

AN INVESTIGATION ON THE ROLE OF GRADE R TEACHERS IN CREATING
A CONDUCIVE ENVIRONMENT FOR LEARNING NUMERACY
AT VHURONGATHE VHEMBE DISTRICT IN SOUTH AFRICA

BY

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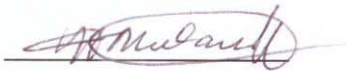
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DECLARATION

Student Number: 487-608-6

I declare that *The Role of Grade R Teachers in Creating a Conducive Environment for Learning Numeracy at Vhuronga in the Vhembe district in South Africa* is my own work and that all the sources I have used or quoted have been indicated and acknowledged by means of complete references.



SIGNATURE

26-10-2016

DATE

ABSTRACT

South Africa's recent participation in the national, regional and international studies revealed that the South African learners perform poorly in mathematics when compared with other same-level learners in other participating countries. In response to the results, the Department of Basic Education implemented intervention strategies such as Foundations for Learning and the Systemic Evaluation among others to enhance learner performance in mathematics.

This study investigated the role of Grade R teachers in creating a conducive environment for learning numeracy using schools in the Vhuronga circuit of the Vhembe District in South Africa as case studies. The investigation encompassed: (a) the extent to which Grade R teachers create a conducive environment for learning numeracy; (b) how Grade R teachers are implementing the numeracy curriculum and (c) classroom factors that influence approaches teachers employ during numeracy teaching. A qualitative methodology using case study research design was adopted for collecting data in Grade R classrooms at Vhuronga. Interviews, observation, and document analyses ensured valid data. Qualitative data analysis involved coding and categorizing patterns from field notes in order to identify themes for discussion.

The study established that inadequate resources which include limited classroom space, lack of appropriate learning materials, furniture, and in-service teacher training programmes, were impediments that restricted Grade R teachers from creating a conducive environment for learning numeracy. The study further established that whole-class teaching dominated numeracy lessons. A few teachers who taught small classes implemented a variety of play-based activities that encouraged interaction and exploration of adequate learning materials in small-groups in order to create a conducive environment for learning numeracy. In contrast, most teachers with large classes considered the classroom layout fixed. The teachers arranged the desks in rows and engaged the whole-class in similar learning activities. Additionally, the study established the need for ongoing training to refine and update teachers' skills in creating well-organized classrooms that are conducive for numeracy learning.

The study recommends that the Department of Basic Education should create opportunities for Grade R teachers to participate in regular in-service training that emphasize practical work, in order to strengthen their capacity in creating conducive classrooms for learning numeracy and ensure quality education.

Keywords: conducive environment; activity areas; play-based approaches; numeracy achievement; teaching and learning resource materials; Grade R; constructivism.

DEDICATION

I dedicate this thesis to my family with sincere gratitude.

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LIST OF ABBREVIATIONS

ANA Annual National Assessment.

CA	Content Area.
CAPS	Curriculum and Assessment Policy Standard.
DBE	Department of Basic Education.
DOE	Department of Education.
ECD	Early Childhood Development.
FFLC	Foundations for Learning Campaign.
FP	Foundation Phase.
IEA	International Association for the Evaluation of Educational Achievement.
LO	Learning Outcome.
LOLT	Language of Learning and Teaching.
LP	Learning Programme.
NAEYC	National Association for the Education of Young children
NCS	National Curriculum Statement.
NCTM	National Council of Teachers of Mathematics
NEEDU	National Education and Development Unit.
OECD	Organization for Economic Co-operation and Development.
RNCS	Revised National Curriculum Statement.
SA	South Africa.
SACMEQ	Southern and Eastern Consortium for Monitoring Education Quality.

SE	Systemic Evaluation.
TIMMS	Trends in International Mathematics Science Studies.
TLSM	Teaching and Learning Support Material.
UNESCO	United Nations Educational, Scientific and Cultural Organization.
WCED	Western Cape Education Department.
ZPD	Zone of proximal development.

CHAPTER 1

ORIENTATION TO THE STUDY

All children must learn to think mathematically to learn mathematics (Kilpatrick, Swafford, & Findell, 2001:200).

1.1 Introduction and Background of the Study

South Africa's recent participation in the national, regional, continental and international studies has shown that South African learners perform poorly in mathematics when compared with other same-level learners in other countries (DBE, 2011b; DoE, 2009; Chisholm, 2011; Martin, Mullis, Foy & Stanco, 2012). These recent findings have confirmed past trends of poor performance in numeracy (mathematics) among South African learners. These past trends, in addition to recent findings, formed the basis of this study. Speaking at the first foundation phase (FP) conference in Limpopo (2008), the former Minister of Education in South Africa, Mrs. Naledi Pandor stated that,

"Our learners cannot count and calculate at expected levels".

Pandor further emphasized that in the FP learners must learn to read, write and calculate numbers confidently and with understanding to enhance opportunities of success when pursuing or learning mathematics beyond the phase. Pandor further indicated that low attainment levels in numeracy are unacceptable because they reduce chances of success in further learning (DoE, 2008:2). Pandor's claim highlights the value of counting and calculating, as well as exposure of learners to the power of numbers in their everyday lives as building blocks that lay the foundation for mathematics achievement.

South Africa's initial focus was on the improvement of academic achievement in Grade 12 (matric) examinations particularly in mathematics for a period of time. However, this failed to achieve the desired expectations, creating the need to improve academic performance in mathematics in lower grades. This resulted in an emphasis on

benchmarking academic achievement in the lower grades, especially within FP classrooms (DBE, 2010; UNESCO, 2002; UNESCO, 2012). In addition, South Africa implemented the 2011 systemic evaluations system to serve as a baseline assessment for learner performance in numeracy. The 2001 average scores for numeracy in the Limpopo Province were 26% but then declined to 24% in 2007. The results confirmed that the numeracy levels of South African learners in Limpopo persistently remained low ((DoE, 2008).

According to DBE (2011a); Howie (2004); and Meier (2011), in response to the low numeracy achievement, South Africa implemented intervention strategies, namely the 2008 Foundations for Learning Campaign (FFLC) and the 2011 Annual National Assessments (ANA) with the aim of improving numeracy performance in all schools. Botha, Maree and de Witt (2005); Chisholm (2011); DBE (2011a) and Pietersen (2006) however indicated that the performance of South African learners has been most disturbing and even surprised the country. South Africa also participated in international studies and the findings of the studies confirmed the trends of poor numeracy levels emerging from the national (local) learner assessments tests.

Evidence of poor mathematics achievement in FP schools of South Africa validated that among the participating provinces, namely: Eastern Cape, Free State, Gauteng, KwaZulu-Natal, Mpumalanga, North West, and Limpopo, Limpopo achieved the lowest numeracy scores in 2007 (24%) compared to the South African overall score of 35% (DoE, 2009; Karlsson, 2008,2009; Kühne, O'Carroll, Comrie & Hickman, 2013).

Table 1 presents the results of Grade 3 systemic evaluations for numeracy (province by province), which the South African DoE conducted in 2001 and 2007/2011. The achievement scores for numeracy, namely: 26% in 2001 and 24% in 2007, suggest that the achievement levels in numeracy in the Limpopo Province are declining and remained low (General Household Survey, 2007; Statistics South Africa, 2008).

Table 1: Grade 3 mean average achievement scores (%) for numeracy, 2001 and 2007

Province	Numeracy average scores in 2001	Numeracy average scores in 2007
Eastern Cape	34	36

Free State	29	42
Gauteng	32	42
KwaZulu-Natal	31	36
Limpopo	26	24
Mpumalanga	29	31
North West	25	29
Western cape	32	49
South Africa overall	30	35

Source: Department of Education 2011 Grade 3 Systemic Evaluation, Pretoria: DoE.

The crisis of low mathematics achievement has been evident in the South African schooling system since the early 1990"s (Chisholm, 2011; UNESCO, 2001). It is against this background that the South African DoE implemented numerous initiatives to improve teaching and learning outcomes among the South African numeracy learners. Such initiatives include the QUIDS-UP programme, Dinaledi schools, the Foundations for Learning Campaign, the National Curriculum Statement Grades R-12 (NCS), amongst others.

Initially, the Dinaledi schools Campaign was implemented to improve mathematics achievement in rural areas, and was followed by the QUIDS-UP programme designed to support teachers and districts in low performing foundation phase (FP) schools with regards to mathematics achievement. It was followed by the Foundations for Learning Campaign (FFLC), which focused on improving the achievement levels for numeracy to at least 50% by 2011 (OECD, 2008). Lastly, the National Curriculum was reviewed and restructured several times, in pursuit of quality education and ultimately, the national curriculum statement (NCS) Grades R-12 is currently being implemented in South African schools. Despite the governmental initiatives to improve teaching and learning

achievement outcomes, the numeracy outcomes of South African learners are still alarming (Botha, et al. 2005; DBE, 2011a; Howie, 2001).

Given the low numeracy achievement levels of South African learners, it was evident that there is need to conduct an empirical study in FP schools of Vhuronga, to investigate the role of Grade R teachers in creating a conducive environment for learning numeracy. Schools in Vhuronga were selected because the district is one of the lowest performing districts in terms of numeracy achievements in the Limpopo Province. In addition, the schools were based in rural disadvantaged communities, characterized by overcrowding classrooms and lack of adequate learning resources.

In order to emphasize the numeracy skills of children, the discipline of Mathematics is called Numeracy during the first three years of formal education (Baroody & Lai, 2006a; Clements & Sarama, 2010, 2007a, 2007b; Mannigel 1992). Numeracy is defined as a human activity that involves observing, representing, and investigating patterns and quantitative relationships in the physical and social environment and between mathematical objects. Through this process, new mathematical ideas and insights are developed (DoE, 2002; Mannigel, 1992). The development of numeracy concepts is described below to help the readers understand how effective teaching and learning numeracy in Grade R can be promoted.

1.1.1 The Development of Numeracy Concepts

This section presents how learners use their readiness to explore mathematical concepts throughout their early lives (NAEYC, 2002). According to Geary (2006) and Shumway (2011), learners share cookies and a bowl of crackers fairly well with siblings or playmates. They also compare quantities, find patterns and grapple with real-life problems such as erecting a tall building with construction blocks, sharing learning materials or taking turns in the play area (Charlesworth & Lind, 2013; Sarama&Clements, 2009a; Ginsburg, Klein, and Starkey, 1998). When playing indigenous games, such as skipping rope, snake and ladders (in the South African context), they learn counting and number patterns among others (Naudé& Meier, 2014; Van de Walle, Karp & Bay-

Williams, 2010). These activities provide a well-grounded foundation for learning numeracy in the early years. When different stakeholders in the Department of Basic Education are involved, they support teachers to provide ageappropriate numeracy activities and assist Grade R learners to broaden their knowledge-base with regards to numeracy concepts.

Baroody (2004) Seo and Ginsburg (2004) highlight that young learners often explore numerical concepts, for example, in sorting and classifying objects, comparing quantities, and observing shapes and patterns in play and in their daily activities. On the other hand, Clements and Sarama (2010) Ginsberg, Cannon, Eisenband and Pappas (2006) argue that although Grade R learners can learn basic numeracy concepts on their own, teachers need support from various stakeholders in FP education to maximize these learning experiences. Jennings (1993) Morgan, and Harmon (1984) Yarrow, McQuiston, McTurk, Mc Carthy, Klein and Vietze (1983) concurred and emphasized that learners have an inherent need to explore goal directed numeracy activities. According to Bergen (2002); Bodrova and Leong (2003a) teachers should provide hands-on experiences to learners that sustain active learning.

The National Association for the Education of Young Children [NAEYC] (2001) indicated that challenging and accessible numeracy activities for young children is a vital foundation for understanding future mathematics concepts (NAEYC, 2001:1). Van Luit (2000) supports this argument, maintaining that if learners do not develop a grounded understanding of numbers during their early years, they do not flourish in learning more complex mathematical skills and concepts in later grades.

