in groups to play a game that was aimed at teaching them to match things that looked the same or that went together. The learners sat on the mat in groups of six. At the centre of each group there were a playing board which had different pictures on it and playing discs which had similar pictures to the ones that appeared on the playing boards. The teacher instructed learners not to touch either the discs or the playing boards until she had read a phrase on her flash card. She told them that she would read a phrase from a flash card and learners had to listen very attentively so that they would understand the phrase and be able to select the correct disc and match it with a corresponding picture on the playing board. She then informed learners that the group that managed to match a full row or column correctly must shout "Bingo!" because it would be the winning team. Learners were very excited and they seemed to be familiar with the rules of that game.

The teacher took flash cards randomly from her hand and started to read phrases. The game continued as follows:)

Teacher Ntsoaki: *A pair of shoes and a pair of socks.*

(Learners looked for a disc that portrayed the picture similar to the phrase read by the teacher. One learner shouted a word from the phrase in Sesotho ["likausi"]. As the learner shouted the word, others were able to select the correct disc and match it on the playing board.

The teacher was moving around the groups to check if all the groups were following the instructions. In each of the groups there were two or three learners who seemed not to follow what others were doing but the teacher just ignored them. Four learners, each from a different group, moved totally from their groups and went back to their seats quietly looking at other learners as they worked. The teacher made no effort to bring them back to the mat.)

The second phrase read as follows:

Teacher Ntsoaki: *Open window and open curtain.*

(Groups one, three and four got the disk that portrayed the corresponding picture quickly and matched it on the playing board. Teacher continued to read another phrase.)

Teacher Ntsoaki: *A tree near and a tree far.*

(Learners struggled to match the phrase with a similar disk and picture but group five accomplished the match first. Teacher moved on to read another phrase.)

Teacher Ntsoaki: *Three maize plants and three maize cobs.*

(Most of the learners shouted the phrase in Sesotho ["poone le seqo"] and most of the groups were able to identify and match the correct disk and picture. The teacher moved on to read another phrase.)

Teacher Ntsoaki: *Dog behind the door.*

(Most learners were able to match the correct disks on the matching board quickly and shouted at the teacher to come and have a look at their work. Teacher Ntsoaki moved on to read another phrase.)

Teacher Ntsoaki: *A triangle.*

(One leaner shouted, "Triangle, triangle!" It was easy for most of the groups to select the appropriate disk. As a result, the teacher continued reading another phrase.)

Teacher Ntsoaki: *Four carrots.*

(One learner shouted, "Bananas!" The teacher asked, "Are carrots bananas?")

Learners *(together)****:*** *No, teacher.*

Teacher Ntsoaki: *Ok! Good. Now look for a disc that has a picture of four carrots.*

(The groups continued to look for a disc that had four carrots. Two groups complained that they had no more discs, but the teacher ignored them and continued to read another phrase.)

Teacher Ntsoaki: *Someone is climbing.*

(Another three groups matched their last discs. The teacher then stopped reading phrases and distributed other discs. After the distribution she read another two phases at the same time.)

Teacher Ntsoaki: *Seven fish. Animal jumping over.*

(Learners were first battling to find the matching discs for two phrases but it was not too difficult because the discs were few now so most groups succeeded with their matching. The teacher read another phrase.)

Teacher Ntsoaki: *A circle.*

Group three learners *(shouting together)****:*** *Bingo, bingo! Heee bingo!*

(The teacher asked other learners to have a look at the work of group three to check if they had won the game. Not all, but most of the learners went to group three and all shouted, "Bingo! Bingo!")

Teacher Ntsoaki: *Have they got all of them correct?*

Learners *(together)****:*** *Yes teacher, they have won the game.*

(Another learner asked, "Can we continue with the play?" But the teacher denied them the opportunity and asked them to stand up and go back to their seats because the game was over. So all learners moved back to their seats and the teacher called upon leaders of the groups to collect and store the playing boards and discs in their boxes. Meanwhile there was a lot of noise made by some learners, claiming that they had been very close to winning the game.)

Teacher Ntsoaki *(shouting): Hey! Hey! Keep quiet! Lironts'o, shut up! Shhhhhh!*

(Learners slowly became silent and the teacher told them to go to the toilet because the mathematics lesson was over. All the learners rushed to the door, pushing one another, but in the end they all moved out to rush to the toilet. The teacher then prepared materials for Literacy which would be the next lesson when the children returned from the toilet.)

Teacher Ntsoaki's understanding of mathematics teaching had a limited influence on her learners' learning of mathematical skills because from the above observation it was clear that

she was challenged by a limited understanding of how to teach the mathematical concepts she was trying to focus on. As a result, she missed important elements in the lesson. For instance, teacher Ntsoaki's lesson was about matching concepts using a bingo game. The lesson did not specify whether learners were to match things which were alike or which were different. However, most of the learners were able to follow because they seemed to be familiar with the game. The teacher did not use the game to teach the concept of matching because after every match she would read another phrase and learners would have to look for a matching disc. The game continued without any explanations. The teacher also did not ask any critical questions which could have helped learners to notice the similarities or differences between the discs and the pictures on the board. It is therefore possible that learners did not learn the concept of matching. She could have noticed if learning was taking place or not by assessing learners during and after the lesson, but she did not apply any assessment strategies. The mathematical concepts (e.g., *circle* and *triangle*) occurred coincidently and but she failed to discuss their properties. The lack of focus on this element in mathematical teaching was a barrier rather than a bridge to learning.

However, although Teacher Ntsoaki planned just one activity, she managed to incorporate learning styles such as visual, kinaesthetic and auditory. She would read a phrase while learners were to listen, then they would search amongst many discs on a mat to visually find the one that matched the read phrase, and then they were to put the matching disc on the corresponding picture on the playing board. This activity did not suit all learners' cognitive development because some learners did not understand the game properly because they did not understand the English language that the teacher used while reading the phrases. They could also have suffered from boredom if they had played the game often before. Teacher Ntsoaki was trying to engage all the learners even though there were challenges with classroom management and learners' discipline. Learners' prior knowledge was thus not reviewed or focused in a planned manner. They were also denied an opportunity to match real or concrete objects; as a result learning was not connected to their real-life experiences. Teacher Ntsoaki also failed to contextualise the game. She missed the opportunity of contextualising the game even when one learner shouted in Sesotho "seqo le poone" (maize cob and maize plant) after she had read a phrase "three maize plants and three maize cobs". She ignored the learner and continued with the game. This shows that the teacher did not understand that teaching has to be contextualised so that learners easily comprehend what they are learning.

I noticed that teacher Ntsoaki used teaching strategies such as a game, group work, and questioning and answering to teach. Free play was used to familiarise learners with the materials which were intended to be used during the teaching process and during that play she asked questions about their creations. This was a good strategy which could have been used to great advantage when introducing the lesson, but it failed in its effectiveness because no constructive questions which would have required learners to think critically about their play were asked. Instead, most of the questions were recall questions which merely required of learners to describe their creations. No 'why' or 'how' questions were used to stimulate deep learning.

I further observed that teacher Ntsoaki arranged the classroom by partitioning it into five corners namely book, block, fantasy, art and discovery corners. I learned that those corners were used to reinforce content of the theme/topic which was being taught throughout the week. Learners were allowed to play in these corners during free play or structured play. The classroom of teacher Ntsoaki had a discussion area where learners sat on a mat in a semi-circle. However, there was no space to display learners' work. Materials at the disposal of learners in the different corners were concrete locally available items. There were different posters on the classroom walls which included posters showing mathematical concepts.

4.3.3 Lesson Observation 3

Teacher Manyai

Classroom Environment

The classroom was of a rectangular shape comprising an area of sixty square metres. The inside walls were clean. It had eight windows. There were posters of animals, plants, people, numerals and pictures of important places like a post office, a police station and a clinic. There was a chalkboard mounted on the wall.

The classroom arrangement included partitioning into five 'corners' known as a fantasy corner, a book corner, an art corner, a block corner and a discovery corner. In each of these corners there were collections of a variety of recycled and local materials. At the centre of the classroom there was a mat surrounded by learners' desks and chairs. There was also a quiet corner with a mattress for learners to rest or sleep on.

I arrived at the school during toileting time (09:15). The principal was absent, so I was welcomed by a class seven teacher who accompanied me to the Grade R class. After washing their hands, the learners entered the classroom. The Grade R teacher welcomed me to her class and told me that she was about to teach mathematics.

Classroom Observation

She ordered learners to sit on their benches. There were twenty one learners altogether. The teacher requested them to keep quiet, and then told them that they had a visitor who was going to learn how they learned mathematics - so they had to behave well.

After that, the teacher told the learners that they were going to learn about ordering. She informed them that they would ***order things according to their height****. She took a box filled with empty tins and bottles, then arranged five bottles according to height. She then told learners that she had demonstrated how to arrange bottles according to their height. Teacher Manyai then asked the learners to count the number of bottles she had arranged.*

Learners *(together): One, two, three, four, five.*

(The teacher was pointing at the bottles as the learners counted.)

Teacher Manyai: *Good!*

(Teacher Manyai explained that the bottles had been arranged in order of height.)

Teacher Manyai *(pointing at bottles): Do you see? I have put the* ***short*** *bottle first, then I have ordered them up till the last bottle which is the* ***tallest*** *of all the bottles.*

Learners (together): *Yes, teacher.*

Teachers Manyai: *Okay! Now I want you to come and arrange tins from the boxes like I did.*

(A number of learners ran towards the table where the arrangement had been demonstrated by the teacher. The teacher had to shout to restore order.)

Teacher Manyai: *Hey, Hey! Don't rush, all of you go back. I will select those ones who are still seated.*

(All the learners went back to their seats and the teacher asked 'Mamalia, one of the learners who had remained seated, to come and order tins according to height. 'Mamalia walked towards the table and the teacher told her that she should begin her arrangement with the shortest tin.)