Based on the above-stated claims, it is imperative that teachers should intervene early in teaching the basic number skills. In this sense, teachers will assist young learners to lay a strong foundation with regards to numeracy education (Blevins-Knabe, 2008; Kersaint & Chappel, 2001).

The importance of a well-grounded primary school-child, with adequate numeracy knowledge and skills is recognized in the global society (Department of Education, 2002; NCTM, 2000). According to Geogenham (2002:1), numeracy is an important knowledge that cannot be overemphasized in any society. Stevenson and Stigler (1992) have further shown that the qualities of early numeracy experiences are essential proficiencies which

determine succeeding learner achievement. This claim is also supported by Van Luit (2000) indicating that adequate competence in numeracy provides a solid foundation for learners in the early years to solve problems in their everyday lives. A focus on numeracy learning is laid on the following:

According to Van de Walle (2007:28) the manner in which a class is conducted, the social climate that is established within the classroom and the materials available for learners to work with, all have an impact on what is learned and how well it is understood.

This means that the classroom environment sets the tone that stimulates mathematical thinking and assists learners to develop numeracy knowledge. It is against this background that this study investigates the role of Grade R teachers in the FP schools of Vhuronga in creating conducive classroom environment for learning numeracy.

1.2 Statement of the Problem

It is widely acknowledged that the South African schooling system performs below its potential (Botha et al., 2005; Kühne, O'Carroll, Comrie & Hickman 2013). In this light, the improvement of basic education outcomes is essential for schools to better prepare learners to count, calculate and solve numerical problems (DBE, 2011; Wright, Martland, & Stafford, 2006).

Research evidence regarding low mathematics achievement of South African learners in the various key grade levels of the schooling sector is recognized (DBE, 2011; Reddy, 2006). Firstly, the Trends in International Mathematics and Science Study (TIMSS) of 1995, 2003, 2007 (Howie, 2004, 2001; Soudien, 2007) indicated that South African learners obtained the lowest scores among the 39 member states. This was followed by the results of the national systemic evaluation 2001 (26%) and 2007 (24%), which suggested that learners in the rural areas of Limpopo where this study was conducted, perform poorly in numeracy (DoE, 2008; UNESCO, 2006).

Despite numerous governmental interventions and policy changes to improve the levels of educational outcomes, numeracy achievement in South African schools remained persistently low (Bobis, Clarke, Thomas, Wright & Young-Loveridge, 2005; Cohen, Raudenbush & Ball, 2000; DoE, 2008; Spaull, 2011).

Piece (1994); Van De Walle and Lovin (2006) pointed out that the nature of the classroom environment has an influence on how well learners achieve their educational outcomes. This was supported by Naudé and Meier, 2014; According to Naudé and Meier (2014); Meier and Marais (2007); and Taylor (2008a), South African teachers work in challenging classroom environments. These scholars claimed that issues of class size (overcrowding, high learner-to-teacher ratios) and lack of adequate learning materials among others, characterized the classroom environment where numeracy lessons in most disadvantaged rural communities of South African schools are taught. In addition, Grade R classes are often offered in a space that has been planned and intended for another purpose such as community center or elementary classroom (Meier & Marais, 2007; UNESCO; 2006).

From the foregoing, researchers and teachers noted that if the classroom environment in the early years is not conducive enough for teaching and learning, the academic outcomes will not improve (Akinsolu, 2004).

This study sought to investigate the role of Grade R teachers in creating a classroom environment and to determine if such teaching and learning environments are conducive for learning numeracy in foundation phase schools of Vhuronga in South Africa or not.

1.3 The Research Questions

The study was guided by the following research questions:

1. What kind of classroom environment do Grade R teachers in the Vhuronga circuit of the Vhembe District in Limpopo create during numeracy learning classes?
2. How are Grade R teachers implementing the numeracy curriculum?

3. What classroom factors influence the approaches Grade R that teachers employ during numeracy teaching?

1.4 Research Design and Methodology

1.4.1 Research Design

This study was conducted within a naturalistic setting of a qualitative design from an interpretive paradigm (Babbie & Mouton, 2011; Neuman, 2000). A case study design involving four schools of Vhuronga circuit in the Vhembe District of Limpopo was adopted as indicated by (Yin,2003b; Merriam, 1998). Schumacher and MacMillan (2006) indicated that a research design specifies a plan for generating empirical evidence that will be used to answer the research question.

According to (Yin, 2003a) and Neuman (1997) the strength of a case study method is its ability to examine an in-depth “case” within its “real-life” context to identify patterns in the lives, actions, and words of people. The four schools constituted a case because they achieved poorly in the 2011 ANA systemic evaluations; that is, they each scored an average performance of less than 50% on numeracy within the same circuit (Bothaet al. 2005). Although the four schools constituted a „case“, each individual school was a major source of data and details with Grade R teachers as participants of the study.

Detailed descriptions of the case study are provided in chapter three.

1.4.2 Methodology

The study employed qualitative research methodology, focusing on a triangulation of qualitative data collection methods including interviews, classroom observations, and document analysis as major sources of data as highlighted by (Barbie, 2010; MacMillan & Schumacher, 2010; Yin, 2003b). A qualitative research methodology was appropriate for this study, because it enabled the researcher to deeply investigate the behaviour of

Grade R teachers and their experiences in creating conducive environments for teaching numeracy. This research methodology was also suitable for the study because the participants were studied in their natural setting i.e. Grade R classrooms (Barbie & Mouton, 2010; Neuman, 2000). In addition, it allowed the researcher to obtain rich and thick descriptions of data in the form of words, directly from the participants by listening to their views and observing their interactions during lesson activities (MacMillan & Schumacher, 2010).

Four schools were purposefully selected as descriptive case studies. Purposeful sampling was utilized to provide rich cases for in-depth studies as highlighted in (Patton, 2002).

1.5 The purpose of the Study

The objectives of the study are as follows:

1. To investigate the classroom environment Grade R teachers create during numeracy classes.
2. To examine how Grade R teachers implement the numeracy curriculum.
3. To examine classroom factors that influence the approaches that Grade R teachers employ during numeracy teaching.

Scholars such as Woods (2004) have shown that teaching and learning numeracy in (FP) has been under-researched in comparison to the subsequent grades. This view has been echoed by Chisholm (2011) and Hoadley (2012) arguing that there has been limited classroom-based research that probed educational problems in South Africa since the 1990s; for example, the role of Grade R teachers in creating a conducive environment for numeracy learning.

At the time of writing; no study had ever been conducted in FP schools of Vhuronga to examine whether Grade R numeracy was taught in conducive classroom environments or not. Researchers such as Boaler (1999) Cobb and Hedge (2000) and Moloï and Strauss (2005) highlighted that the classroom environment has potential benefits on learner achievement. The researchers further showed that the activities in the classroom, such as the repeated actions in which learners engage as they learn, are critical for the development of foundational skills in numeracy. This can be demonstrated for example when teachers involve learners in sorting and matching the number of bottle caps they are counting, pointing the dots on the lady bird while counting or counting the number of jumps while skipping the rope (Carruthers, & Worthington, 2006; Ginsburg, Lee, & Boyd, 2008; Meier, & Marais, 2007).

With regards to this study, the researcher gained first-hand prior experience both as a numeracy teacher in FP schools (Grade R-3 classes) in the rural areas of the Vhembe District, and as a remedial education teacher in the local resource center, assisting FP learners in the neighborhood with mathematical problems. The researcher also learnt from experience as a university lecturer, teaching mathematics methodology modules in the Bachelor of Education Degree programme, specializing in foundation phase teaching (BEd TEF), Department of Early Childhood in the school of Education in one of the rural institutions of Limpopo.

The wealth of experience gained motivated the need to examine the extent to which Grade R teachers create a conducive environment for learning numeracy, in order to determine why achievement levels of learners at Vhuronga are lagging behind the national and international standards (WCED, 2009).

1.6 Significance of the Study

- The findings of the study will contribute towards the understanding of the stakeholders in FP education; i.e. Grade R teachers, and curriculum advisors of Vhuronga circuit in the Vhembe District on planning the classroom environment with activity areas to provide active learning through play activities.

- Teachers should use the strategies proposed in this study such as active learning as applicable guidance for the set-up of activity areas that stimulate active learning during numeracy classes. Teachers should further be trained on strategies for implementing active learning (Feeney, Moravcik & Nolte, 2013; Naudé & Meier, 2014). It should be noted that active learning utilizes play as a principal means for learning. Play further encourages learners to construct their own numeracy knowledge as recommended by constructivism (Naudé & Meier, 2014; Van de Walle & Lovin, 2006).
- Curriculum advisers can utilize the findings of the study to develop professional training programmes on the implementation of play-based approaches in teaching and learning numeracy. The training of teachers should be offered on a continuous basis and should also be facilitated by knowledgeable trainers to improve the quality of teaching numeracy in Grade R classrooms. The trainings should also be aimed at enriching the numeracy achievement of learners in the FP schools, particularly in Grade R. Teachers should be trained to provide learners with the opportunity to handle and explore the learning materials in the classroom in order to develop knowledge and skills that make sense to them.

The findings of this study will close the mathematics achievement gaps in literature with regards to the creation of conducive Grade R classrooms for learning numeracy. Research on mathematics learning achievement in South Africa have mainly focused on the higher grades of schooling, and not on numeracy learning achievement of Grade R learners (DBE, 2011; Chilsholm, 2011; Woods, 2004). This study therefore would therefore add a different literature coverage on mathematics learning achievement because it focuses on lower grades of schooling, mainly Grade R.

1.7 Delineation of the Study

The study was conducted in one circuit of the Vhembe District in Limpopo, South Africa. There are twenty-six foundation phase schools in the Vhuronga circuit. The study is delineated to Grade R teachers in four foundation phase schools only. The schools were nominated because learners in these schools did not perform well in the 2011 Annual National Assessment on numeracy. Each school scored less than the average 50%

envisaged from all schools by the South African DoE. The teachers in the sampled schools were well-suited to the study because they have knowledge of teaching Grade R classes in disadvantaged rural schools with limited resources such as the learning space and the Teaching and Learning Support Materials (TLSM).

1.8 Limitations of the Study

There are twenty-six Foundation Phase schools in the Vhuronga circuit. Only four schools participated in the study. The schools were approximately fifty to sixty kilometers apart from each other and were not easily accessible due to sandy roads with potholes.

The small sample size made it hard to generalize the findings to all Grade R teachers in the Vhembe district. Nevertheless, the samples provided thick descriptions of consistent qualitative data that shed more light on the empirical experiences regarding classroom settings teachers created that affected teaching and learning of numeracy in the circuit.

1.9 Definition of Key Terms

1.9.1 Grade R: Grade R in this study refers to the class preceding Grade 1 which caters for the 5-6 years old children (UNESCO: 2006).

1.9.2 Grade R teacher: In this study the term refers to adults in a South African school context who care for and educate a group of young children in Grade R (NAEYC, 2002).

1.9.3 Conducive Environment: This term refers to all conditions that affect children's surroundings and the people in them (Gordon & Browne, 2014) including equipment and material that facilitate all areas of development; i.e. the physical classroom space, learning experiences, and teachings during numeracy lessons that can determine learner achievement (Feeney, Moravcik, Nolte & Christensen, 2013). Furthermore, conducive environment in this study refers to the physical arrangement of the classroom e.g. posters on the walls, examples of learners' work on display, the arrangement of desks or tables

in groups, a well-planned space, adequate resources and enough opportunities for active learning achieved through play-based activities. Grade R teachers should set up activity areas to create an atmosphere that promotes interaction among learners, enabling them to learn numeracy through active participation using hands-on learning materials (Meier & Marias, 2007).

1.9.4 Numeracy: This is the ability to process, communicate and interpret numerical information in a variety of contexts (Askew, Brown, Rhodes, Johnson & William, 1997; Perry, 2000). In this study, numeracy means the ability of Grade R learners in foundation phase schools of South Africa to develop foundational skills which involves confidence and competence in working with numbers and measures. Numeracy also demands practical understanding of the ways in which information is gathered by counting and measuring, and is presented in graphs diagrams, charts and tables and to apply this knowledge and skills in their everyday contexts (DoE, 2002).

1.9.5 Teaching Approaches: In this study, this refers to methods of teaching numeracy in foundation phase classrooms. These includes whole-class, small-group teaching, problem solving, active learning as well as play-based approaches which teachers employ when teaching numeracy lessons in Grade R (Perry, 2000; DoE, 2002; Doig, McCraire and Rowe, 2003).

1.9.6 Systemic Evaluation: This refers to the learner assessment programme, conducted by the South African Department of Education, which focuses on the key Grade levels of schooling, i.e. Grades 3, 6 and 9 (DoE, 2009). In this study, Systemic Evaluation refers to an assessment programme for monitoring numeracy learning achievement in foundation phase schools in the Vhuronga circuit in Limpopo.

1.9.7 Annual National Assessments: Anational intervention strategy that the Department of Basic Education in South Africa implemented to measure learner achievement annually on Literacy and Numeracy competencies (DBE, 2011). In this

study, ANAs refers to a diagnostic tool (assessment tool) for monitoring learner achievement of numeracy in foundation phase schools of South Africa in order to identify learners with mathematics problems and providing intervention strategies to improve numeracy results (DBE, 2011).

1.9.8 Foundations for Learning: A four-year campaign to create a national focus to improve reading, writing and numeracy abilities for South African children (DoE, 2008). Foundations for learning in this study is a call for commitment to teaching and learning numeracy in order to improve the level of achievement of South African learners on numeracy to not less than 50 percent (50%) in 2011 and beyond.

1. 10 Report Structure

Chapter 1 gives the background of the study. It puts the study in context, explaining the importance of the research and clarifying what the study is investigating. The chapter further gives the statement of the problem, the research questions and the purpose of the study. The concepts of delineation, limitations and other concepts are highlighted and unpacked.

Chapter 2 firstly presents a literature review that provides the theoretical framework that guides the teaching and learning of numeracy in Grade R; i.e. constructivism, Piaget's cognitive constructivism and Vygotsky's social constructivism. This is followed by the extent to which teachers create a conducive environment to numeracy learning in Grade R. The chapter then presents how teachers are implementing the Grade R numeracy curriculum followed by classroom factors that influence the approaches teachers employ for numeracy teaching. Lastly, the trends for learner achievement in mathematics education are also presented. The chapter concludes with a summary of the literature reviewed regarding the conducive environments that teachers create for teaching numeracy lessons.

Chapter 3 explores the research design, and methodology employed to carry out the investigation of the study. The chapter describes the choice and the development of the research instruments; including the theories that guided the development of data

collection and instruments utilized. The chapter also describes the sampling, sampling procedure and ethical considerations and procedures.

Chapter 4 elaborates on the empirical data of the six teachers in the sampled schools in the form of narratives. The narratives give detailed descriptions and insight with regards to numeracy lessons each of the sampled teachers taught during the three consecutive days of classroom observation. The analysis of curriculum documents and teacher's views during the initial and final interviews lays the foundation for discussion and insight to answer the research questions of the study.

Chapter 5 concludes with the discussion of the main findings, the contributions and limitations of the study. The main themes emerging from implications of the results are elaborated and recommendations for opportunities for further research.

CHAPTER 2 LITERATURE REVIEW

“Play is the work of childhood” (Naudé& Meier, 2014:52).

2.1 Introduction

The previous chapter provided background information on the role of Grade R teachers in creating a conducive environment for learning numeracy in foundation phase schools in Vhuronga in Limpopo. The purpose of this chapter is to review related literature on the influence of the classroom environment on the achievement of numeracy outcomes. The chapter is divided into six sections which are arranged as follows:

- (1) The theories of teaching and learning numeracy in Grade R classrooms (conceptual framework) that guided this study and its implications on numeracy learning are discussed.
- (2) The extent to which teachers create a conducive numeracy environment for learning in Grade R.
- (3) A presentation on how Grade R teachers are implementing the numeracy curriculum
- (4) Classroom factors that influence the approaches teachers employ in teaching numeracy.
- (5) Trends for learner achievement and Grade R numeracy outcomes.
- (6) Implications of research studies on teaching and learning numeracy in South African Grade R classrooms.

2.2 Theories of Teaching and Learning Numeracy in Grade R Classrooms

Some studies have shown that constructivism is suitable for teaching and learning numeracy in early childhood education as presented in this section. It describes the process of knowledge construction as an active rather than a passive process (Major & Mangoepe). Constructivism can be defined as an approach to learning in which “learners are provided the opportunity to construct their own sense of what is being learned by building internal connections or relationships between the ideas and facts being taught” (Borich & Tombari, 1997:177; Kamii & Ewing 1996:260). Constructivists therefore believe that knowledge should not be deposited in the child’s mind, instead it should be constructed by learners through active involvement in the learning process. When children learn to construct their own knowledge, they tend to have control over the development of mathematical concepts and learn to think mathematically (Major & Mangoepe, 2012). The main aim of teaching and learning mathematics through a constructivist approach is to help learners become critical thinkers and competent in mathematics.

There are two major trends of constructivism, namely: Piaget’s cognitive trend and Vygotsky’s social constructivism that are central to the development of the child. The two trends however focus on different aspects of development (Killen, 2006; Niemand & Monyai, 2006). Carey (1989) and Van de Walle (2007) have shown that the principle of constructivism is based on the notion that “children construct knowledge as they interact with the concrete environment”. In addition, Donald, Lazarus and Lolwana (2002; 100) agree with Carey, showing that “knowledge is not passively received but actively constructed.”

The preceding paragraph suggests that the cognitive constructivism places the importance of the construction of knowledge in teaching and learning mathematics on the learner’s point of view (Donald et al, 2002; Maker & Noddings, 1990; Zwaal & Otting, 2012). Grade R teachers should therefore create opportunities for learners to engage actively in experiences, activities and discussions which help them construct knowledge in their classroom environment. In this sense, learners should be actively involved in handling a variety of physical learning materials in problem-based classroom settings and problem-solving activities, discussing and sharing ideas about what they learn.

The teacher should design the classroom and the activities to help learners construct knowledge internally rather than imposing on learners (Carey, 1989; Killen, 2006; Van de Walle et al., 2010; Zwaal & Otting, 2012). Teachers should further provide learners with concrete learning materials (objects), assisting them to explore and use in their own ways; for example: count, classify, compare and develop new knowledge (Bruner, 1966; Gordon & Browne, 2014; Seefeldt & Barbour, 1998). This proposes that learners should interact with the teacher and classmates in the classroom in order to construct knowledge that makes sense to them (Borich & Tombari, 1997; Gordon & Browne, 2014; Van de Walle & Lovin, 2010) and learn numeracy concepts such as counting, ordering and comparing amongst others.

In my opinion, constructivism is relevant to this study because learning in Grade R is achieved through active learning (learners playing and learning by doing). This suggests that when learners are given an opportunity to sort and group the learning materials of various shapes, they discover concepts (for example, number or colour patterns, size of the different shapes) amongst others.

2.2.1 Piaget's Cognitive Constructivism

Cognitive constructivism is defined as “an approach to learning through which learners are provided the opportunity to construct their own sense of what is being learned by building internal connections or relationships between the ideas and facts being taught” (Borich & Tombari, 1977:177). This suggests that learning is a process of creating new knowledge and not just a process of acquiring knowledge. This approach emphasizes that learners actively construct knowledge for themselves by forming their own representation of the materials to be learned, selecting relevant information by themselves and interpreting this on the basis of the existing knowledge and needs (Zwaal & Otting, 2012).

Piaget drew attention to his theory on the development of the individual learner who constructs knowledge through interaction with the concrete environment (cognitive constructivism). According to Gordon and Browne (2014); Naudé and Meier (2014),

Piaget's theory suggests that when learners manipulate physical objects in the classroom, they construct their own knowledge (e.g. building puzzles), to learn the relationship between the concepts of shapes and colour when connecting the different puzzle pieces as they construct knowledge they develop understanding of the mathematical concepts.

Piaget further identified four major stages of cognitive development, namely: the sensory stage (0-2years), the preoperational stage (2-7 years), the concrete operational stage (6-12 years) and formal operational stage (12years - adulthood). Piaget then goes on to indicate that each learner goes through these four major stages in the same order; however, the rate of development will vary depending on the individual and his/her experiences (Charlesworth & Lind, 2000; Gordon & Browne, 2014; Killien, 2006). In the same line of argument, teachers are encouraged to provide learning activities that suits the developmental level of the learners they teach in order to help them participate actively in constructing their own mathematical.

2.2.2 The Effect of Piaget's Cognitive Constructivism on Teaching and Learning Numeracy.

From the Piagetian's perspective, teachers should provide adequate time and learning materials (both concrete and visual) in the Grade R classroom to encourage learners to engage in play activities in order to develop their own numeracy knowledge. When teaching mathematics, teachers should refrain from telling learners how to solve a problem (teacher-centered approach), they should rather ask questions to encourage critical thinking skills (learner-centered) and learning opportunities (Donald et. al. 2005; Gordon & Browne, 2014). In this sense, learners should be provided with many objects to manipulate and create mathematical concepts. The objects should include opened materials (to be used in various ways); for example, construction (blocks), classification and matching games amongst others (Kühne et al., 2013; Van de Walle & Lovin, 2006).

2.2.3 Vygotsky's Social Constructivism

Vygotsky focuses on the social aspect of learning, such as how teachers can assist learners to understand concepts they learn (social constructivism). Social constructivism sees learning as a “social process whereby learners acquire knowledge through interaction with the environment instead of merely relying on the teachers’ knowledge” (Powers-Collins, 1994:5). The social constructivist concept therefore highlights that meaningful learning occurs when teachers help learners build their understanding (scaffolding). The idea further proposes that the teacher should provide a learner with adequate help to complete a task and then gradually decrease help as the learner reaches a stage where he/she can work independently (Zwaal & Otting, 2012).

According to Killen (2006) and Naudé and Meier (2014), Vygotsky claimed that learning occurs at three levels. Firstly, learning happens when learners interact with other people in their environment in order to learn. Secondly, learning occurs when learners interact with a more knowledgeable other (for example, a teacher, a parent or older sibling). Thirdly, learning occurs between two borders; on the one hand, learning occurs when the learner is able to solve a problem with the support and guidance from the teacher, while on the other hand the learner is able to solve a problem independently (without the input from others).

Vygotsky believed that learning occurs between these two borders and identifies the distance between the two borders as the zone of proximal development (ZPD). The ZPD refers to the difference between two things that children can do by themselves and the things they can do with the help of others during teaching and learning numeracy (Killien, 2007; Niemand & Monyai, 2006; Donald et al. 2005).

Given the 3 levels of learning numeracy teachers should in my view, recognize that numeracy learning begins with the handling of teaching and learning support materials (TLSM), practicing skills such as ordering amongst others. The teachers should be trained through professional development to create opportunities for Grade R learners to handle a range of TLSM in order to progressively develop numeracy knowledge and skills.

2.2.4 The Influence of Social Constructivism on Teaching and Learning Numeracy.

From a Vygotskian perspective, the development of knowledge does not happen in isolation, but when the teachers and learners share ideas. This suggests that when learners interact with the teacher in the classroom on a mathematical problem, the teacher should probe on specific questions to assist learners to think logically and develop mathematics ideas and concepts (Naudé& Meier, 2014; Killen, 2006). The ZPD is identified during teaching and learning mathematics when learners get “help from others” (Naudé& Meier, 2014:6). This means that when learners interact with one another in small groups or when the teacher asks specific questions to help learners discover answers on their own.

2.3 Defining a Conducive Environment

According to Gordon and Browne (2014); Feeny et al. Moravcick, Nolte and Christensen (2010), a conducive environment refers to the total sum of the physical and human qualities that combine to create a space in which children and adults work and play together. This suggests that a conducive environment is the total picture teachers create: from the flow of the daily programme, and the number of chairs at a table, the arrangement of the classroom, the routines and the planning of teaching and learning activities. Gordon and Browne further stated that a conducive environment also entails the choices teachers make concerning the equipment and materials (the physical setting), the number of children and the way in which they interact in the classroom.