Teacher Manyai: *'Mamalia, are you going to arrange tins, bottles or boxes? You have to choose.*

'Mamalia: *Tins.*

Teacher Manyai: *Good girl. Show us the shortest tin then.*

'Mamalia *(pointing at the shortest tin): This one.*

Teacher Manyai *(to the class)**:** Is she correct?*

Learners *(together, some saying yes while others were saying no): Yes teacher/ No teacher!*

Teacher Manyai: *Ok, 'Mamalia, continue with the arrangement.*

('Mamalia arranged the tins starting with the shortest tin. After she had arranged the tins, the teacher asked her to lead all the learners in counting those tins. After they had counted the tins, the teacher asked Lerato to come to the front to rearrange the same tins and start with the tallest tin. Lerato did as instructed by the teacher. The teacher asked Mosa to come and arrange blocks according to height. Mosa walked to the table to arrange blocks and she told the class that she was going to start her arrangement with the ***smallest and go to the biggest****. The teacher allowed Mosa to continue with the arrangement. Teacher then called upon another learner, Moeketsi, to come and rearrange the blocks, starting with the biggest. Moeketsi rearranged the blocks starting with the biggest block. Teacher Manyai then showed the learners other containers, informing them that those containers were filled with different contents; as a result, they had different* ***weights****, so learners had to arrange them according to weight, starting with the one with the* ***most weight*** *to the one with the* ***least weight (i.e., from the heaviest to the lightest)****.)*

Teacher Manyai: *Yes, Thapelo, come and arrange the containers according to their weight.*

(Thapelo marched forward to the table and arranged the containers. After the arrangement, the teacher asked Thapelo to explain how he knew that the container he had put first was heavier than the other two containers, but Thapelo had no answer. The teacher ignored him and asked another learner to come and judge which container was heavier than the others, so another learner called Bopane went to the table to judge and justify which container had more weight than the others. Bopane rearranged the containers and when the teacher asked her why she had come up with such an arrangement, Bopane responded that the

first container was filled up with water while the other containers were empty. The teacher then emphasised that the container which was filled with water was shorter than an empty container but since it was heavy, it was good that it was put first and an empty container was put after it. She then concluded the lesson by telling learners that they had learned about ordering objects according to ***their height and their weight****. She then asked learners to sing as they marched out of their classroom to take a short break.)*

From this observation I learned that teacher Manyai's understanding of the teaching of mathematics had a limited influence on her teaching of mathematics because she experienced challenges in not understanding the mathematical concept she was teaching. For instance, teacher Manyai was teaching ordering according to height. Firstly, she did not clearly use ordering words appropriate to describing ordering arrangement; even her instructions were not clear as to which word to use in order to arrange objects. For instance, she asked one learner to arrange blocks starting with the smallest to the 'biggest'. This showed that the teacher did not know the content she was teaching. She could have identified a word to explain ordering such as 'tall', so that the ordering would be described as 'tall, taller, and tallest'. Her arrangement could have been of three objects only, and not five. She could also have asked them 'why' questions that would have made them aware of the use of '...er' and '…est' in words to denote degrees of comparison. Five bottles were arranged on the table but she used opposite words (tall and short) to explain the ordering that was done; she could have used three bottles instead so that she would have size modifiers (adjectives) such as 'tall, taller, tallest' or 'short, shorter, shortest'. This would have addressed the need for mathematics learning to be linked with language learning.

Secondly, she failed to focus on one category like 'height'; instead she wanted learners to order things according to 'height' and 'weight', which caused confusion among the learners. This showed that she had a very limited understanding of how to teach mathematics in this grade. Planning and teaching more than one concept with the incorrect use of mathematical terms brought confusion to both the teacher and the learners. This was a clear indication that teacher Manyai did not understand or know the subject content or the learners that she was teaching. Her activities were not presented sequentially such as starting with concrete objects first, then moving on to semi-concrete objects, as she had mentioned in the interview. This

means that she might have theoretical knowledge but that she had not yet made the link between theory and practice. However, she partially asked a 'why' question regarding weight. The classroom activities of teacher Manyai partially addressed the required learning styles but were not appropriate for cognitive level development in her learners. This was owing to confusion which was as a result of her planning to teach more than one mathematical concept at a time. Moreover, the majority of the learners were not actively involved in the learning process. The teacher chose a few learners to do ordering, which demonstrated that she did not understand that young learners need to experiment their learning; they need to use all their senses to learn and not sit by and watch passively. She could have brought enough materials for each learner to do his or her ordering. Through questions, learners could have been given an opportunity to describe their ordering, sharing ideas and comparing their own results with those of others. Teacher Manyai did not ask questions to check if learning had taken place and she failed to review learners' prior knowledge. Other subjects were not integrated into this lesson. In fact, a golden opportunity to combine mathematics and language was missed.

Teacher Manyai used teaching strategies like demonstration, questioning and answering, discussion, and free play. However, she did not have strategies to manage learners' behaviour. The fact that she allowed learners to leave their groups and separate themselves from the lesson was worrisome. The fact that Teacher Manyai's class was arranged to accommodate various key development areas and that she used concrete materials to support her teaching showed that she had some understanding of the need for the use of both concrete and abstract materials in her teaching.

Moreover, the discussion area in teacher Manyai's classroom where learners sat on a mat in a semi-circle during discussion of themes was also a positive step in getting close to her learners and thus getting to know them and their needs in a more intimate manner. However, she needed to apply her knowledge of her learners and their needs in her lesson, instead of ignoring some and giving opportunities for learning to others. Having well arranged tables and chairs for each learner was also a positive set up because Grade R learners are expected to practice writing skills so that arrangement afforded learners a chance to practice good sitting posture.

4.3.4 Lesson Observation 4

Teacher Moliehi

Classroom Environment

The classroom was rectangular comprising twenty four square metres. There were twenty four learners altogether. There were two windows on which learners' school bags were hung. As a result, it was dark in the classroom because the light shining through the windows was insufficient. The inside walls were not clean. They had scratches all over which were probably caused by learners' tables and sharp objects like steel nails which were used to hang posters. There were dilapidated posters of different animals, people, plants, and different kinds of food, different kinds of soil, and a picture of the national flag.

There were tables and chairs for learners, but they were made to sit, each on his or her cushion, on a mat forming a semi-circle and the teacher positioned herself in front of them. I was invited to sit behind the door, on a chair that had been borrowed from the Grade 1 class. I used my lap to support my dairy when taking notes of the observations. The classroom arrangement included five 'corners', namely a fantasy corner, a block corner, a discovery corner, art corner and a book corner. There was a locker in which some of the playing materials like toys were kept safe. There was a small table with two buckets filled with clean water. There were also a washing basin and a bottle of Sunlight Liquid soap. The water was used to wash hands after toileting, after handling paints, or before eating lunch. The clean water was used for drinking.

Classroom Observation

I arrived during snack time and I received a warm welcome by the principal. We greeted each other and she apologised for not accompanying me to the class because she was on her way to a meeting. She further informed me that she knew about my coming to the school and she had read and acknowledged my consent letter. After the principal's welcoming remarks, she showed me the Grade R classroom. I was then met by the teacher who was assisting learners to clean their hands and tidy up the classroom because they had had their snacks in the classroom. Learners were singing as they picked up rubbish on the floor.

Learners** (singing together)**: *Pick it up; pick it up; into the bin.*
Pick it up; pick it up; into the bin.

(Teacher Moliehi then instructed them to sit on the mat, each learner on his or her cushion. She then introduced me to the learners and told them that I was visiting their class because I was interested to observe how she helped them to learn mathematical concepts. Teacher Moliehi then reminded them that they had discussed the sub-theme for the day earlier that morning. She told them that they would continue with a mathematics activity. She then called upon a group of learners known as the 'Cats' to come to the front. The 'Cats' rushed to the front. The teacher then gave them a bucket with objects of different colours and shapes and also a plastic bucket filled with empty milk, juice and soap containers.

Teacher asked two learners from the Cats group to ***sort those objects according to colour****. Two learners whom the teacher had chosen sat on a mat and started to sort objects. The rest of the group members and the other learners were observing as the two learners performed the activity. Without asking learners questions such as "Mention the colours they have discovered as they sort the objects" in order to check if they understood the activity, the teacher asked two learners to look at the categories of different* ***colours and then to sort objects from those categories according to their shapes****. The two learners continued to sort objects according to their shapes and they were struggling to differentiate between shapes so they took a lot of time doing the activity. Most learners lost interest; their attention wandered and they started playing and making a lot of noise.*

The teacher ignored them and when the two learners had finished sorting objects according to their ***colour and shape****, she then ordered another group named the 'Kittens' to take their turn to sort other objects (blocks, empty boxes of spices, milk) which were left on the mat. Two learners were randomly selected from the Kittens to sort objects according to their shapes. No questions were asked. The learners were told to return to their seats after the participants had completed the activity.)*

Teacher Moliehi *(shouting): Keep quiet, please! Stop going up and down in the class like this. Thato, come back.*

(Learners started to get settled; the teacher then told them that they had learned to sort objects according to their shapes and colour, so tomorrow they would learn to order things according to their height. Learners were then released to go

outside to play so they all ran out of the classroom. The lesson ran for fifteen minutes.)

The above observation indicated that teacher Moliehi's understanding of the teaching of mathematic had a very limited influence on her actual teaching of mathematics because she had planned and taught a lesson which was not developmentally appropriate to her learners' development level. First, it aimed to teach two categories (colour and shape) in one lesson. Some of the materials which were to be sorted such as empty boxes of soup, milk, matches, sweets and drinks had a combination of many different colours and that made it difficult for learners to decide in which categories to place the containers. Moreover, the shapes of the containers were too different (solid shapes such as cubes, cylinders and flat shapes like squares, triangles of varying sizes), so it was a challenge for learners to sort them. She did not explain the main points of the lesson or asked questions after objects had been sorted so that learners could understand why particular objects were sorted together. Teacher Moliehi was challenged by not presenting activities organised sequentially; the introductory activity to review prior knowledge of learners and concluding activities which would lead her to assess learners did not occur in this lesson. She did not assign enough time for the activities so her lesson took approximately fifteen minutes.

Teacher Moliehi was limited in her use of teaching strategies. She wanted to use group work but she only identified two learners from the two groups which she selected to do all the activities, and she ignored the rest of the learners. As a result, there were behavioural challenges but she did not have any strategies to manage learners' behaviour. Moreover, her activity did not cater for different learning styles. The Visual learning style – colour and shapes; kinaesthetic – touching concrete objects were catered for. However, only a few learners involved.

Teacher Moliehi's classroom was small but she managed to arrange it by partitioning it into five corners namely book, block, fantasy, art and discovery corners. I learned that those corners were used to reinforce the content of the theme which was being taught throughout the week. So learners were allowed to play in these corners during free play or structured play. She had a discussion area where learners sat on a mat in a semi-circle. There were learners' tables and benches which were arranged in the middle of the classroom, probably because along the classroom walls there were different 'corners'. Even though there were no posters displaying mathematical concepts inside the classroom, the arrangement was good but

the classroom was too small for learners to freely explore mathematics such as allowing them to sit on the mat to do sorting individually. The limited light due to school bags that hung from the windows created a dark atmosphere which demotivated learning in all aspects. She used concrete materials which were locally available like empty containers and bottle tops to teach mathematics, but her teaching did not integrate mathematics with any subjects.

4.3.5 Lesson Observation 5

Teacher Tselane

Classroom Environment

The classroom was square, comprising an area of 121 square metres. The inside walls of the classroom were clean. There were posters of three food groups, types of soil, plants, body parts and animals, and flash cards of the alphabet and of numbers. There were six windows with white lace curtains and blue main curtains. There was also a statue of Jesus Christ and Holy Mary. The classroom was partitioned into five corners; a fantasy, block, art, discovery and book corner. Learners' benches and tables were properly arranged and at the centre of the room there was a mat that served as a discussion area. There was a gas heater and a 19kg gas cylinder at the back of the classroom. On the other side of the classroom there was a laptop on a chair and two small speakers underneath it which the teacher used when teaching phonics and action songs or for learners to watch films of stories.

I arrived in the morning and reported to the guard at the gate. He directed me to the principal's office. I met the principal in her office. She welcomed me and I briefly explained the purpose of my visit and she acknowledged that she knew about the consent letter, therefore she had no objection to my presence. She called the Grade R teacher to the office. On her arrival in the office, the principal introduced me to her and the teacher responded by telling us that her learners were ready to meet me because she had told them that they would be receiving a visitor who wanted to see how she taught them mathematics. The principal excused us and we went to Grade R classroom.

Classroom observation

(Learners were seated on chairs eating soft porridge from mugs. There were seventy two learners in the class. After breakfast, the teacher helped them to clean their hands, mouths and noses and then she ordered them to sit on the mat. She informed them that their visitor had arrived and warned them to behave well.

She then distributed blocks and asked the learners to engage in free play. Learners were excited and they played in pairs and in groups while a few played alone. Teacher Tselane moved around each group and asked questions that required learners to explain their play or game. Learners' responses were different: some told the teacher that they had built a church or a house while some were playing 'morabaraba and liketoane'.

After ten minutes of free play the learners were asked to return the blocks to the container, but Mosola, who had been playing alone, was instructed not to dismantle his creation and all the learners were asked to look at his work. The teacher asked learners to explain what Mosola had done. Some learners contributed that Mosola had put red blocks on one side and green blocks on the other side and just one yellow block on its own.)

Teacher Tselane: *Good! Mosola has sorted blocks according to colour and size.*

(Teacher Tselane was not correct when she said that Mosola had sorted blocks according to size; the correct category which was clearly demonstrated by Mosola's creation was only colour, as learners had responded.

Teacher Tselane then asked each learner to take two blocks from the containers and instructed them to arrange the blocks according to size. Learners rushed to the containers and were fighting over blocks. The teacher intervened by taking the container and then starting to hand out two blocks to each learner. After all the learners had been given blocks they were seated on the mat to order the two blocks according to size. The teacher moved around handing out more blocks. After each learner had completed the task, the teacher asked them to stand and form a circle around their creations.)

Teacher Tselane: *Look at your creations! Aren't they beautiful?*

Learners *(together): They are beautiful.*

(The teacher told the learners that they had ordered those blocks according to size. She informed them that some blocks were ***tall*** *and that others were* ***short****. She then asked learners to make pairs of short and tall learners. Learners paired*

themselves as instructed but it was difficult for some learners to find a partner because most of the learners were of the same height. The teacher then asked those who did not have partners to sit down. She then asked the 'tall' learners to raise their hands and the other learners were to confirm if all the learners who had raised their hands were taller than their partners. Before the learners could contribute, the teacher concluded that those learners with their hands up were taller than their partners. The teacher then asked all learners to be seated on the mat. She then concluded the lesson by telling them that they had learnt to order things according to size; as a result they had learned about tall and short objects. The teacher then asked the learners to go for a short break. The lesson took approximately seventeen minutes.)

This observation demonstrated that teacher Tselane's understanding of the teaching of mathematics had a limited influence on her teaching of mathematics because she was challenged in understanding the mathematical concepts she was teaching. Her lesson was about ordering according to size but her teaching referred to height; in this context she used inappropriate words to describe size, such as 'tall' and 'short'. This indicated that teacher Tselane was not competent in using the content itself; nor was she competent in teaching at the development level of her learners. This shortcoming led her into problems such as failing to emphasise the main points of the lesson, omitting to consider learners' prior knowledge and failing to connect it to new knowledge, and not asking challenging questions that would help learners to think critically. As a result, it was possible that learning did not occur.

Teacher Tselane had planned activities to engage learners to learn mathematics but those activities were not engaging learners in deep learning of mathematical concepts. She engaged all learners even though there were challenges with classroom management and learners' discipline. Learning styles were not appropriately addressed by the activities so this demonstrated that teacher Tselane's teaching of mathematics in this Grade was not effective.
Teaching strategies like questioning and answering, discussion strategies and free play were used. During play teacher Tselane was walking amongst the learners and asking questions about their creations. She was able to use free play as an introductory activity for the lesson, and that was good.

Teacher Tselane arranged her classroom by partitioning it into five 'corners', namely a book, block, fantasy, art and discovery corner and there were different concrete materials such as

empty containers and boxes. However, while teaching a sorting skill, teacher Tselane used only bought plastic blocks despite the fact that there were lovely home-made wooden blocks in the block corner. She also had a laptop which she reportedly used to teach phonics or stories. The classroom was big enough to allow learners to explore mathematics through physical activities and games, but the activity that I observed was relatively stagnant. There were posters on the classroom walls denoting numbers. There was a discussion area where learners sat on a mat in a semi-circle during discussion time and even when sorting shapes, they were nicely scattered on the floor and the space was enough to accommodate each learner.

4.4 Conclusion of the Classroom Observations

Shulman (1987) states that it is expected that teachers (in Grade R) possess an understanding of the subject matter of the subject that they teach and also that they teach what is relevant for the developmental level of the particular grade that they teach. These requirements are important because teachers need to be able to sequentially organise lesson activities and ensure that there is a link between and progression from one activity to the next in order to assist learners to systematically learn concepts and thus acquire knowledge. Such learning leads to easy comprehension of the content (Krogh & Slentz, 2001). The teachers participating in this study found the application of these requirements a challenge and I had to conclude that effective mathematics teaching did not occur in the majority of the lessons that I observed, especially in the classrooms of teachers Ntsoaki, Manyai, Moliehi and Tselane. Effective teaching of mathematics requires that teachers understand and have a sound knowledge regarding the following: the informal knowledge that learners imbibe in their homes and backgrounds and that they bring with them to class; the new knowledge that learners need to acquire; and the application of methodologies that are appropriate for exposing learners to the effective learning of mathematics content (NAEYC & NCTM, 2002). All the participating teachers failed to address learners' prior knowledge, which demonstrated unequivocally that these teachers' understanding had a negative influence on the teaching of mathematics in Grade R.

Shulman (1987) insists that teachers should have knowledge of the content regarding the subject they are teaching. They should know the facts, concepts, organisation, principles and structures of the subject. Therefore, when teachers have mathematics content knowledge, they will be able to teach the correct content to learners and they will be able to present the

content logically so that learners comprehend the mathematical concepts easily. However, it was evident from the classroom observations that most teachers did not have sufficient knowledge of mathematics subject matter; hence they encountered challenges in planning and teaching mathematical concepts to their learners, thereby exerting a negative influence on the teaching of the subject and hence on children's learning.

It was already evident from the interviews that the teachers did not clearly understand what was meant by and expected with regards to the effective teaching of mathematics because they were all indicating that effective teaching of mathematics meant to teach the contents of the curriculum. Sadly, it was discovered that even the contents of the mathematics curriculum for Grade R was a nebulous area for these teachers as they were not familiar with the most basic of terms or requirements. It became painfully obvious that the participants experienced challenges with regards to the teaching of mathematics to Grade R when they were unable to clearly explain the differences between three commonly taught shapes in Grade R, namely a square, a rectangle, and a triangle. Data from the Course Outline for Mathematics/Numeracy document of their training also revealed that the subject matter content knowledge of mathematics was not comprehensively catered for. This document only focuses on how particular mathematical concepts should be taught.

The Grade R curriculum for mathematics also impacted negatively on the understanding of the teachers because it does not have example of activities teachers may follow to design their lesson plans. Moreover, it does not indicate the sequence and depth of the mathematical concepts that should be taught, so this lack leads teachers to ignorantly pick and choose the concepts as they wish, thereby ending up teaching more than one concept at a time.

NAEYC and NCTM (2002) point out that the learning of mathematics is a process; as a consequence teachers are expected to be knowledgeable and creative in selecting and employing different strategies to teach mathematics in Grade R. It is advised that the selected methods should allow learners to play, explore and manipulate mathematical ideas in an interesting manner. Teachers should therefore relate tasks or activities to learners' life experiences and allow them enough time to work on any assigned tasks. All the respondent teachers employed some active teaching strategies while teaching mathematics. The commonly used strategies among the five teachers were questioning and answering, free play, and discussion. These strategies did not address the requirement for effective teaching of

mathematics in Grade R. Shulman (1987) insists that teachers should know the learners that they teach. They should know how they learn mathematics best so that they are able to select teaching strategies which will effectively help learners to learn mathematics in a natural manner. The commonly used strategies used by these five teachers denied learners the opportunity to socially construct their own knowledge. Moreover, the manner in which the teachers employed the limited strategies they used also denied them the opportunity to creatively facilitate learning as they did not engage all the learners in activities that compelled them to connect their own life experiences with the content they were learning so that new understanding and learning of mathematical concepts could occur (Piaget, 1973; Bruner, 1965). Those strategies could have been used effectively if coupled with other strategies like discovery, exploration and projects.

Shulman (1987) states that teachers should possess pedagogical content knowledge which will afford them opportunities to make use of different teaching strategies like discovery, demonstrations, group work, games, and play, which will enable learners to understand mathematics. Teacher Itumeleng came closest to the requirements because she used different teaching strategies like allowing learners to explore at the playground searching for objects with circular shape, group work and presentations. She also demonstrated good use of strategies to manage learners' behaviours. This shows that teacher Itumeleng has positive understanding regarding the use of teaching strategies hence her teaching was to somewhat extent effective.