Feeny et al. (2013) concurred with this account, and emphasized that a conducive environment comprises of all conditions that affect children’s surroundings and the people in them, including equipment and materials that facilitate all areas of development, namely the physical classroom space, teaching and learning experiences.

Classrooms are the heart of each day's world for both children and the staff; hence, that space should allow children to feel secure, and not overwhelmed, while simultaneously permitting organization, and encouraging exploration (Caples, 1996:14).

Caples's statement suggests that Grade R teachers should endeavor to create conducive classroom environment for teaching numeracy. A conducive environment can stimulate learner's interest to participate actively in learning, and to develop knowledge and skills (Gordon & Browne, 2014).

From the views addressed above, it is evident that the stakeholders in education should assist teachers in setting up (planning) conducive classroom environment in order to encourage learners to participate in active learning and assist them in developing their own numeracy knowledge (Naudé & Meier, 2014; Van De Walle & Lovin, 2006).

This study seeks to investigate to what extent and lengths Grade R teachers strive towards creating classroom environment through which numeracy lessons are taught to determine if such classrooms are conducive for numeracy learning or not. The role of the teacher in organizing the classroom environment for teaching numeracy is discussed in the next section.

2.3.1 The Role of Grade R Teachers in Organizing the Classroom Environment for Teaching Numeracy.

According to Naudé and Meier (2014) and the Organization for Economic Co-operation and Development (OECD, 2008) the classroom is a significant setting where teaching and learning occurs. Brookover (1982) and Piece (1994) agreed that the classroom environment emphasizes the total learning site where the learner finds himself. This includes the total infrastructure, the pattern of grouping learners as well as the teaching and learning material. The researchers also indicated that the classroom environment is a critical focus for learner-interaction and academic development. It should be noted that the nature of the classroom environment has a powerful influence on how well learners achieve their academic outcomes, particularly in mathematics (GoodLord, 1984). Teachers should create conducive classrooms to meet the child's needs to learn adequately.

2.3.1.1 The Arrangement of the Physical Environment of the Classroom for Teaching and Learning

The physical arrangement of the classroom environment is an ongoing activity worldwide. According to Gerdes, Durden and Manning (2013) the arrangement of the physical environment of the classroom can have a big impact on teaching and learning. Gerdes et al. further stated that the arrangement of the physical classroom should include regular materials (teacher-made) and readymade or purchased learning materials which learners should explore in order to develop numeracy concepts. Researchers, Feeney et al. (2013) Gordon and Browne (2014) Seefeldt and Barbour (1998) endorse this claim indicating that teachers should adopt a flexible approach when arranging the classroom environment. Additionally, Gordon and Browne (2014) and Meier and Marais (2007) emphasized that Grade R teachers should provide challenging teaching and learning environment to assist learners to discover numerical knowledge, skills and attitudes spontaneously through learner-centered activities (DBE, 2011; Naudé and Meier 2014).

Donald et al. (2005) indicated that teachers should take into cognizance the layout of the classroom to ensure that it stimulates cooperation and encourages effective teaching and learning. Donald et al. goes on to say that teachers should also consider that the size of the classroom they create should be adequate for the number of learners because large classes can negatively affect the social instructional aspects of the classroom environment.

According to Gordon and Browne (2014) and Meier and Marais (2007), teachers in Grade R classrooms can think of multiple uses of furniture when designing the classroom; for example, extra tables or desks can be used as room dividers. Similarly, Gerdes et al. (2013) suggested that the furniture should be intentionally arranged to foster socialization and cognitive learning skills. In this sense, young learners should sit at tables rather than individual desks. The outdoor space can also be used to cope with limited classroom space. In addition, Feeney et al. (2013) Gordon and Browne (2014) further indicated that if the classroom is not functioning smoothly, teachers should reassess the arrangement and make the necessary alterations to suit the needs of the learners.

Feeney et al. (2013) and Gordon and Browne (2014) also suggested that if a classroom is too large, for instance, if a large gym or church meeting hall is used for a classroom, teachers can divide the room with shelves and use part of it or create quiet areas. Click (2000); NAEYC (2009) Perry (1985) agreed with this notion by highlighting that if the classroom is too small, teachers can also consider an additional space outdoors such as a verandah (balcony), to create opportunity for engaging learners in active learning (assisting learners to participate in the learning and exploring the classroom).

According to Click (2000); NAEYC (2009) Perry (2000), learners in Grade R classrooms seldom need to be seated at the same time. They preferably spend most of the time working on the floor or moving in and out of groups. Teachers can thus move tables and desks around or change the routine in the classroom to create adequate space for teaching and learning. Furthermore, teachers can even remove any piece of furniture that isn't being used, including teachers' desk, since the teachers' desk takes up space in Grade R classrooms.

According to Click (2000) NAEYC (2009) Perry (1979) inadequate space in a classroom limits opportunities for active learning. Teachers should thus be aware that when space is limited, learners tend to be less involved in the teaching and learning activities and seem to withdraw socially. Physical aggression and discipline problems similarly increase as space decreases. In this sense teachers should offer learners the opportunity to participate in various activity areas in order to develop their own numeracy knowledge.

Click (2000) Naudé and Marais (2014) have further shown that teachers should recognize that the proper planning and management of the classroom environment in early childhood needs careful consideration. Click, Naudé and Marais have similarly shown that teachers should also recognize that the physical classroom in Grade R can either hinder or support teaching and learning. Koralek, Colker and Dodge (1993); Gordon and Browne (2014) supported this opinion and suggested that a well-structured classroom environment tends to improve the academic outcomes. A well-structured classroom similarly motivates learners to work productively with each other. A view maintained by Angeline Motshega, the Minister of Basic Education in South Africa (DoE, 2009) is that teachers in the early years should recognize that a well-organized and resourced classroom is an asset for providing effective teaching and learning. In this sense they

should create classrooms that nurture the development of social competence, discovery and creativity while fostering numeracy knowledge (NCTM, 2000).

According to Meier and Marais (2007) and Taylor (2008b), South African teachers work hard to educate children in challenging classroom environments. Large classes in some of the disadvantaged rural communities of South Africa namely Limpopo, Eastern Cape, KwaZulu-Natal and Mpumalanga among others, exceed the norm of 40 learners (DBE, 2010). Similarly, some of the teachers teach more than fifty learners in their classrooms. It should be noted that when teachers work in such classroom environments they fail to attend to individual needs of learners in large classes. Many schools in disadvantaged communities, particularly in FP classrooms of South Africa are still characterized among other things by:

- i. Inadequate classroom space; ii. high learner-to-teacher ratios;
- iii. Insufficient furniture; iv. Insufficient equipment for teaching and learning; and v. Use of poor teaching methodologies.

Olaleye (2009); Okapala (2000); and UNESCO (2006) highlighted that when classrooms are characterized by the above inadequacies they limit the child's right to learn and are not likely to provide quality education.

2.3.1.2 Activity areas

Joubert, Bester and Meyer (2008) indicated that teachers should divide the Grade R classroom into various activity areas to engage learners in active learning. Joubert et al. highlighted that active learning contributes towards a conducive classroom environment for teaching and learning numeracy effectively. Grade R teachers should provide activity areas in the classroom to create opportunity for learners to participate in the development of knowledge that make sense to them (Van de Walle & Lovin, 2006). On a similar note, Gordon and Browne (2014) and Meier and Marais (2007); showed that young learners

require a well-planned classroom space to learn through play-based activities. When designing activity areas in the classroom environment, teachers should understand that the layout is not permanent or rigid; and should also take into consideration that new or expanded areas can be added as learners' interest and play behaviour expand (Davin & van Staden, 2004; Meier & Marias, 2007).

It is important to note that a large group (whole-class) meeting area is an essential activity area in Grade R classrooms because it provides learners an opportunity to share and listen to each other's ideas and accomplish their numeracy challenges. During gatherings by whole class, the teacher provides direct instructions to the whole group, demonstrate new experiences, facilitates the sharing of learned experiences and provides encouragement for their learning (DBE, 2010; Taylor, 2008b). Small-group work activities are nevertheless a critical factor that should be planned in the Grade R classrooms to create an opportunity for interaction and learning (DBE, 2011; Naudé and Meier 2014).

In this sense, teachers can provide activity areas such as the block play, fantasy (makebelieve) play, as well as a math and science areas and manipulative play among others (Naudé & Marais, 2014; Van de Walle et al. 2010; Young-Loveridge, 1993b).

Manipulative play learning materials refer to physical objects learners utilize to develop foundational numeracy skills such as sorting, counting, and grouping among others to stimulate the active participation of learners during numeracy lessons. Gordon and Browne (2014) concurred and highlighted that a well-structured classroom environment tends to improve the academic outcomes of learners.

In this sense, it can be noted that a Grade R classroom should provide play areas which include:

- Block play and big construction area;
- Mathematics area;
- Educational games;
- Small construction, manipulation and fine motor skills area;
- Fantasy play area (Meier & Marais, 2007; Davin & van Staden, 2004).

Meier and Marais (2007) also emphasized that teachers can create a classroom environment that will meet the unique needs of their groups. The number of activity areas will depend on the following aspects:

- Age of the group;
- Size of the playroom;
- Number of children in the group;
- Specific needs and interests of the group.

Teachers should also understand that even a small classroom can offer young learners exciting play opportunities if they plan creatively. If the classroom is too small to accommodate a variety of activity areas, the areas can be changed weekly or bi-weekly in order to give learners opportunity to learn through play from all possible activities (Naudé & Meier, 2014; Quinn, Osher, Warger, Hanley, Bader, & Hoffmann, 2000).

Given the importance of constructing activity areas through which innovative ideas of developing the basic knowledge of numeracy concepts through play activities can be triggered, I suggest that Grade R teachers should design well-structured classrooms, with activity areas and provide ample TLSM to stimulate play-based opportunities. It is important to note that the activity areas can remain the same throughout the year and others can be changed as advanced developmental needs arise. In addition, if the physical classroom space presents a challenge that limits teachers from creating activity areas, only one activity area can be offered to engage groups of learners alternatively in structured play throughout the week. Grade R teachers can thus provide learners the opportunity to handle the concrete learning materials in the activity area and discover numerous possibilities of solving numerical problems.

2.3.1.3 Teaching and Learning Support Materials (TLSM) in Numeracy Classrooms

Teaching and learning support materials (TLSM) help make teaching and learning interesting for learners (Ball, 1992; Copple & Bredekamp, 2009; DoE, 2008). Many school teachers today believe that the use of TLSM is the best way to develop foundational (basic) abilities in numeracy, for example, the ability to manage and solve problems. This includes learning experiences that could incorporate mathematics content areas such as number and operations, measurements, understanding space, data and numbers in a variety of formats (Clements, Sarama, & DiBiase, 2004; Starkey & Cooper, 1995).

Research by Jennings (1993) Morgan and Harmon (1984) and Yarrow, et al. (1983) highlighted the need for TLSM during teaching and learning numeracy. This indicates that children have an inherent need to handle TLSM in order to explore and master the development of numeracy knowledge. TLSM includes both visual and concrete objects (manipulatives). According to Uttal, Scudder and DeLoache (1997), young children learn best through interaction with concrete objects (manipulatives) which are designed to specifically help them to learn numeracy.

Uttal et al. (1997) further emphasized that “whether concrete objects are termed manipulative, concrete materials or physical materials, they are widely recognized as critical to the improvement of numeracy learning” (Ball, 1992:16). Feeney, et al. (2013) concurred and suggested that every classroom should have enough TLMS for the number of learners accommodated. TLMS usually refer to smaller, less expensive items such as puzzles, games, books and toys. It should also be noted that the TLSM stimulate the achievement of numeracy outcomes through active learning (DoE, 2003; Miller, 2002; Van Luit, 2000). When the school is not in the position to provide the TLMS, teachers should improvise and make their own TLMS from waste material to engage learners in play activities in order to learn mathematics concepts effectively.

Gordon and Browne (2014) indicated that the lack of TLSM can create passive and unhappy learners due to boredom. An analysis of the national studies (DoE, 2008) regarding South African public schools; particularly in predominantly rural communities (Karlsson, 2008/2009) confirmed this claim, highlighting that lack of TLSM can influence learner achievement in mathematics in South African schools. The findings of the Systemic Evaluation at Grade 3 level (DoE, 2001 and 2007) further validates that learners

in schools with more TLSM obtained higher scores than learners in schools with less learning material (DoE, 2009). In a similar point of argument, Botha, Maree and De Witt (2005) highlighted that 40% of children in South Africa (SA) are rarely exposed to appropriate TLSM in their classrooms, due to the fact that they live in extremely impoverished circumstances.

Botha et al. (2005) Peters and Young Love-Ridge (1994) indicated that young learners also need physical activities during numeracy lessons. For example, teachers can provide geometric shapes in class for learners to handle and play with, grouping the shapes according to colour, size or type. Harries and Spooner (2000) suggested that the physical resources improve support for the development of numeracy concepts.

When learners explore concrete learning materials, they also develop discovery learning (Cobb, Wood, Yackel & McNeal, 1992; Saxe, Guberman, & Gearhart, 2000). According to Van de Walle (2007) discovery learning assists learners to explore the learning materials and to construct their own learning. Concrete learning materials describe educational tools such as counters (commercially acquired or teacher made), abacus, and mini clocks (Cristol, 2003; Van Luit, 2000).

Grade R teachers should provide concrete learning materials (manipulatives) during numeracy lessons thus assisting learners to construct knowledge and skills to operate in their everyday lives. In this sense learners can use coloured beads and coloured bottle caps for sorting according to colour, compare the groups to learn the concept of more and less. In addition, Martin, Lukong and Reaves (2007) confirmed that concrete learning materials sustain the development of mathematical/ numeracy concepts. In a similar thread of argument, Geoghegan (2002) and Peters and Young-Loveridge (1994) suggested that learning materials such as Legos (construction blocks) and card games help learners to promote their mathematical thinking from a young age. In addition, Charlesworth and Lind (2013) and Maclellan (2001) highlighted that mathematics begins with the handling and exploration of learning materials such as construction blocks, manipulatives, as well as toys.

Kennedy and Tipps (1994) suggested that the concrete learning materials (manipulatives) make even the most difficult mathematical concepts easier to understand. Kennedy and Tipps further indicated that manipulatives enable learners to connect abstract numeracy

concepts to real objects. In this sense, mathematics researchers worldwide have found that numeracy is better learned, and should be taught by engaging the learners in handling manipulatives to develop mathematical concepts (DoE, 2008; Naudé & Meier, 2014). Additionally, Martinez (1987) claimed that manipulatives can provide a cure for maths anxiety among learners.

The TLSM in my understanding are essential in teaching and learning numeracy because learners associate them with real life situations which they understand better. It is therefore important to note that several learning materials can be used to enrich teaching and learning numeracy and can also be integrated into different activity areas of Grade R classrooms, such as dramatic play, mat work or in the game center.

Gerdes et al. (2013) Naudé and Meier (2014); Van de Walle and Lovin (2006) suggested some of the TLSM that enrich numeracy/mathematics learning are:

- Card games for identifying colours, shapes and patterns. Teachers should assist learners to identify patterns in clothing, for example, lines (stripes), and circles among others to incorporate patterns into everyday experiences and thus make patterns meaningful to children.
- Real and pretend money to help learners begin to understand the value of money and practice basic addition and subtraction.
- Board games as tools for counting, adding, and subtraction. Games such as up and back counting, counting on, and patterns on the hundreds chart are essential for enriching numeracy learning.
- Card games to help learners identify numbers and figure out which numbers represent more or less than other numbers (for example, 9 is more than 5).
- Nonstandard (sticks, strings and fingers) and standard units of measurement (rulers, and grams) can be used to facilitate concepts of tall and short.
- A scale for weighing objects in the classroom can be in the discovery area. Learners can weigh the material on the discovery table and begin to understand weight and balance.
- A collection of materials for (sorting and counting) should be provided throughout classroom.

Bodrova and Leong, (2003a) concurred with the claim and highlighted that when young learners play with concrete learning materials they become competent in numeracy skills such as classification, stacking and constructing (Fox, 2002; Stager, 1999). Furthermore, Bergen (2000); and Bodrova and Leong, (2003a) emphasized that the use of concrete learning materials also assists learners to develop the ability to enumerate small sets through counting, ordering numbers in the correct sequence, and establishing one-to-one correspondence between number names and objects counted (Bergen, 2002; Bodrova & Leong, 2003a). It can be argued that most learners in FP learn best if they use concrete learning materials and educational tools in teaching and learning numeracy. Grade R teachers in my opinion, should provide a range of concrete TLSM to engage learners in active learning in order to develop their own numeracy knowledge. Learners can handle and play with TLSM in structured play activities to understand the numeracy concepts effectively.

Uttal, Lui, and DeLoache, (2005) however, cautioned teachers against overusing concrete learning materials. The researchers also suggested that learners should not rely on using such materials for modeling numbers, but should rather be assisted to develop mental pictures associated with these materials. Askew (1997) confirmed that practical work on its own is not enough and should have an element of „in the head“ (understanding) to avoid giving young learners the impression that mathematics is only taught through practical work. In a similar vein of argument, Fox (2002) also advised that the choice of educational tools alone cannot ensure the successful development of numeracy knowledge. According to the Department of Education (2008), teachers should realize that the learning materials must be displayed in various activity areas that are easily accessible to all learners in the classroom.

In my personal opinion, participation in a learner-centered classroom environment is indispensable. This is because it assists Grade R teachers to display a range of TLSM to encourage learners to participate in the numeracy activity area and achieve numeracy outcomes. Learners can participate actively in matching, sorting and sequencing games. Through these play-based activities (games) Grade R learners can accordingly develop the concepts of more, less and the same as well as ordering to learn first, second and last among others.

2.3.1.4 Displays

Carruthers and Worthington (2006) have shown that displays can be an important resource that assist Grade R learners to develop numeracy knowledge and skills.

Teachers should brighten the classrooms by displaying children's work on the classroom walls and other parts of the classroom. According to Quinn et al. (2000) most of the wall displays should be utilized for children's own work, or charts made by the teacher, which must be replaced from time to time.

Additionally, Donald et al. (2005) agreed that there should also be display and shelf space in Grade R for items that have been made by learners. These must be displayed at locations and heights that are accessible physically and visually to all learners in the classroom (Quinn et al., 2000). It should be noted that when learners become involved in the preparation and participation of wall displays and putting them up, this can serve to be a valuable learning activity. Additionally, Donald et al. (2005) indicated that teachers should put up the learners' own pictures and drawings representing numbers to offer positive messages, indicating that the child's ideas and effort are valued (Naudé & Meier, 2014). Learners can thus for example, respond to a question, a drawing, or an idea with regard to the displays. The involvement of learners in creative and practical activities maximizes the quality of teaching and learning provided through the curriculum.

2.3.2 Teachers' Implementation of the Grade R Numeracy Curriculum

This section focuses on the literature regarding how teachers implement the numeracy curriculum in Grade R classrooms of South Africa. It also considers the relative short history of classroom-based studies in South Africa, which provides the context for discussing curriculum implementation.

2.3.2.1 The Grade R Numeracy Curriculum

The numeracy curriculum in Grade R provides the framework through which teaching and learning activities relevant to the child are created (Bennie & Newstead, 1999; Copple & Bredenkamp, 2009; DoE, 2002, 2003). The numeracy curriculum is the source of numeracy knowledge, skills and orientation regarding learner's everyday lives (DBE, 2011; Meier & Marias, 2007; UNESCO, 2009). The aim of numeracy curriculum in Grade R is to help learners acquire knowledge and skills that promote their number sense (number knowledge). The curriculum also puts emphasis on maximizing the learners' potential to learn numeracy concepts effectively and lay a strong foundation for teaching and learning mathematics in the advanced grades (Bennie & Newstead, 1999; DBE, 2011; Shumway, 2011).

After the first democratic elections in 1994, South Africa implemented a new national curriculum to provide quality education to its citizenry who were disadvantaged by the previous dispensation (apartheid) (DoE, 2002; UNESCO, 2009). Grade R teachers have thus implemented the numeracy curriculum since 2002 (DoE, 2003; UNESCO, 2006). This suggests that the teachers should implement an integrated planning of learning activities competently, through which numeracy knowledge and skills in Grade R classrooms are developed (DBE, 2011; Naudé & Meier, 2014).

Dwyer, Christie, Chait, & McKee (2000) agreeably highlighted that the integrated Grade R numeracy curriculum should cut across learning programmes (LP) to maximize teaching and learning opportunities. According to the DoE (2002, 2003); Dwyer et al. (2000) the Grade R teaching and learning experiences should be derived from the numeracy LP and encourage direct, first hand, and interactive learning with natural and manipulative vocabulary.

In addition, the DBE (2011) Dwyer et al. (2000); DoE (2002, 2003) pronounced that teachers should provide a numeracy curriculum that incorporates the following content:

- instructions and practice in the recognition of numerals;
- counting objects;
- naming and describing shapes;
- reproducing and extending simple patterns;

- using basic measurement tools; and
- collecting and organizing information.

Doig et al. (2003) argued that the Grade R numeracy curriculum should also include simple geometric figures comprised of copying a series of simple geometric shapes and write some numbers. The curriculum should also develop children's understanding of key vocabulary.

In view of the above, I believe that there is a need for Grade R teachers to unpack topics from the numeracy LP that can assist learners to acquire knowledge and skills aligned to the Grade R numeracy curriculum. In this sense learners will develop numeracy concepts from the integrated content stipulated in the numeracy curriculum. This can be achieved through the opportunities afforded to learners by the teacher to work with number cards, number charts and number lines to recognize, read, write, count as well as order numbers amongst others (DBE, 2011; Naudé & Meier, 2014; UNESCO, 2006).

2.3.2.2 The scope of teaching and learning numeracy curriculum in Grade R

The Grade R numeracy curriculum focuses on the development of knowledge and skills among Grade R learners (DoE, 2003; NEACY, 2002). Furthermore, the (DBE, 2011; NEACY, 2002) stated that the numeracy curriculum aims at developing the following in the learner:

- Critical awareness of how mathematical relationships are used in social, environmental, cultural and economic relations;
- Confidence and competence to deal with any mathematical situation without being hindered by fear of mathematics;
- A spirit of curiosity and love of mathematics;
- Appreciation for the beauty and elegance of mathematics;
- Recognition that mathematics is a creative part of human activity;
- Deep conceptual understanding in order to make sense of mathematics; and □
Acquisition of specific knowledge and skills necessary for:

- The application of mathematics to physical, social and mathematical problems;
- The study of related subject matter (for example, other subjects); □ Further studies in mathematics.

According to the South African national curriculum framework RNCS and (NCS), teaching and learning numeracy in Grade R should be planned through structured activities, emanating from the five (components) learning outcomes (LOs) or content areas (CAs) of the numeracy LP (DoE, 2003, 2002; Dwyer, chat, & McKee, 2000; NAEYC, 2002, UNESCO, 2006). The five mathematics components are identified as follows:

i) **Numbers, operations and relationships:** this is the first CA which suggests that Grade R teachers should create opportunities for learners to develop the number concept through working with physical objects, for example counting a collection of objects in order to solve word (contextual) problems; ii) **Patterns and functions (algebra):** this is the second LO/CA, that assists Grade R learners to copy and extend simple patterns using physical objects and drawings (shapes and colour) in order to create their own patterns and develop the concept of pattern making; iii) **Space and shapes (geometry):** the third LO/CA assists Grade R learners to recognize and describe objects and shapes in the classroom environment that resemble mathematics objects and shapes. Grade R teachers should thus create opportunities to learn numeracy through practical (doing), handling the objects and shapes (cutting and drawing), as well as describing them using appropriate and expanding mathematical vocabulary to describe;

iv) **Measurement:** is the fourth LO/CA that assists learners to develop the concept of measurement by working practically with different concrete objects and shapes. Grade R teachers should assist learners to develop appropriate vocabulary to describe and compare the different objects and shapes they handle in the classroom (for example „shorter than“; or „longer than“).

v) **Data handling:** through the last LO/CA, Grade R teachers should create chance for learners to handle and sort through various features of objects or data. Learners should thus be able to represent data involving a one-to-one correspondence.

a) The teacher as facilitator of learning

Cobb, Yackel, and Wood (1992) have shown that Grade R teachers should implement their own Learning Programme to facilitate teaching and learning numeracy. This suggests that teachers should develop their own programmes of teaching and learning activities guided by NCS policy framework (Meier & Marais, 2007). The numeracy learning programme thus creates many unique opportunities for teachers to build relationships with learners (Othman & Kadir, 2004). According to Killien (2006), this suggests that the teachers' responsibilities have shifted from a traditional dominant information transmitter to that of a facilitator of knowledge.