Moreover, the Course Outline for Mathematics/Numeracy document that teachers use during their training does not address the theories which talk to how learners of this age group learn mathematics; nor does the Grade R Curriculum for Mathematics suggest any teaching strategies which teachers may follow when teaching a particular mathematical concept. During the interviews some teachers mentioned good strategies like demonstration, discovery, play, asking questions as they play, guiding, and facilitating learning, but the classroom observations revealed that teacher respondents mostly used strategies that did not afford learners the opportunity to construct their own knowledge. It is clear that teachers' understanding of the teaching strategies had a very limited influence on their actual teaching of mathematics, and hence on the learners' opportunities to learn.

Assessment is very important in the teaching and learning of mathematics in Grade R because it also helps teachers to identify learners' special strengths and needs in order to inform instruction. 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). From my observation it was clear that all the teachers failed to assess their learners during and after the lessons, with the exception of teacher Itumeleng who presented (probably unwittingly) a creative feedback and demonstration assessment opportunity at the end of her lesson. It is doubtful, however, that she understood and utilised this opportunity for assessment. It is therefore clear that these teachers missed a very important part in teaching because they failed to determine if learning had occurred or not. Shulman (1987) posits 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. These elements were lacking in the lessons that I observed.

Research evidence indicates that learners show interest in and enjoyment of mathematics even before they come to school. From a very young age learners are already engaged in exploring and using mathematics in their daily lives. It is therefore important that teachers organise and arrange 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). 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 things like resources, the behaviours of learners, and the ability to organise and arrange a classroom in a manner that caters for the differences among learners. In the context of this study, these are essential requirements for the teaching and learning processes that occur in mathematics lessons. This means that there could be different types of posters of mathematical concepts on the classroom walls. If financial constraints present a challenge, such posters could be designed by the teacher and the learners themselves. The classroom observations revealed that most teachers understood that the classroom needs to be arranged in a manner that contributes positively to teaching and learning; hence during the interviews they all claimed that they would like to have a 'maths corner' in their classrooms. However, it was evident that 'number and number operations' was the content area of mathematics that was predominantly taught because the (mostly dilapidated) posters in the classrooms were of numbers, and

nothing else. Moreover, if teachers understood the necessity for classroom arrangement that facilitates learning, it was puzzling that none of the 'corners' established in the classrooms was for mathematics, particularly in the light that teachers acknowledged in the interviews that there was a need for such an area. One exception may be teacher Itumeleng's creative use of the playground where she took her children for real-life experiences of mathematics when her classroom was too small.

NAEYC and NCTM (2002) state that learners in Grade R do not perceive their world as divided into separate entities, but that they view it as a whole entity. Likewise, effective practice in life does not limit mathematics or literacy to a certain period of time of the day. Therefore teachers are advised to integrate mathematics with learners' experiences with other subjects like language, science and art, or with daily activities that occur as different daily routines. For example, when learners are lining up the teacher can ask those with black jerseys to be first in the line and those learners wearing white jerseys to be next. In observing the teachers, it was clear that none of them utilised the many opportunities that presented themselves to integrate mathematics either with routines or with other subjects. As discussed in the section on the schools environment (cf. 3.5.1), I also observed that there was no provision for sand and water play in any of the five schools; as a consequence it is possible that the integration of such activities with mathematics does not occur. This integration of mathematics with other subjects or routines is in cognisance of Shulman's' theory which suggests that teachers should know the curriculum of the subject matter they are teaching as well as the curriculum of other subjects and grades.

Learners construct conceptual knowledge when reflecting on things that they see such as patterns and relationships. It is the role of teachers to plan activities that help learners to construct the three types of knowledge namely physical, social, and conceptual knowledge as discussed in Chapter Two by creating situations that enhance the revelation of number patterns, their structures, and so on. Young as they are, learners in Grade R should be encouraged to reflect on what they are doing and thinking (Department of Basic Education, 2012).

During the observations I noticed that all the teachers had planned activities to engage learners to learn mathematics, but it was evident that those activities were not engaging learners in a deep learning of mathematical concepts, as suggested by scholars like Clements

(2001). The literature that I perused, Engel *et al*. (2013) suggests that teachers of young children are challenged by not possessing adequate knowledge of mathematics which thus limits them to topics for teaching which they feel they understand. As a consequence they plan very shallow lesson activities which do not benefit the learners. The findings of my study unequivocally corroborated the literature in this regard, as I observed that the respondents remained within 'safe' parameters of transferring knowledge of the topics they proposed to 'teach'. Sadly, very little of their 'teaching' was transformed into learning.

Davin and Van Staden (2005) point out that learners differ in terms of how they learn. Therefore teachers are advised to consistently adapt their teaching so that all learners benefit from their lessons. Davin and Van Staden (2005) further state that every person has his/her own way of acquiring knowledge. Some learn best when they are listening, others when they are looking, and others when handling physical objects or using their bodies. During the classroom observations I particularly noted whether at least the three most predominantly used learning styles (auditory, visual and kinaesthetic) were catered for. I also tried to determine whether the applied activities were developmentally appropriate as suggested by Piaget's theory of the cognitive development of learners. Knowing the developmental level and abilities of learners is important because that knowledge provides teachers with understanding of how their learners think and what they are capable of learning. With this knowledge teachers are able to plan activities that are appropriate to learners' cognitive development (Shulman, 1987). The findings of the study, the observations and the interviews revealed that the participating teachers had some theoretical knowledge of these requirements (one teacher even commented in the interview on the importance of learners' socio-economic background), but the teaching practices that I observed clearly demonstrated a profound gap between teachers' (sometimes limited) theoretical understanding and their classroom practices. Although teachers utilised some variety of learning styles (kinaesthetic where learners handled concrete objects, visual where they had to sort colours and shapes, auditory and language where they had to listen and respond to oral instructions), these learning styles were not extended to deep learning. Moreover, by presenting more than one mathematical concept in one lesson, some teachers also did not understand the need for single concept formation at this level of learners' development.

Prior knowledge involves the formal and informal experiences that learners bring with them to the classroom; such experiences may be deep-rooted or contested. A misfit of prior and

new knowledge may confuse learners and, as a result, effective teaching and learning may not occur (Mueller, Yankelewitz & Maher, 2010). The observations revealed that not all the teachers reviewed learners' prior knowledge or connected it with new knowledge; nor did they contextualise their teaching. Contextualising the content is very important because what they are learning becomes meaningful to them (Shulman, 1987). This indicates that some teachers did not understand how learning becomes more meaningful when it is contextualised. One exception was teacher Itumeleng who took the learners to the playground where they had to use their prior knowledge of shaped structures to identify circles in a real-life context (i.e., a playground). Only by using prior knowledge of various shapes in a contextualised environment could these learners correctly distinguish circular shapes. She then applied this contextualised prior knowledge to guide learners to identify circles among concrete objects and to utilise this shape in a new context – i.e., pasting circular objects in a larger circle onto a piece of paper. However, she missed an opportunity for in-lesson deep learning and assessment by failing to ask probing questions ('why?' and 'how?') and by not involving all the learners.

The following section presents a discussion on the analysis of documents as mentioned in Chapter Three. Relevant documents were analysed and important data were generated for triangulation purposes.

4.5 Document Analysis

4.5.1 Lesson Plans

I analysed the lesson plans of the five participating teachers, basing my analysis on the following components: lesson format; lesson objectives; materials; lesson activities; and assessment, as discussed in Chapter Two of this study.

The analyses revealed that all the teachers used the same format which is known as a 'thematic daily lesson plan'. Theme-based learning (cf. 2.8.2) affords the teacher the opportunity to choose a theme, for instance animals, water or plants, which may run for a week or two weeks depending on the length of the theme. Activities related to the theme and integrated with other subjects such as mathematics, science and arts are then developed. From the observations it was clear that all five the participating teachers followed - or intended to follow - the integrated thematic approach because each teacher had planned activities for that

week based on a theme even though their teaching of mathematics did not integrate any other subject or a theme. It was treated as a standalone subject.

The lesson plans stated the objective that was expected to be achieved by the learners at the end of the lesson and they indicated the skills or information that the learners were to demonstrate after the lesson. The lesson objectives of teachers Itumeleng and Ntsoaki were clear and developmentally appropriate. Learners were expected to demonstrate one skill. For instance, teacher Itumeleng's lesson objective required *learners to be able to identify a circle shape* and teacher Ntsoaki's lesson objective expected *learners to be able to match pictures*. However, the lesson objectives proposed by teachers Manyai, Moliehi and Tselane were not developmentally appropriate because they expected learners to demonstrate multiple skills. For instance, the lesson objective for teacher Manyai required *learners to be able to order objects according to size, height, weight and colour*. Teacher Moliehi's lesson objective demanded *learners to sort according to shapes, height and size*. The lesson objective for teacher Tselane also required learners *to sort according to colour and size*. The literature perused for this study is clear that teachers must possess knowledge of learners' cognitive development, the school context and their prior knowledge (Shulman, 1987). This knowledge helps teachers to set lesson objectives which are achievable by their learners. However, it was clear that some of the teachers did not understand these vital requirements for teaching at the Grade R level.

All the teachers listed the materials that were intended to be used during the lesson. Teaching strategies were also listed in all the lesson plans. However, there were inconsistencies between the lists of strategies in the lesson plans and what I observed during classroom practice. Teacher Itumeleng used group work effectively in her teaching but it was not listed in the lesson plan. Teacher Ntsoaki used a game to teach a matching concept but her lesson plan did not have a list of teaching strategies at all - the slot for teaching strategies was blank. Teachers Manyai, Moliehi and Tselane adhered to the strategies they had written in their lesson plans. It seemed as if teachers Itumeleng and Ntsoaki did not understand the importance of indicating all the teaching strategies in the lesson plan before the actual teaching of the lesson. Again, this showed that some teachers did not possess the general pedagogical knowledge which was required to organise and manage their teaching in all aspects in order to enhance effective teaching of mathematics and to avoid disciplinary problems which could be provoked by improper planning of the lesson activities. It was

evident from teacher Ntsoaki who was referring to her lesson plan time and again that she did not know her lesson activities; she was not properly organised or familiar with the lesson itself.

Lesson activities were stated in all five the lesson plans. However, the presentation of the activities was severely challenged as logical and sequential arrangement was lacking and because the activities were not written in detail or presented step-by-step to show how the activity would take place. Moreover, the materials to be used for some activities were not listed and the proposed duration of each step or activity was not indicated. The teaching strategies which were to be used such as 'learners work in groups of four' or 'learners work in pairs' were not indicated either. None of the lesson activities in the lesson plans showed logical and clear procedures such as an introductory activity, main activities, and closure.
None of the lesson plans indicated any form of assessment during the teaching of the mathematics lessons as required at the end of all lessons plans.