In my opinion, Grade R teachers should design a variety of teaching and learning activities emerging from the numeracy LP to equip learners with knowledge and skills regarding numeracy concepts, namely counting numbers, measuring time or capacity, and representing data in pictography amongst others. When learners engage in teaching and learning activities embedded within the numeracy LOs/CAs, their opportunity to achieve numeracy outcomes can be maximized.

b) The teacher as Designer of Learning Programmes and Materials

The South African Curriculum and Assessment Policy Statement for Grade R (CAPS) emphasized that teaching and learning numeracy in Grade R should be realized through play (DBE, Mathematics, 2011; Meier & Marais, 2007). As a confirmation, the Life Skills policy explicitly states that Grade R learners should be offered ample time to learn through play rather than spending time sitting behind desks engaged in formal work (DBE, Life Skills, 2011). This suggests that the DBE (2011) offers guiding principles to teachers through which play-based learning should be implemented within the Grade R mathematics curriculum framework (DBE, 2014, 2011; DoE, 2003, 2002).

According to Botha et al. (2005) Killien (2006) Meier and Marais (2007), Grade R teachers should organize teaching and learning activities through the LP that describes what learners should achieve during teaching and learning numeracy. According to DoE (2003)

the numeracy LP translates into a year-long, grade specific work schedule and lesson plans containing short teaching, learning and assessment activities for Grade R. In this sense, the LP clarifies what Grade R teachers and learners actually do in the classroom to achieve the numeracy/mathematics outcomes. The numeracy LP in Grade R is thus integrated with the daily routines to indicate how teachers are implementing the numeracy curriculum.

A ministerial statement of Pandor, the former Minister of Education in South Africa (DoE, 2008) and Clasquin-Johnson (2011) have shown that Grade R teachers, particularly in South Africa, face immense challenges of implementing play-based learning. Pandor and Clasquin-Johnson further indicated that although the South African DBE Curriculum Policy is intended to provide a framework for teaching Grade R numeracy through active and play-based learning, the opposite case is actually observed in reality.

Based on the challenges facing Grade R teachers as stated above, I consider the need for professional development programmes as crucial in training Grade R teachers to design play-based teaching and learning for developing numeracy knowledge and skills. The teachers can ultimately develop self-confidence in implementing play-based learning through ongoing professional development training programmes.

2.3.2.3 The Integration of the Grade R Daily Programme with Teaching and Learning Numeracy

The DBE (2011) and Naudé and Meier (2014) showed that teaching and learning of numeracy in Grade R classrooms should be organized through a daily programme. The daily programme is a Grade R timetable that describes the way in which the teaching and learning activities and time should be organized throughout the day. It is important to note that the daily programme incorporates three main components, namely: teacher-guided activities (Whole-class), routines (Whole-class) and child-initiated (Small-group) activities (DBE, 2011; Naudé & Meier, 2014).

Teacher-guided activities on one hand (Gordon & Browne, 2014; Shumway, 2011) take the form of play-based activities the teacher presents according to planned curriculum, for example number recognition (identifying quantity using number name five, matching it with number symbol 5, dot card with 5 dots and 5 stones). Routine activities on the other hand (DBE, 2011; Morrison, 2013) include all the daily activities that are done regularly for a specific purpose, e.g. bathroom time, or snack time through which the concept of „waiting for a turn“ is learnt. In addition, child-guided activities (DBE, 2011; Naudé& Meier, 2014) occur during free play through which the teacher presents activity areas such as sand and water play to learn the concepts of capacity (for example full and empty) amongst others. Teaching and learning numeracy activities in Grade R are integrated with components of the daily programme to promote the acquisition of emergent numeracy.

Emergent numeracy refers to knowledge and skills that precede mathematical learning; for example, counting, recognizing and working with patterns and measuring time (DBE, 2011; Naudé& Meier, 2014). This allows Grade R learners to discover mathematical concepts through structured play activities (DBE, Life Skills 2011), such as threading beads according to a given pattern, and card games amongst others (DBE, 2011; Naudé& Meier, 2014). The acquisition of emergent numeracy in my view provides a proper basis for problem solving skills among Grade R learners. It is thus important for Grade R teachers to create an environment conducive to encourage signs of numeracy readiness through which learners can express a willingness to count, telling time and wearing a wrist watch, as well as trying to write numbers.

In a personal sense, Grade R teachers should appreciate the value of structured play activities through which numeracy concepts are learned effectively. They should frequently engage Grade R learners in structured play activities which they enjoy because they learn through „doing“ and „playing“ in order to develop the basic knowledge and skills in regards to numeracy concepts.

2.3.2.4 Teaching numeracy in Grade R

Meier and Marais (2007) and Van de Walle et al. (2010) found that numeracy is an essential skill of young children's everyday lives. Meier and Marais further stated that Grade R learners should thus be given the opportunity to use basic numeracy concepts such as one-to-one correspondence, problem solving, reasoning and critical thinking skills to develop a number sense. Learners can, for example develop the ability to know that there is one apple for each learner during snack time (DBE, 2011; Naudé & Meier, 2014).

According to Gelman (2000); and Geary (1996) numeracy knowledge in the early years develop naturally and universally. Naudé and Meier (2014); Osana and Rayner (2010) agree that the learning experiences in Grade R should include play-based (informal & incidental learning) activities that promote concept acquisition on topics conveying quantity and number, counting, addition and subtraction amongst others. In addition, Baroody and Lai, (2006b) and Sun Lee and Ginsburg (2007) stated that teaching and learning numeracy should also contain informal knowledge which assist learners to become competent in acquiring more complex mathematical concepts and skills. The relationship between the frequency of early numeracy experiences and later performance in school mathematics is apparent (Blevins-Knabe, 2008; Naudé & Marais, 2014; Starkey & Klein, 2000). Grade R teachers should in my personal view, appreciate the significance of a well-structured classroom in facilitating the self-confidence of learners and improve the quality of learning.

Blevins-Knabe, Berghout, Musun-Miller, Eddy and Jones (2000); Clements and Sarama (2009b, 2007a); found that Grade R learners in the global society (predominantly from disadvantaged communities) do not frequently engage in numeracy activities or play with objects that represent numerical relationships before they are enrolled in Grade 1. In view of that fact, these scholars recommended that one way to increase the frequency in which Grade R learners engage in numerical thinking is to include learning experiences that promote concept acquisition through play, for example sorting shapes to develop colour pattern (such as two green and three yellow and repeating the same pattern a few times) during free play (Gordon & Browne, 2014; Shumway, 2011). It is important to note

that “During play learners enjoy the activity, and improve their self-esteem and through play learners can repeat and rehearse reality until they understand” (Naudé & Meier, 2014:52).

Young children learn by doing and actively engaging with teaching and learning materials (TLMS) in their classroom environment. In this sense I believe that stakeholders in early childhood education (curriculum advisors and cluster officers) should train Grade R teachers in creating the physical classroom space that provides TLMS and a developmental context through which numeracy learning can be maximized. The teachers can also be trained to explore various types of raw materials that can be used to make TLMS to engage learners in active learning.

Numerous scholars, Clements and Sarama (2009b, 2007b); and Carpenter, Franke, Jacobs, Fennema, and Empson (1998) also pointed out that the teaching and learning experiences in Grade R should include contexts that support the development of fundamental numeracy concepts such as problem solving. Greens, Ginsberg and Balfanz (2004) Osana (2010) Griffin (2004) Sarama and Clements (2004) suggested in this light that when Grade R learners directly engage in hands-on tasks, they incidentally (informally) learn the number concept, such as measuring capacity (for example, coloured or soapy water) to develop the concept of full, half-filled and empty (active learning).

Kamii and Kato (2005) similarly recommended the implementation of board games, while Clements and Sarama (2009a, 2007b); Jennings, Jennings, Richey, and Dixon-Krauss (1992) acknowledged story book reading in the classroom as a means to show positive effects on the development of numeracy knowledge, for example, grouping and comparing objects to determine a set with less and more. It is important to note that most of the games learners play convey important mathematical concepts such as how different numbers relate to one another, one-to-one correspondence and problem solving (Kühne, et al., 2013; Naudé & Meier, 2014).

In my view, it is imperative to note that Grade R teachers should select tasks that engage learners in structured play and games incidentally (informally), to develop the basic knowledge of the number concept. In this way, the teachers are therefore able to provide learners with developmentally appropriate activities which they enjoy, understand and thus enhance their learning experiences.

2.3.2.5 The Development of Number Concept in Grade R

Bredenkamp (2011); Clements and Sarama (2009a; 2009b); and Ginsberg (2008) have illustrated that learners in the early years have a natural inclination to discover numbers. Bredenkamp and Ginsberg further indicated that learners use numeracy as a fundamental way of understanding and describing the basic number concept. The purpose of numeracy in Grade R classrooms is to enable learners to make sense of numbers and to become numerate citizens (DoE, 2002, 2003; Reys, Van de Walle, et al., 2010; Shumway, 2011).

According to Baroody and Li (2009a); Naudé and Meier (2014), the development of number knowledge and skills in Grade R entails components such as conceptual understanding and procedural fluency; for example, counting skills or manipulating concrete objects to make sense of how the number concept works (Naudé&, Meier, 2014;Gordon & Browne, 2014; Shumway, 2011; Van de Walle, 2007). Conceptual understanding of numbers on one hand consists of logical relationships constructed internally and existing in the mind as part of the network of ideas. Procedural fluency on the other hand is a mathematical skill acquired by people when they carry out mathematical procedures flexibly, accurately, and competently (Naudé& Meier, 2014; Van de Walle & Lovin, 2006). In my assessment, learners need both conceptual and procedural knowledge in order to relate the existing knowledge with the new knowledge.

The study of Kilpatrick, Swafford, and Findell (2001); and Shumway (2011), found that young learners can engage in numerical concepts including multiplication, division, measurement and Algebraic reasoning to develop mathematical proficiency (Bastable & Schifter, 2007; Mulligan & Mitchelmore, 1997). This notion describes the ability of learners to think and reason mathematically. From these claims, it is apparent that there is a strong relationship between the frequency of early experiences and later performance in school mathematics (Blevins-Knabe & Musun-Miller; 1996; Dearing, McCartney, & Taylor, 2009; Le Fevre, Skwarchuk, Smith-Chang, fast, Kamawar, & Bisanz, 2009).

According to Charlesworth and Lind (2013); Clements and Sarama (2009b); and DBE (2011), there are six different basic processes of working with numbers; namely: matching objects with a common property, sorting them into sets with the property, including those

that do not have the property, ordering and comparing the objects into the relevant set, recognizing, reading and writing number names in conventional order, pairing the ordered objects with number names in order; as well as using the final number name cardinally to describe the set of objects counted.

Naudé and Meier (2014); and Van de Walle (2007), pointed out that FP learners in general and Grade R in particular, develop the number concept through their understanding of how the quantities they count can be represented in different ways. Furthermore, learners in the early grades realize that they should represent numbers physically, verbally and in writing in order to communicate their thoughts about numbers. Naudé and Meier and Van de Walle further indicated that the counting skills become more complex when learners make a connection between quantities (e.g. 4 objects), number names (e.g. four) and a number symbols (e.g. 4). It is important to note that learners often struggle to master the connection of number representation and therefore need multiple opportunities to make the connection between the quantities, number name, as well as the number symbol represented.

This in my observation suggests that teachers should identify learners with mathematical problems as early as in Grade R and develop intervention strategies to address the problem areas and enable learners to learn mathematics competently in higher grades. This is a recommendation for Grade R teachers to create a conducive environment through which numeracy can be learnt.

DBE (2011); Reys, Lindquist, Lambdin, Smith and Suydam (2009) and Van de Walle et al. (2010) found that learners progress in different levels when they represent numbers in order to develop the number concept, namely: concrete level, semi concrete level, and the abstract level.

When learners are using concrete objects to represent quantities on one hand, they operate at the concrete level of understanding numbers. The researchers goes on to indicate that teachers should provide real objects at this level such as five (5) oranges to assist learners count the oranges physically and draw the five (5) oranges on a one-to-one correspondence basis (pairing or matching objects) in a one-to-one relationship (Clements & Sarama, 2009a; Naudé& Meier, 2014).

The semi-concrete level on the other hand develops when learners begin to use pictures to represent numbers or quantities and have had much experience in handling and playing with concrete materials (Gordon & Browne, 2014; Shumway, 2011; Van de Walle & Lovin, 2006; Van den Heuvel-Panhuizen, Kühne & Lombard, 2012). The final phase of development of representing numbers and quantities is the abstract level. At this stage, learners understand that one written symbol can be represented in the form of tallies, (dots) and dominoes (DBE, 2011; Naudé& Meier, 2014).

The final stage (abstract) symbolizes a conceptual understanding of quantity and numbers because at this level, the learner realizes that one single symbol, for example (four) 4, can be used to represent (four) 4 objects, (four) 4 pictures, or one tally, that is resemblance of five or ten lines (Naudé& Meier, 2014; Van de Walle et al. 2010).

It may be argued that Grade R teachers should engage learners in a variety of concrete learning experiences to help them construct their own numeracy knowledge. Learners will be well prepared to learn advanced mathematics content in the higher grades, when they play with a variety of numeracy TISM and games to support the achievement of numeracy outcomes.

□ Counting

Many mathematical concepts that learners acquire in the early years are related to counting. Counting is an important skill for problem solving, particularly in Grade R. It refers to the process of matching a number in an ordered sequence with every element of a set (Naudé& Meier, 2014; Reys et al. 2009).

It is important to note that since counting is a strategy for finding answers to early addition, subtraction, division as well as multiplication activities, Grade R teachers should involve learners in counting activities such as counting forward and backwards from different starting points, breaking numbers into different groups, counting in multiples of 2s, 3s and so on; estimation and knowledge of how numbers are made up of different groups (DoE, 2002; DBE, 2011; Naudé& Meier, 2014). These skills enable learners to develop fluency in working with numbers or doing calculations. It is against this backdrop that counting is regarded as a vital part in the formation of a stable number concept and lays the

foundation for the development of all numerical concepts in general (Van de Walle et al. 2010; Reys et al. 2009).

The argument presented above suggests that Grade R teachers should provide a wide range of TLSM counting activities, namely snap cubes, magnetic numbers, foam number cubes, dominoes, bottle caps, number blocks, and sticks amongst others. The concrete TLSM can create many opportunities for Grade R learners to learn counting with enjoyment and understanding. These counting activities will prepare Grade R learners to participate in more complex and progressive mathematics learning in the grades beyond Grade R.

□ **Matching**

Learners develop concepts spontaneously by recognizing and selecting properties that are common to a range of their experiences. Matching objects using colour assists learners to use their concept of colours such as green, blue, yellow and red to describe those concepts. In addition, teachers should provide learners with suitable language to describe the common properties that they recognize, for example, „big“, „bigger than“ and „small“, „smaller than“ (Kühne, et al. 2013; Van de Walle, 2007). It should be noted that the initial matching activities for Grade R learners should involve concepts they have already formed or are likely to be able to form immediately, for example, selecting apples from a collection of fruit. They can also select a red ball out of a collection of balls. The purpose of such activities is to make learners aware that common properties are essential in matching activities.

In view of that, teachers should provide learners with sufficient practical matching activities essential for concept formation.

□ **Sorting**

Sorting is an activity that often arises during free play as well as during tidying up after play. It involves picking and breaking up a set with common properties into new sets of matching individuals (Van De Walle & Lovin, 2006; Van de Walle, et al. 2010). Teachers

should provide learners with an opportunity to sort resources according to size, shape and colour in order to form the appropriate numeracy concepts.

□ Ordering

Ordering often arises in play activities such as story lines involved in ordering quantities (for example, three little pigs, Goldilocks and the three bears). Ordering numbers means showing the relative position in a sequence of numbers by ordering objects in a set, for example, the first, second and third (Charlesworth & Lind, 2013; Bredenkamp, 2011). It is against this background that Teachers can involve learners in ordering toys or pictures (such as pigs and bears) in a row focusing their attention on the vocabulary „first“, „second“, and „last“, to describe the sequence.

□ Recognize, read and write numbers

According to Wright et al., (2006) learners need numerous opportunities of first-hand experiences of working concretely with numbers (primary presentation), observing everyday objects such as toys and food items being handled and shared among learners in class during snack time, for instance. Naudé and Meier (2014) confirm that this assists the learners to make a connection between number names (for example, three); number symbol (for example, 3) and quantity (3 objects/apples). Teachers should in addition, design activities that involve learners in singing/reciting rhymes that underlie the learning of number names, for example, „one, two, buckle my shoe..., three ..., and so on. Learners can also be involved in meaningful counting, identifying numbers, for example 5 in various contexts; on the door, on the shoe, a picture book and so forth indicated that young Grade R learners can experience difficulty in problemsolving when required to apply their counting skills.

It should be noted that teachers should engage learners in well-designed and thoughtful problem-solving strategies, such as pointing, writing, drawing and making gestures, to allow them to demonstrate their knowledge in specific number concepts.

□ Pairing

Pairing is also a basic activity essential for introducing number concepts to young Grade R learners, using precise terms relating to numbers such „as many as“, „more than“, and „fewer than“. Pairing refers to „one-to-one correspondence“ (Kühne, et al. 2013; Charlesworth & Lind, 2013).

Grade R teachers should recognize the value of engaging Grade learners in pairing activities which encourage active involvement such as dramatizing rhymes and songs, comparing quantities on a balancing scale to determine the concepts more and less. The concrete learning experiences allow learners the opportunity to actively participate in their learning. The teachers should also realize the need of the physical arrangement of the TLMs to assist learners to have easy and open access to the materials that are used to support teaching and learning.

2.3.2.7 Challenges in Numeracy Learning

Landsberg (2005) found that one in seven learners experience mathematics problems at school. Landsberg further indicated that most of these difficulties are discovered in the learners' first year of school, namely, Grade R. Additionally Landsberg indicated that the first symptom of mathematical difficulties is evident through learners' tendency to avoid mathematics because it causes anxiety. Such learners are also identified through confusion during numeracy lessons, because they work very slowly and spend time thinking before solving a problem at hand.

Clements and Sarama (2009b); and Landsberg (2005) also found that Grade R learners mainly work on a low level numeracy content. Low level content refers to straight forward strategies for learning numeracy, for example, “Mary has 5 coloured pencils and she gets 5 more, how many coloured pencils does she have altogether”? As learners with mathematics problems work very slowly and often make errors, they would experience

difficulties even with the simplest problem sum indicated above. Landsberg accentuated that the learners could make use of dots or counts on their fingers to get the correct answer.

The study of Naudé and Meier (2014) and Reys, et al. (2009) highlights that learners need constant exposure to, and practice with counting sequences to become fluent with counting. The ability to count fluently assists learners with counting to become acquainted with and making sense of numbers. In addition, Shumway (2011) and Van den Heuvel-Panhuizen, et al. (2012) indicate that counting proficiency includes understanding counting sequences, recognizing and using counting patterns, as well as using additive and multiplicative ideas.

Reys et al., (2009); and Clements and Sarama (2009b) suggested that teachers should observe learners closely counting objects to determine if they are counting with understanding. The scholars further explained that teachers should thus determine whether learners say a number while they are touching the object and whether they say the number sequence in the correct order. In addition, teachers should find out if learners skip some counters while counting. This can enable learners to perfect their counting skills which influence their competence in numeracy learning.

According to Clements and Sarama (2009b); and Landsberg (2005); if an error occurs during teaching and learning numeracy, teachers need to attend to that specific kind of a problem in order to close the learning gap. Landsberg further indicated that if a learner cannot achieve a specific learning outcome for a grade, the learner may not be able to achieve the learning outcomes for a higher grade. Some of the challenges Grade R learners experience in numeracy learning are:

- i) Problems sorting objects according to different colours; ii) Counting slowly because they first have to decide which number follows in the counting sequence;
- iii) Cannot relate simple numeracy concepts to their daily life situations (Landsberg, 2005).

It may be argued that counting is thus one of the foundational skills young learners need in order to learn numeracy competently. When learners are competent in counting

activities, they are likely to develop understanding of the basic numbers and develop problem solving skills in their daily lives.

2.3.2.8 Research on South African Grade R Classrooms

According to Hoadley (2012), teachers in South African Grade R classrooms adopted authoritarian roles and did most of the talking (teacher-centered), during teaching and learning. Furthermore, learners' responses were mostly in the form of whole group chorsing (speaking together). Hoadley goes on to highlight that the chorsing and rhythmic chanting in the classrooms hinder individual performance. Chorsing has been found to be a strategy to disguise learners' lack of understanding of academic content. Muller (1989) agreed, declaring that South African classrooms are also characterized by drill work and rote learning derived from an analysis of the social status under apartheid before the 1994 democratic era (the segregation of South African citizens according to colour, language and gender among others).

The survey done by the DoE (2009) established Grade R classrooms in most South African learners sit in formal desks like Grade 1 learners. It should be noted that the Grade R learners in these classrooms are engaged in structured teaching and learning activities. The national curriculum in South Africa however, suggested that Grade R learners should engage in learner-centered activities during teaching and learning numeracy which are focused on the learner (DoE, 2003; NAEYC, 2000).

Botha et al. (2005) Wagmeister and Shiffrin (2000) found that before the implementation of the new national curriculum, Grade R teachers in South African schools did not plan for teaching and learning numeracy in a structured way. Botha et al. also found that the teachers also did not integrate numeracy activities with the daily programme for Grade R, they however, taught numeracy through counting rhymes and shapes or even referred to numeracy concepts informally (incidental learning). In my view, these activities contribute towards the development of emergent numeracy, which includes cognitive development (problem solving) and language development (the language of

mathematics). Grade R teachers should thus be trained to engage learners in structured play activities to develop basic number concept effectively.

After the transition to a democratic state in 1994, and the implementation of the postapartheid curriculum, a President's Educational Initiative (PEI) was undertaken in 1998 (NAEYC, 2002; Taylor, 2008a; UNESCO, 2006). The PEI showed that teachers lacked knowledge to interpret the new national curriculum. The Former Minister of Education

Ms Naledi Pandor, concurred and indicated that "we recognize that teachers are still struggling to translate the curriculum into good classroom practice" (DoE, 2008:4). This suggests that Grade R teachers should be offered continuous teacher development training to close the knowledge gap to address the challenges of implementing the new national curriculum. The South African DoE also found that although teachers were implementing forms of „learner-centered“ approaches and co-operative learning, there was very little learning actually taking place in the classrooms. The overview of classroom-based research in South African Grade R classrooms, provides the context for discussing the influence of the classroom environment on the achievement of numeracy outcomes.