Only one form of assessment was predominantly applied in all the lessons that I observed, and this was when teachers asked questions to merely recall information. Teacher Itumeleng asked learners *to mention the name of the shape* they had learned; teacher Ntsoaki asked them *to mention things that they had matched*; and teachers Manyai, Moliehi and Tselane wanted the learners to mention *objects used during* the lesson. Additionally, in teachers Manyai's and Moliehi's lessons, learners were asked *to name objects that they had been ordering* and in teacher Tselane's lesson learners were to mention *objects used when sorting*. It seemed that the teachers lacked knowledge and understanding of the purpose of assessment and as a result they failed to assess whether all their learners had learned the intended content set by the stated objectives in their lesson plans. One exception that is worth mentioning is the opportunity that teacher Itumeleng used for assessment through group feedback and demonstration. Although this assessment objective was not mentioned in her lesson plan, this strategy allowed for self and peer assessment as the learners could assess whether they themselves and/or their peers had pasted all the circular shapes in the circle on the paper. Some learning was required as the learners also needed to assess whether all the circular shapes had been pasted correctly, or whether any had been left among the other shapes on the desks. This also required some prior knowledge of other shapes that learners may have acquired informally at home. However, teacher Itumeleng seemed oblivious of this challenge as she brushed over the obviously valuable opportunity for assessment and instead of using it

for deep learning, she ignored the chance for ‘why’ and ‘how’ questions and concluded the lesson.

The above discussion has indicated that, in general, the teachers lacked subject matter (i.e., mathematics) content knowledge; as a consequence they encountered difficulties in stating the lesson objectives and the assessment strategies they would use to determine if their learners had mastered the intended objectives. Shulman (1987) suggests that teachers should have subject matter knowledge of the subject that they teach because that knowledge includes knowledge of the facts, concepts, organisation, principles and structures of the subject.

What I noticed when comparing the lesson plans with what I observed during classroom observations was that there was confusion with regards to the content of the lesson that had been planned and what was actually presented in the lessons. Learners who were not involved in activities were not attentive, therefore disciplinary issues arose. This unacceptable state of affairs was possibly due to the teachers’ lack of the general pedagogical knowledge (Shulman, 1987); knowledge which demands that they master the organisation and management of their teaching in all aspects such as the classroom environment, time allocation, well-planned and logical steps of lesson activities, and the ability to employ techniques to manage learners’ behaviours (Krogh & Slentz, 2001; Hollins, 2011) Without an adequate knowledge of the learners, of general pedagogical and subject matter, and of pedagogical content, it becomes possible for teachers not to assess during and after the lesson, to ignore learners’ prior knowledge, to use materials ineffectively and also to use teaching strategies which do not engage learners in the explicit learning of the subject matter.

It is suggested in Chapter Two (cf. 2.5) that teachers of young learners must try as far as possible to plan mathematics lessons that involve all the learners in a conversant curriculum and teaching practices as this will help them to learn mathematics effectively. The mathematics lesson plan should follow a particular format which stipulates standard components in order to plan lessons. It is expected that in that plan teachers should suggest how each component will be addressed during the teaching of the lesson. It is therefore important to write detailed lesson plans that include all the necessary information in order to enhance effective teaching (cf. 2.8.2). Shulman (1987) suggests that teachers should possess general pedagogical knowledge because teaching goes hand in hand with planning in all aspects of teaching. Therefore teachers should be skilful in planning the classroom

environment and lessons. The latter should portray well-planned lesson activities that follow clear procedures. Shulman also insists that teachers should be skilful in managing learners' behaviours, stating that through proper planning and good use of appropriate teaching strategies effective teaching and learning will be achieved (Young & Stuart, 2011). Findings revealed that teachers developed lesson plan which followed integrated approach and standards components of the lesson plan were followed. However all lessons activities were written very briefly there by omitting important information like procedure and time allocation for each activity. It was also noticed that teacher had challenges in managing learners' behaviours and thus could be due to improper planning of the lesson itself.

Table 4.1 presents a summary of the elements required in a lesson plan for mathematics in Grade R and the extent to which teachers addressed - or failed to address - them:

Table 4.1 Summary of Teachers' Lesson Plans

Contents	**Teacher Itumeleng**	**Teacher Ntsoaki**	**Teacher Manyai**	**Teacher Moliehi**	**Teacher Tselane**
Lesson plan format	Appropriate format	Appropriate format	Appropriate format	Appropriate format	Appropriate format
Objective	Outlines skills to be acquired; appropriate for learners' developmental level.	Outlines skills to be acquired; partially appropriate for learners' developmental level.	Outlines multiple skills to be acquired; as a result not appropriate for learners' developmental level	Outlines multiple skills to be acquired; as a result not appropriate for learners' developmental level	Outlines multiple skills to be acquired; as a result not appropriate for learners' developmental level
Materials	Listed and relevant	Listed and relevant	Listed and relevant	Listed and relevant	Listed and relevant
Teaching strategies	Listed - but used group work that had not been listed	Not listed - but used a game while teaching.	Listed - were used during the actual teaching.	Listed - were used during the actual teaching.	Listed - were used during the actual teaching.
Lesson activities	Listed and logically applied; too brief.	Listed but not logically applied; too brief.	Listed but not logically applied; too brief.	Listed but not logically applied; too brief.	Listed but not logically applied; too brief.
Procedures	Not indicated	Not indicated	Not indicated	Not indicated	Not indicated
Assessment	Indicated to occur only at the end of the	Indicated to occur only at the end of the	Indicated to occur only at the end of the	Indicated to occur only at the end of the	Indicated to occur only at the end of the lesson.

	lesson.	lesson.	lesson.	lesson.	

4.5.2 Lesotho IECCD Grade R Curriculum

The findings revealed that IECCD Curriculum for Reception Class (Grade R) (2007) used by the teachers stipulated only three major content areas of mathematics instead of five. It also lacked suggested activities or teaching strategies to guide teachers. Moreover, it did not indicate the sequence and depth of the topics to be taught; as a consequence, it was found that this curriculum had a negative influence on teachers' understanding of the teaching of mathematics in Grade R.

As discussed in section 2.8.1, curriculum standards for mathematics should have flexible guidelines based on available research on the developmental level of learners and the major content areas of mathematics. However, the guidelines contained in the current curriculum used by the participating teachers had not been based on any research because on the first page of the document it was stated that reception class teachers and National Teacher Trainers (NTT) had raised concern that there was a need to develop guidelines for the content of mathematics to be taught in the reception class because it seemed as if reception class teachers were teaching Grade 1 class content. It was this concern that lead to the development of the curriculum for Grade R which was a final working draft at the time of the study. It was previously mentioned (cf.2.8.1) that a curriculum must be underpinned within a particular concept. A curriculum should be designed to reflect integrated teaching and learning; it would therefore be understandable if academic subjects are brought together to ensure a more meaningful learning experience. However, this curriculum deviates from this because subjects are separated and therefore, as a consequence, it does not allow teachers to plan their teaching in a manner that would promote learning to take place due to the life experiences of both teachers and learners.

Learners develop mathematics concurrently across five major content areas namely: numbers and operations, geometry, algebra, measurement, and data analysis (NCTM, 2013). It is emphasised in Chapter Two (cf. 2.8.1) that it is important for the curriculum of early childhood education to encompass all five areas of mathematics as mentioned above. However, the curriculum available to in-service teachers training at LEC stipulates only three areas of mathematics, namely: number and operations, measurement and shapes. The curriculum had an impact in the teaching of mathematics on all five teachers because they

were teaching sorting according to shapes, and matching and ordering according to height and size. All these concepts range among the three areas of mathematics that appear in the curriculum that they used. It lacks two areas so teachers concentrated on only those elements which appear in the curriculum.

It is stated in section 2.8.1 that a curriculum should stipulate activities for the classroom and for parents so that they will be able to assist their children. This curriculum contains suggested activities for the classroom which are briefly explained and listed next to each area of mathematics, but activities and guidelines for parents are not stated. An analysis of the curriculum document unfolded that its structure lacked important aspects that need to be contained in a curriculum such as sequence, scope and depth of content. It also failed to stipulate any long- and the short-term goals and objectives as required in a curriculum document. It was therefore possible that teachers lacked adequate knowledge of the teaching of mathematics in Grade R as the curriculum document that they used was inadequate. Moreover, even though teachers were able to mention reflective reasons which portrayed possible long-term goals and objectives for teaching mathematics in Grade R, the curriculum document itself did not stipulate those objectives; as a consequence teachers were denied an opportunity to possess knowledge of educational aims, goals and purposes in terms of the long- and short-term goals of education and also of the subject, as should be spelled out by government authorities (Shulman, 1987).

4.5.3 The Course Outline of Mathematics/Numeracy document used by in-service teachers at LCE

The findings indicated that the Course Outline of Mathematics document used by in-service teachers at LCE outlined only three major content areas of mathematics similar to those that appeared in the Grade R Mathematics Curriculum document, namely: number, measurement and shapes. The document further stipulated the year, the semester, the name of the course, and a division of the major content areas of mathematics to be covered during the duration of the training. Neither expected ‘outcomes and methods of evaluation’ nor ‘methods of assessment’ were stated in the document; as a consequence I was challenged to determine if teachers had to master and were assessed on crucial concepts of mathematics at the conclusion of the semester and during their actual teaching.

Training offered to teachers should equip them with adequate knowledge and skills that will enable them to blend together content knowledge, knowledge of learners, and contextual and general pedagogical knowledge (Shulman, 1987; NAEYC & NCTM, 2002) (cf. 2.9). The five teachers who participated in this study were completing their training at LCE where a mathematics/numeracy course was one amongst many courses that they had to study. I analysed the Course Outline for Mathematics/Numeracy document basing my analysis on the components of a standard course outline as discussed in Chapter Two (cf. 2.9). The components that I focused on were topic areas of a subject, instructional goals, and expected outcomes which aligned with course polices, curricular design, and methods of evaluation and assessment. And my findings revealed that the mode of the course outline used during the training of these teachers possibly impacted their teaching of mathematics negatively because the course did not cover all the major content areas of mathematics. The course also did not cater adequately for subject content knowledge, as posited by Shulman (1987). This course seemed to cater for pedagogical content knowledge (Shulman, 1987) only because it dwelled extensively on how to teach selected mathematical concepts that appeared within the three areas of mathematics. In my view, information on content knowledge suffered a lot; as a consequence the teachers' pedagogical content knowledge was affected negatively, as demonstrated by their lack of understanding of the mathematical concepts that they were to teach in Grade R.

4.6 Conclusion

In this chapter, the findings from the interviews with and my observations of five in-service teachers and an analysis of relevant were presented and discussed. The discussion began with the findings from the interviews which were conducted in order to gain deep understanding of each teacher's understanding of the teaching of mathematics in Grade R. Four themes were used to analyse the interviews, namely Effective teaching of mathematics; Planning teaching and learning; Knowing the differences among learners; and Strategies for teaching mathematics.

The presentation of the data and a discussion of the findings from five classroom observations followed the presentation of the interviews. In this section data from the classroom observation process were presented and each observation was followed by reflection and discussion.

The findings from an analysis of the documents that I perused were also presented and discussed. The lesson plans presented by all five teachers were compared and summarised in a table. The documents that were analysed were the Grade R Curriculum for Mathematics, the Course Outline of a Mathematics/Numeracy Course, and teachers' lesson plan.

The next chapter presents the conclusions and recommendations.

CHAPTER FIVE
STUDY SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter highlights the main conclusions emanating from the findings. It also provides recommendations regarding the findings which were revealed when exploring teachers' understanding of the teaching of mathematics in Grade R.

5.2 Summary of the study

This study explored teachers' understanding of the teaching of mathematics in Grade R. A comprehensive literature review provided a theoretical framework within which the study was located. The study mainly focused on three case study schools in Lesotho where teachers were interviewed and observed during teaching mathematics to Grade R learners. Relevant documents were reviewed in order to supplement the data obtained from the interviews and observations and to triangulate the findings. This study concluded that teachers experienced challenges to teaching mathematics effectively because they lacked knowledge of the domains of professional knowledge as advocated by Shulman (1987), such as subject matter content knowledge, pedagogical content knowledge, curriculum knowledge, and knowledge of the learners. The lack of such knowledge negatively impacted their planning and actual teaching of mathematics in Grade R.

5.5 Recommendations

5.5.1 Recommendation One: Training

The findings of this study indicated that teachers possessed limited knowledge and understanding of the professional domains of knowledge (Shulman, 1987) that each teacher should possess in order to teach effectively in any applicable discipline. I therefore recommend that the training of mathematics teachers should offer a module that will introduce them to different educational theories that disclose how young learners learn mathematics. Teacher trainees should also be exposed to a module that will facilitate the acquisition of subject matter knowledge of mathematics.

5.5.2 Recommendation Two: Revision of the Curriculum

It was evident that teachers were not familiar with the Grade R Curriculum for Mathematics document as they all responded during the interviews that effective teaching meant to teach the contents of the curriculum; however, they experienced difficulties in referring to the contents of the curriculum. This showed that the teachers were not planning their teaching with reference to the curriculum. I therefore recommend that the MoET prepare as a matter of urgency a Grade R curriculum document for mathematics based on sound research using, for example, NCTM (2013) guidelines. The new curriculum should include all five major content areas of mathematics and all the necessary information such as the scope, sequence, and depth of the topics to be taught as well as activities that guide teachers to design relevant and interesting lesson plans for mathematics. Data obtained from the Grade R Curriculum for Mathematics document revealed that the curriculum lacked many elements that need to be addressed, because important omissions form such a document affect teachers' understanding of what is to be taught in Grade R.

5.5.3 Recommendation Three: Workshops and Short Courses

To pursue studies in an in-service mode has its own challenges such as limited time for contact sessions and then having to rush back to spend time at school. Such breaks in focus could affect teachers' proper acquisition of content knowledge during their short training periods. Teachers therefore need to be additionally capacitated by means of focus workshops throughout the year. I therefore recommend continuous professional building through short training and workshop sessions (NAEYC & NCTM, 2002) conducted either by the MoET or LCE. Such capacity building sessions will stimulate teachers' motivation and improve their knowledge of mathematics. The content and skills which could be shared during such workshops or training sessions could help teachers construct their mathematics lesson planning which may incorporate, among others, the proper way of developing lesson objectives. I noticed that this aspect presented particular challenges for most teachers (Ntsoaki, Manyai, Moliehi and Tselane) and that these challenges caused significant confusion in their teaching. For instance, they had objectives that expected learners to learn multiple elements in one lesson in Grade R (e.g., '*to be able to sort according to shapes, height, and size')*.

Workshops could also assist teachers to develop lesson activities that follow clear procedures and that stimulate the three kinds of knowledge that learners need to acquire when they learn mathematics (Department of Basic Education, 2012). The proper planning of lessons will help teachers to maintain class discipline as proper time will be allocated for each activity, the materials for each activity will be organised and arranged well in time, and strategies which the teacher wishes to use (like group work or pairing learners to do the activity) will be prepared and arranged well in time. Proper planning will help teachers to understand the subject matter which they are planning to teach and will minimise the incorrect use of mathematical terminology, such as when one teacher used '*tall and short*' instead of '*tall taller tallest*' when learners arranged objects according to height. The former *tall* and *short* are not ordering words but are opposite words that do not show sequence. Mistakes like these will be minimised through ongoing trainings.

The selection of appropriate teaching strategies to teach mathematics was another challenge that was highlighted by the findings of the study. Teachers seemed to rely on play as the main strategy, even though during my observations I noticed that it was not used as a teaching strategy as such but that they used it as an introductory activity that familiarised learners with the teaching materials that they would use during the lesson. I observed that most teachers used discussion, and then they asked learners recall questions. Thus the predominantly used strategies were discussion, questioning and answering, and these strategies are not effective or sufficient for learners to deeply learn mathematical concepts (Ginsburg *et al*., 2008). I therefore recommend that workshops be held to address effective strategies when teaching mathematics in Grade R.

Workshops could also be used to illuminate the use of theories (Piaget, Vygotsky, Brunner, and constructivism) that will guide and underpin teachers' teaching practice, thereby guiding them to understand the basic principles of teaching and learning.

Assessment is also important and teachers need to be made aware of the various assessment strategies that may be employed when teaching mathematics in Grade R. Teachers should know that they need to assess their teaching as well as the learners, because that will help them to improve their instruction (Varol & Farran, 2006). Workshops that focus on assessment strategies should thus be held regularly.

5.5.4 Recommendation four: Proper Physical Facilities for Grade R

The findings of this study revealed that some schools/ECD Centres do not have physical features to support the teaching of Grade R learners like spacious classrooms and outdoor play equipments. For instance teachers' Itumeleng and Moliehi classrooms were too small and dark and children were many. For instance during the classroom observation, I noticed that teacher Itumeleng's classroom was

> *a rectangular shaped classroom comprising forty square metres. There were forty eight learners in the classroom; twenty five were boys and twenty three were girls.*

Teacher Moliehi's classroom was

> *a rectangular comprising twenty four square metres. There were twenty four learners altogether. There were two windows on which learners' school bags were hung. As a result, it was dark in the classroom because the light shining through the windows was insufficient.*

This indicates that there is a dreadful lack of proper facilities so that effective teaching takes place. I therefore recommend to the MoET or that urgent attention should be given to the provision of appropriate facilities for Grade R. For instance most schools did not have outdoor play equipments mounted on the play ground. Some did not have lock-up and storage facilities. The learner ratio should also be considered to avoid the situations where one teacher teaches 72 Grade R learners.

Ginsburg *et al*. (2008) insists that that the learning environment should be conducive and arouse learners' curiosity so that spontaneous learning takes place. ISSA (2010) agrees with Ginsburg *et al*. that learners should be taught in classrooms which afford them opportunities to explore, learn independently, interact and play. With the given situations of some of the classrooms it shows that teachers experience challenges to create positive learning atmosphere in the classroom.

5.6 Implications for Future Studies

This study was limited to an investigation of only five in-service teachers of Grade R classes in five schools. Perhaps future studies could extend the investigation to ECD teachers from both Grade R and Grade 1 classes in primary schools. Research topics could focus on ECD teachers' pedagogical content knowledge to teach mathematics, and ECD teachers' mathematical knowledge of teaching mathematics in Grade R and Grade 1.

Further studies could involve more than five schools. This study could also be replicated over a wider area; that is, researchers could look at schools in other geographical areas or districts for comparative studies.

5.7 Conclusion

This chapter provided a summary of the study and offered recommendations. The study aimed at exploring in-service teachers' understanding of the teaching of mathematics in Grade R, using a case study of five schools located in four districts of Lesotho. Teaching of mathematics in Grade R was singled out as the main point of interest in this study. In general, the findings revealed that in-service teachers had limited understanding of the teaching of mathematics in Grade R, which consequently had a poor influence on their teaching of mathematics. I therefore made some recommendations such as the need to capacitate teachers with adequate skills in a curriculum that will deepen their understanding with regard to the teaching of mathematics, the provision of on-going professional support from the Department of Education or the Lesotho College of Education, and the provision of appropriate physical facilities to support the teaching of Grade R learners. These were deemed the most urgent priorities for supporting teachers engaged in teaching Grade R learners. The chapter was concluded with suggested implications for future studies.

REFERENCES

Abdul Gafoor, K. & Umer Farooque, T.K. (2010). The paper on Ways to Improve Lesson Planning: A Student Teacher Perspective. International Seminar Cum Conference on Teacher Empowerment and Institutional Effectiveness: All India Association for Educational Research. http://files.eric.ed.gov/fulltext/ED517056.pdf

Aldridge, J., Fraser, B., & Ntuli, S. (2009). Utilising learning environment assessments to improve teaching practices among in-service teachers undertaking a distance-education programme. *South African Journal of Education, 29*(2), 147-170.

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching what makes it special? *Journal of teacher education, 59*(5), 389-407.

Benner, S. M., & Hatch, J. A. (2009). From the editors: Math achievement and early childhood teacher preparation. *Journal of Early Childhood Teacher Education, 30,* 307-309.

Benz, C. (2012). Attitudes of Kindergarten Educators about Math. *J Math Didakt, 33*, 203–232.

Best, J. W., & Kahn, J. V. (2003). *Research in Education* (9th ed) Boston: Pearson.

Betram, C., & Christiansen, I. (2014). *Understanding Research: An introduction to Reading Research*. Pretoria: Van Schaik.

Boston, C. (2002). The concepts of Formative assessment. ERIC Digest.www.eric.ed.gov.

Brown, M., Askew, M., Baker, D., Denvir, H., & Millett, A. (1998). Is the national numeracy strategy research-based?. *British Journal of Educational Studies, 46*(4), 362-385.

Bruner, J. S. (1965). The growth of mind. *American Psychologist, 20*(12), 1007.

Chukwbikem, I. E. P. (2014). International Letters of Social and Humanistic Sciences. *Resources for Early Childhood Education, (E.C.E), 8*(1), 1-91.

Clements, D. H. (2001). In the Preschool. Retrievd from: www.ntcm.org.

Clements, D. H. & Samara, J. (2007). Effects of a Preschool Mathematics Curriculum: Summative Research on the Building Blocks Project. *Journal for Research in Mathematics Education, 38*(2), 136-163.

Cohen, L., Manion, L., & Morrison, K. (2011). *Research Methods in Education* (7 ed.). London: Routledge.

Community Learner Care Victoria (2011). *Early Literacy and Mathematics Self-Guided Learning* Package: Resource and Development Unit.

Creswell, J. W. (2013). *Qualitative Inquiry & Research Design: Choosing Among Five Approaches*. Los Angeles: SAGE.

Creswell, J. W. (2011). *Qualitative Inquiry & Research Design: Choosing Among Five Approaches*. Los Angeles: SAGE.

Davin, R. J., & Van Staden, C. (2005). *The reception year: learning through play*.(2nd ed.). Johannesburg: Heineman.

Engel, M., Claessens, A., & Finch, A. M. (2013). Teaching Students What They Already Know? The (Miss) Alignment between Mathematics Instructional Content And Student Knowledge in Kindergarten. *Educational Evaluation and Policy Analysis, 35*(2), 157-178.

Fosnot, C. (1996). *Constructivism: Theory, Perspectives and Practice*. New York: Teachers College Press.

Fraenkel, R. J., & Wallen, E. N. (2008). *How to Design and Evaluate Research in Education* (7th ed.). Boston: McGraw-Hill.

Foundation Phase Conference Report (2008). Department of Education.

Ghanaguru, S., Nair, P., & Yong, C. (2013). Teacher Trainers' Beliefs in Microteaching and Lesson Planning in a Teacher Training Institution. *The English Teacher, XLII*(2), 216-228.

Ginsburg, P., Lee, J. S., & Boyd, J. S. (2008). Mathematics Education for Young Learners: What it is and How to promote it. Social Policy Report. *Society for Research in Learner Development, 22*(1), 2-23.

Ginsburg, H. P., & Amit, M. (2008). What is teaching mathematics to Young children? A theoretical perspective and case study. *Journal of Applied Developmental Psychology*,(29), 274-285.

Gober,Y. S. (2002). *Six simple ways to Assess Young Children. Australia*: Delmar Thomson Learning.

Greenes, C., Ginsburg, H. P., & Balfanz, R. (2004). Big math for little kids. *Early Childhood Research Quarterly*, *19*, 159-166.

Grossman, P. L. (1990). *The making of a teacher*: *Teacher knowledge and teacher education.* New York: Teachers College Press.

Hartshorn, R. B. & Sue, V. S. (1990). Experiential learning of mathematics: using manipulative. ERIC Digest.

Henning, E. (2014). Khululeka. *South African Journal of Childhood Education, 3*(3), 2-59.

Hollins, E. R. (2011). Teacher preparation for quality teaching. *Journal of Teacher Education, 62*(4), 395-407.

Howden, H. (1986). The Role of Manipulatives in Learning Mathematics. *Insights into Open Education, 19*(1), 2-11.

Hurrell, D. P. (2013). What Teachers Need to Know to Teach Mathematics: An Argument for a Reconceptualised Model. *Australian Journal of Teacher Education, 38*(11), 21-78.

International Step by Step Association (2010). Competent Educators of the 21st Century: Principles of Quality Pedagogy *International Step by Step Association* Netherlands.

Jordan, C. N., Kaplan, D., & Locuniak, N. M. (2009). Early Math Matters: Kindergarten Number Competence and Later Mathematics Outcomes. *Developmental Psychology, 43*(3), 850-867.

Jung, M., & Conderman, G. (2013). International Mathematics Teaching in Early Childhood Classrooms. *Childhood Education, 89*(3), 173-177.

Klein, L., & Knitzer, J. (2007). *Promoting Effective Early Learning*. New York: National Center for Children in poverty. www.nccp.org

Klibanoff, R. S., Levine, S. C., Huttenlocher, J., Vasilyeva, M., & Hedges, L. V. (2006). Preschool Learners' Mathematical Knowledge: The Effect of Teacher "Math Talk. *Developmental Psychology, 42*(1), 59–69.

Krogh, L. S., & Slentz, L. K. (2001). *The Early Childhood Curriculum.* Mahwah: Lawrence Erlbaum Associates.

Leedy,P. D., & Ormrod, J. E. (2005). *Practical Research: Planning and design*. Thousand Oaks: Sage Publications.

Lesotho College of Education (2007). *Curriculum for the Certificate in Early Childhood Education Programme*. Maseru: Lesotho College of Education.

Lesotho. Ministry of Education and Training (2013). *National Policy for Integrated Early Childhood Care and Development*. Maseru: MoET.

Lesotho. Ministry of Education and Training. (2012). *Education Statistics Bulletin 2012*. Maseru: MoET.

Lesotho. Ministry of Education and Training (2005). *Education Sector Strategic Plan 2005-2015*. Maseru: Paragon Business Products.

Lesotho. Ministry of Education and Training (2007) Integrated Early Childhood Care and Development [IECCD] Curriculum for Reception Class. Maseru: IECCD Department.

Lodico, M. G., Spaulding, D. T., & Voegtle, K. H. (2010). *Methods in educational research: From theory to practice* (2nd ed.). San Francisco: Jossey-Bass.

Long, C. (2005). Maths Concepts in Teaching: Procedural and Conceptual Knowledge. *Pythagoras, 62,* 59-65.

Maree, K. (2009). *First step in Research* (3 ed.). Pretoria: Van Schaik.

Mathematics Learning Study Committee (2001). Adding It Up: *Helping Children Learn Mathematics*. Washington: National Academies Press. http://www.nap.edu.

McGuire, P., Kinzie, M. B., & Berch, D. B. (2011). Developing number sense in pre-k with five-frames. *Early childhood education journal*, *40*,213-222.

Mewborn, D. (2001). Teachers content knowledge, teacher education, and their effects on the preparation of elementary teachers in the United States. *Mathematics Teacher Education and Development, 3*, 28-36.

Missall, N. K., Mercer, H. S., Martínez, S. R., & Casebeer, D. (2012). Concurrent and Longitudinal Patterns and Trends in Performance on Early Mathematics Curriculum-Based Measures in Kindergarten through Third Grade. *Assessment for Effective Intervention, 37*(2), 95-106.

Morrow, W. (2007). *Learning to teach in South Africa*. Cape Town: HSRC Press.

Mueller, M., Yankelewitz, D., & Maher, C. (2010). Rules without reason: allowing students to rethink previous conceptions. *Montana Mathematics Enthusiast, 7*(2&3), 307-320.

National Association for the Education of Young Children and National Council for Teachers of Mathematics (2002). Early childhood maths: Promoting Good Beginnings. Retrieved June 02, 2014 from http://www.naeyc.org/about/positions/pdf/psmath.pdf.

National Association for the Education of Young Children (2003). Standards for Early Childhood Professional Preparation: Advanced Programs: In preparing Early Childhood Professionals, ed. M. Hyson. Washington, DC:NAEYC.

National Council for Teachers of Mathematics (2013). Mathematics in Early Childhood Learning. A Position of the National Council of Teachers of Mathematics. Retrieved July, 15 2014 from www.nctm.org/earlychildhoodmath

National Council of Teachers of Mathematics (2003). *Principles and standards for school mathematics* Reston: NCTM.

Neuman, W. L. (2006). *Social Research Methods* (6th ed.). New York: Pearson.

Notari-Syverson, A., & Sadler, F., H. (2008). Math Is for Everyone: Strategies for Supporting Early Mathematical Competencies. *Young Exceptional Children, 11*(3), 145-156.

Piaget, J. (1973). *Piaget in the classroom*. London; Routlege and Kegan Poul.

Price, R. K. (2013). Using Teaching Portfolio to Anticipate Programmatic Assessment. *Business Communication Quarterly, 76* (2), 207-215.

Republic of South Africa. Department of Basic Education (2012). *Mathematics Handbook for Foundation Phase Teachers Grade R-3 CAPS Edition*. Pretoria: Department of Basic Education.

Republic of South Africa. Department of Education (2003). *Revised National Curriculum Statement. Grade R-9 (schools).Teacher's guide for the Development of Learning Programmes. Foundation Phase*. Pretoria: Department of Education.

Rusznyak, L., & Walton, E. (2011). Lesson planning guidelines for student teachers: A scaffold for the development of pedagogical content knowledge. *Education as Change, 15*(2), 271-285.

Sadler, D. R. (1989). Formative assessment and the design of instructional systems. *Instructional science, 18*(2), 119-144.

Sarama, J., & Clements, D. H. (2009). *Early childhood mathematics education research: Learning trajectories for young children*. New York: Routledge.

Seo, K. H., & Ginsburg, H. P. (2004). What is developmentally appropriate in early childhood mathematics education? Lessons from new research. *Engaging young children in mathematics: Standards for early childhood mathematics education,* 91-104.

Scott, D., & Usher, R. (2011). *Researching education: data, methods and theory in educational enquiry* (2nd ed.). New York: Continuum.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational researcher, 15* (2), 4-14.

Shulman, L.S. (1987). Knowledge and teaching: Foundations of the new reform: *Harvard Educational Review, 57* (1), 1-21.

Stiff, L., V. (2001). Constructivism Mathematics and Unicorns. Retrieved 24/September/ 2014 http://www.nctm.org/about/content.aspx?id=1238

Taylor, H. (2013). How Learners Learn Mathematics and the Implications for Teaching. *Learning and Teaching Mathematics 0-8*, 1.

Van De Rijt, B. A., & Van Luit, J. E. (1999). Milestones in the development of infant numeracy. *Scandinavian Journal of Psychology, 40*(1), 65-71.

Varol, F. & Farran, D. C. (2006). Early Mathematical Growth: How to support Young Childs' Mathematical Development: *Early Childhood Educational Journal, 33*(6), 381-387.

Wilkins, J. L. M. (2008). The relationship among elementary teachers' content knowledge, attitudes, belefs and practices: *Journal of Mathematics Teacher Education, 11*(2), 139-164.

Wood, E. (2013). *Play, Learning and the Early Childhood Curriculum* (3rd ed.). Los Angeles: SAGE.

Wortham, C. S. (2012). *Assessment in Early Childhood Education* (6 ed.). Boston: Pearson.

Yin, R. K. (2009). *Case study research: Design methods* (4 ed.). Los Angeles: SAGE.

Young, H. J., & Stuart, R. (2011). Promoting learners' communication: a kindergarten teacher's conception and practice of effective mathematics instruction. *Journal of Research in Childhood Education, 25*(2), 234-356.

Appendix A Permissions

Approval letter from Lesotho MoET

Prem Mohun
University of KwaZulu-Natal
Research Office: Ethics
Govan Mbeki Centre
Tel +27312604557
Fax+27312604609
E-mail mohunp@ukzn.ac.za
05 June, 2014

The Inspector IECCD

Mr. Moeketsi Motjoli

Ministry of Education and Training

P.O. BOX 47

Maseru 100

Tel no: (+ 266)22324097

Cell no: (+ 266)58125382

E-mail: mmotjoli@yahoo.com

Dear Sir!

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN GRADE-R CLASSES.

My name is Mamasiphole Josephina Setoromo a Master of Education student in Early Childhood Development Education Discipline at the University of KwaZulu Natal in South Africa. The Title of my research study is ***In-Services Teachers' understanding of numeracy skills for Grade-R Class: A Case Study of Reception Classes (Grade R) in Lesotho***. The purpose of the study is to explore in-services Teachers' Understanding of the teaching of mathematics in Grade R Class. I hereby seek your permission to conduct this research in Grade R classes in 2014. Data will be generated by analysing Grade R teacher's lesson plans for mathematics, observing and interviewing the teacher.

You are kindly requested to fill in the attached declaration and consent form which acknowledges the permission granted to undertake my research in Grade R classes. I guarantee that the information gathered will be used for the purpose of the research only. For further information regarding this research you may contact either myself or my supervisor; Ms Blanche Ndlovu, Ndlovubl@ukzn.ac.za or Mrs. Mamasiphole Setoromo: (+266) 62444545 / 0618857757/ zipzipstory@gmail.com.

Your cooperation will be appreciated

Yours sincerely

_____

Mamasiphole Josephina Setoromo

DECLARATION

As the Inspector in the Integrated Early Childhood Care and Development in the Ministry of Education and Training, I understand that: _____I am not being forced to grant Mrs Mamasiphole Josephina Setoromo the permission to undertake her research by analysing the Grade R teacher's lesson plans for numeracy skills, observing and interviewing them.

_____ _____

Signature Date

Letter of request to LCE

Prem Mohun
University of KwaZulu-Natal
Research Office: Ethics
Govan Mbeki Centre
Tel +27312604557
Fax +27312604609
E-mail mohunp@ukzn.ac.za
05 June, 2014

The Rector
The Lesotho College of Education
Box 1393
Maseru 100

Dear Rector!

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH AT THE LESOTHO COLLEGE OF EDUCATION

My name is Mamasiphole Josephina Setoromo a student reading for a master's degree in Education – Early Childhood Development at the University of KwaZulu Natal, South Africa.

My research study is titled**:** In-Services Teachers' understanding of Numeracy Skills for Grade-R Class: A Case Study of Reception Classes in Lesotho. The purpose of the study is to explore in-Services Teachers' understanding of Numeracy Skills for Grade-R Class. I hereby seek your permission to conduct my research at your college in 2014. Data will be generated by analysing the following document; the course outline for numeracy course offered to the in-service teachers enrolled in Certificate in Early Childhood Education (CECE) programme.

Sir, you are kindly requested to fill in the attached declaration and consent form which acknowledges the permission granted to undertake my research in your College. I guarantee that the information gathered will be used for the purpose of the research only. For further information regarding this research you may contact either myself or my supervisor; Ms Blanche Ndlovu, Ndlovubl@ukzn.ac.za or Mrs. Mamasiphole Setoromo: (+266) 62444545 / 0820963185/ zipzipstory@gmail.com.

Your cooperation will be appreciated

Yours sincerely

_____

DECLARATION

As the Rector of the Lesotho College of Education, I understand that:

I am not being forced to grant Mrs Mamasiphole Josephina Setoromo the permission to undertake her research by analysing the course outline for numeracy course offered to the in-service teachers enrolled in CECE programme at the college.

_____ _____

Signature Date

Letter of request to the principals of schools/ECD centres

Prem Mohun

University of KwaZulu-Natal
Research Office: Ethics
Govan Mbeki Centre
Tel +27312604557
Fax +27312604609
E-mail mohunp@ukzn.ac.za
04/08 / 2014

The Principal
_____

_____

_____

Dear Principal!

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH AT YOUR SCHOOL

My name is Mamasiphole Josephina Setoromo a Master of Education student in Early Childhood Development Education Discipline at the University of KwaZulu Natal in South Africa. The Title of my research study is ***In-Services Teachers' understanding of numeracy skills in Grade R Class: A Case Study of Reception Classes (Grade R) in Lesotho***. The purpose of the study is to explore in-services Teachers' Understanding of the Teaching of Mathematics in Grade R Class. I hereby seek your permission to conduct this research at the college in 2014. I will generate data by analysing the following documents; the course outline for Mathematics course offered to the in-service teachers enrolled in Certificate in Early Childhood Education (CECE) programme.

You are kindly requested to fill in the attached declaration and consent form which acknowledges the permission granted to undertake my research in your school. I guarantee

that the information gathered will be used for the purpose of the research only. For further information regarding this research you may contact either myself or my supervisor; Ms Blanche Ndlovu, Ndlovubl@ukzn.ac.za or Mrs. Mamasiphole Setoromo: (+266) 62444545 / 0618857757/ zipzipstory@gmail.com.

Your cooperation will be appreciated

Yours sincerely

_____

DECLARATION

As the Principal of the school, I understand that:

I am not being forced to grant Mrs Mamasiphole Josephina Setoromo the permission to undertake her research by analysing the Grade R teacher's lesson plans for numeracy skills observing and interviewing the Grade R class teacher.

_____ _____

Signature Date

Letter to In-service teachers for Grade R

Prem Mohun
University of KwaZulu-Natal
Research Office: Ethics
Govan Mbeki Centre
Tel +27312604557
Fax +27312604609
E-mail mohunp@ukzn.ac.za
05, June, 2014

Dear Participant/Teacher

RE- REQUEST FOR YOUR CONSENT TO PARTICIPATE IN MY STUDY

My name is Mamasiphole Josephina Setoromo, student number 214580132. I am a postgraduate student at the University of KwaZulu Natal in the School of Education; Early Childhood and Development Discipline at Edgewood campus.

I am currently conducting a research in Early Childhood and Development under the supervision of Ms. Blanche Ndlovu. The purpose of this research is to inform the policy / teachers on understanding of Numeracy Skills for Grade-R Class.

If you agree to participate in this research study, the following will occur:

1. Each participant will be scheduled to be observed once or twice teaching numeracy to Grade R learners. The duration of the observation will be determined by the usual allocation of time for the teaching of numeracy, which is normally 20-30 minutes.
2. All four participants will be asked to participate in a semi-structured interview and may be asked to participate in focus group interview as well. The both the semi-structured interview and focus group interview will be scheduled for the convenience of both the researcher and the participants. The interviews will be audio taped and will be used for the purpose of this research.
3. Each participant's scheme of work and/or numeracy lesson plans will be analyzed.

Confidentiality

The records from this study will be kept as confidential as possible. No individual identities will be used in any reports or publication resulting from the study. All audio tapes, transcripts and summaries will be given codes and stored separately from any names or any other direct identification of participants. Research information will be kept in locked files at all times. After the study is completed and all data has been transcribed from tapes, the audiotapes will be held for five years and then destroyed. You will receive a copy of the final transcript, so that you have the opportunity to suggest changes to the researcher, if necessary. Participation in this study is voluntary and you are free to withdraw your participation from this research study at any point. You will be given a copy of this consent letter for your consent.

Questions

If you have any further questions or queries about the study, please contact:

Mrs. Mamasiphole Setoromo: (+266)62444545 / 0618857757 / zipzipstory@gmail.com

Ms Blanche Ndlovu: Ndlovubl@ukzn.ac.za

Consent form for participants

Prem Mohun
University of KwaZulu-Natal
Research Office: Ethics
Govan Mbeki Centre
Tel +27312604557
Fax +27312604609
E-mail mohunp@ukzn.ac.za
05, June, 2014

CONSENT FORM FOR PARTICIPANTS

The title of the study: In-Services Teachers' understanding of Numeracy Skills for Grade-R Class.

I agree to take part in the study on: Exploring In-Services Teachers' understanding of Numeracy Skills for Grade R Class. I am aware that the researcher will observe me while teaching Numeracy to Grade R learners. I am willing to take part in focus group interviews as well as individual interviews. I am also aware that each interview will be audio taped.

I am also aware that the researcher will analyse my scheme of work and my lesson plans for numeracy.

I have read and understood the accompanying letter and know what the study is about and the part I will be involved in. I know that I can decide not to continue with this research at any time.

Name _____

Signature_____ **Date**_____

Participants

Signature _____**Date** _____

Researcher

Appendix B Schedules

Interview questions

1. What do you understand by the effective teaching of mathematics in Grade R class?
2. Mention major content areas of mathematics which are stipulated in Grade R curriculum and give examples of mathematical concepts/topics under each area.
3. What do you understand are the differences between a triangle, square, and rectangle?
4. In your own understanding which teaching strategies do you consider effective when teaching mathematics to Grade R class? Why?
5. Do you think it is necessary to assess learners while teaching mathematics? Why?
6. Which assessment methods do you understand are good to be used in assessing learners?
7. In your own understanding, how do you think, the Grade R classroom for the teaching of mathematics should be arranged and organised?
8. How do you understand the planning of the lesson plan/lesson activities for mathematics should be like?
9. In your own understanding how do you think learners in Grade R learn mathematics? Explain.
10. In your own understanding what do you understand by the fact that learners are different?
11. In your understanding, do you think mathematics offered in Grade R class are applicable in daily life's activities of learners? Support your answer.

Classroom observation schedule

I observed if the following addressed during the teaching of mathematics lessons.

1. Organization, logic and sequencing of presentation of the mathematical concepts.
2. Effective use of different teaching methods/strategies to teach and assess mathematics.
3. Classroom arrangement and organization.
4. Integration of mathematics concepts with other subjects.
5. Learners' engagement in doing classroom activities.
6. Classroom activities cater for different learning styles and cognitive development.
7. Reviewing prior knowledge of learners before teaching new knowledge.
8. Use of concrete locally available materials.
9. Contextualization of the games, songs and examples used.
10. Engaging learners in activities that helps them to have deep understanding of mathematics by asking why and how questions.