2.4 The Influence of the Classroom Environment on Approaches Grade R Teachers Employ in Teaching Numeracy

Academic achievement has become a phenomenon of interest in the global society and this accounts for the reason scholars have been working hard to improve numeracy achievement (Babatunde & Olanrewaju, 2014). Previous scholars, Boaler (1999) and Moloi and Strauss found that the influence of the classroom environment upon the development of numeracy learning in the early years need attention. Cobb & Hodge (2002) substantiated this claim, highlighting that what happens in the classroom influences teaching and learning. Cobb & Hedge further stated that the activities in the classroom, the repeated actions in which learners and teachers engage as they interact during numeracy lessons are important because they generate knowledge and skills.

2.4.1 The Impact of Class Size on Numeracy Outcomes

Studies by Achilles, Finn and Bain (1998) Bedard and Kuhn (2008) investigated the influence of class size on teaching and learning numeracy in FP classrooms. The results have shown that smaller classes lead to better numeracy outcomes in the early years. According to Finn and Achilles (1999) small classes provide conducive environment for better mathematics achievement. Research studies confirmed consistent improvement of mathematics achievement in small classes (Finn & Achille, 1999; Folger, 1989; Zahorik, 1999). In addition, reduction in class size positively benefits children from disadvantaged and minority communities. Additionally, smaller classes allow teachers more time to work with individual learners and enable them to provide differentiated (group) learning (DBE, 2010; DoE, 2009).

Class size refers to educational tools that can be utilized to describe the average number of learners per class in a school (Achilles et al. 1998; Babatunde & Olanrewaju, 2014; Finn & Achilles, 1999). The improvement in children's learning outcomes was evident where classes have been reduced to the enrolment of 20 learners or less in properly planned, recorded and well implemented initiatives (Capel, Leask & Turner, 1994; Finn & Achille, 1999; Slavin, 1989). The value of a small class in teaching numeracy cannot be underestimated because it assists teachers to give individual attention in order to deepen learning.

Smith and Glass (1978) confirmed that small classes were associated with higher achievement. The results have also revealed that learners in smaller classes perform better on standardized tests in mathematics and reading in Grade R-3. Additional studies, Nye, Hedges and Kostantopoulos (2001) found that large class size is not conducive for numeracy outcomes.

Educational Research on class size has also played a prominent role in the state and local education policy. During the 1990s, state legislature (law makers) and school boards worldwide funded legislation (law) to reduce class size in the early grades as a strategy

for improving learner achievement (Achilles & Lintz (1991; Achille& Hanusshek, 2002;Jeremy, Pannozzo, Achille & Hanusshek, 2002).

It can be argued that South African teachers have a challenge of teaching large classes. The achievement gap in crowded classrooms need continuous intervention strategies to improve teaching and learning numeracy. South African Grade R teachers in my opinion are in need of training through professional development programmes in creating activity areas and displaying appropriate numeracy TISM in the classroom to engage learners in active learning. The activity areas in numeracy classrooms offer learners a range of choices during play-based activities to develop numeracy knowledge.

2.4.2 The Influence of Approaches Teachers Use on Teaching and Learning Grade R Numeracy Outcomes

There are a few studies found, focusing on how different teaching methods affect learner achievement in Grade R. Aitkin and Zukovsky (1994) DBE (2011) and Wentzel (2002), have shown that different teaching methods can have different outcomes on the learning achievement. In addition, the study of Ensor, Hoadley, Jacklin, Kühne and Schmitt (2008) found a positive relationship between achievement, varied classroom settings, as well as teaching approaches used in Grade R classrooms.

2.4.2.1 Play-based Approaches

The early childhood curriculum, the DBE, Mathematics and Life Skills in particular (2014, 2011) Naudé and Marais (2014) clearly indicated that teaching and learning in Grade R should focus on play-based approaches (purposeful play). The aim of „purposeful“ play is to prepare Grade R learners for a transition from an informal classroom environment in Grade R where play is the medium of learning, to the formal classroom environment (primary school), where the medium of learning is structured (formal) learning activities (Hoadley & Reed, 2012; Naudé& Marais 2014).

According to Kühne et al. (2013) Van De Walle (2007) teachers should provide learning activities and materials that stimulate learners' interest to play, and to make sense of numeracy concepts. During play, learners enjoy the activities, feel safe and improve their self-esteem. In addition, through play Grade R learners can repeat and rehearse numeracy concepts until they understand (Naudé & Marais, 2014; Van De Walle, 2007).

Morrison (2013) stated that learning theorists such as Montessori, Piaget, and Vygotsky, advocated for numeracy learning in Grade R classrooms to be achieved through informal play-based approaches. Researchers such as, Meier and Marias (2007) Ball (1992) nevertheless have shown that teachers, particularly in most South African schools face challenges of teaching numeracy through play-based learning. Some of the challenges include constraints such as overcrowded classes and lack of adequate resource materials. In view of that fact, most of the teaching methods Grade R teachers employ are to a large extent influenced by the kind of resources available in numeracy classrooms. These methods in turn influence the level of participation and performance during numeracy learning (UNESCO, 2006; Van de Walle, 2007). Some of the teachers who participated in the study of FP schools in the rural District of Vhembe, South Africa by the Human Science Research Council (HSRC), highlighted that they have not received adequate training to assist them in implementing play-based learning (NAEYC, 2002; UNESCO, 2006).

Grade R teachers should implement play-based learning that assist learners to develop their full potential during numeracy lessons. Davin and van Staden (2004) Killen (2006) have accordingly encouraged the implementation of a play (an informal and enjoyable) approach for learning numeracy. These researches believe that play can stimulate the necessary development of numeracy concepts in Grade R. According to Bergen (2009) and Pui-Wah (2010) learning through play has been discontinued from schools. Perry (1985) nevertheless cautioned that the discontinuity of informal play-based approaches can influence numeracy performance in Grade R.

In view of the above, teachers should provide meaningful and realistic learning activities to enable learners to construct their own understanding of numeracy knowledge (Libiensi & Gutierrez, 2008; Pui-Wah, 2010). In addition, Kellaghan and Madaus (2002) emphasized that the teaching approaches where learners are actively involved in their

own learning are critical for success. This suggests approaches such as playbased and small group approaches. Teachers should accordingly create play opportunities in class, through activity areas, in order to assist learners to choose suitable materials to their developmental needs (Gordon and Browne, 2014; Morrison, 2013).

In my personal opinion, there is a need for capacity building workshops to train teachers to become competent in teaching and learning of numeracy. According to Hunter (2005) and the NCTM (2000) learners need an opportunity to engage independently in small-groups to enable them to share ideas and to learn from others, as well as to gain broader interpretation of mathematical ideas. Based on the observation above, it is evident that the effective implementation of play-based approaches in Grade R, are envisaged to improve numeracy outcomes and assist learners to access quality education from a global perspective.

2.4.2.2 Whole-class Teaching

Previous scholars, Boaler (2008, 1999); and Muijs (1999) have shown that learner achievement is improved when teachers create classrooms that include whole-class teaching. DBE (2011) and Hunter (2005) have confirmed that learners should participate actively in whole-class teaching, where they understand mathematical ideas. Whole-class teaching (adult-initiated or ring activities) means teaching all children a similar thing at the same time (DBE, 2011; Flanagan, 1998).

An investigation conducted by Kostelnik, Soderman and Whiren (2011) validated that learners need an opportunity to sit closer together on the floor and engage in wholeclass teaching. Kostelnik et al. further indicated that during whole-class teaching, learners can also listen to stories, look at pictures and demonstrations, as well as share ideas to generate a numeracy conversation. The DBE (2011) and Flanagan (1998) stated that whole-class teaching can be very effective when teaching new numeracy concepts.

According to the DBE (2011) Grade R teachers are the primary source for nurturing critical thinking skills in mathematics during whole-class teaching. The teachers should monitor learners' participation, recording learners' solutions and emphasizing efficient methods of implementing activities. In addition, Grade R teachers should invite learners

to explain their solutions to others and encourage them to listen to and respect one another. Furthermore, teachers should also consolidate challenging concepts and assign the class general activity and independent activities that learners carry out while he/she engages with small-group focused sessions (Askew, 1996; Brown, et al. 1998; DBE, 2011).

Whole-class teaching is essential in Grade R classrooms because it stimulates interaction between teacher and well as among learners themselves. During this time, Grade R teachers provides direct instruction to the whole group at the same time, and encourage learners to participate actively in their learning, including learners who withdraw themselves from teaching and learning.

2.4.2.3. Small-group Teaching

Meier & Naudé (2014) and Moloï and Strauss (2005) found that learners need opportunity to work in small groups, sharing ideas in order to facilitate interaction and learning from others. Working in small-groups provides the emotional and practical support that learners need in order to understand the tasks on hand and to identify possible ways of engaging in the tasks. DBE (2011); DBE (2013) have additionally shown that during small-group teaching, six to eight learners sit with the teacher on the carpet to engage in activities that encourage discovery. In addition, the teacher works orally and practically with the learners using counters, dots cards, 100 chart, counting frames and money for solving money problems among others. The group-work sessions should be very interactive and learners should be encouraged to “do and talk” (DBE, 2011; Van de Walle, et al. 2010). In addition, Naudé and Meier (2014) recommend that if mat activities cannot be accommodated in the classroom, leaners can work seated at their desks in small groups.

Learners also need space to listen to teacher’s instructions, answering questions and critically assessing their responses to questions posed (DBE, 2013; Hunter, 2005; Woods, 2004). The activity areas in numeracy classrooms assist learners to play in small groups and discover number concepts, for instance, number patterns and measuring length. In addition, areas set aside for table toys, such as number puzzles, for example, offer learners time to work in small groups or on their own (Feeney, et al.

2013).

It is important to note that when such areas are designed for small groups, behaviour such as wandering, fighting over material and repeating the same activity many times can be minimized. It is against this background that the assessment of learner achievement is benchmarked to establish the reason learners in the sampled schools are not performing to the best of their ability.

2.5 The Trends for Learner Assessment Studies and Grade R Numeracy Outcomes

2.5.1 Quality Education in South African Grade R Classrooms

The DoE (2008) and UNESCO (2006) have shown that quality education plays a fundamental role in ensuring that Grade R learners can count and calculate numbers confidently and are well prepared for learning mathematics in subsequent grades. UNESCO has further shown that despite the substantial economic provision on the education budget, the quality of education in South Africa remains elusive, while the output rates are also not improving.

It should be noted that concerns about quality education in South Africa before 1994 have previously focused on learning achievement of the senior certificate examinations (Grade 12) particularly in mathematics. When the Grade 12 examination did not yield satisfactory results the goal post has shifted. Quality education in FP schools have as a result in recent years, raised unique concerns in regards to numeracy achievement (DoE, 2009; UNESCO, 2006).

Due to inadequate output rates with regards to teaching and learning numeracy, Block (2009); and Reddy (2006) indicated that the South African numeracy outcomes are being measured at both local, and international tests (DoE, 2008; Howie, 2007). The local and international studies findings have shown a trend of poor performance and a cause of concern for numeracy learners. In response to poor numeracy outcomes, the country implemented intervention strategies to ensure that quality education as a basic right is

accessible to all children irrespective of colour, gender, sex orientation and race (UNESCO, 2002; RSA DoE, 1996b).

It is against this background that Bansilal (2012:1) stated that “the results of international and national assessments suggested that our children are generally poor in mathematics”. Bansilal recommended that teachers should be competent in using the results from learner assessment studies to identify learners with mathematical problems, and develop remedial programmes (intervention strategies) to improve teaching and learning numeracy. Despite the intervention strategies implemented to improve the quality of teaching and learning outcomes, numeracy achievement in South African schools have remained persistently low (DBE, 2011, Karlsson, 2008/2009; Block, 2009).

Researchers, Stevenson and Stigler (1992); Van Tuil et al. (2002) pointed out that the quality of numeracy experiences in Grade R determine subsequent achievement. Van Tuil et al. (2002:48) have suggested that Grade R learners should constantly be given the best numeracy experiences because the benefits for learning numeracy only occur on a solid foundation. Van Tuil et al. further indicated that the long-lasting impact of an unfavourable start in numeracy learning is that the initial disadvantages seldom disappear and the achievement gaps tend to widen. In pursuit of quality education, South Africa compared the performance of her learners across the grades at local and international deliberations in order to identify problem areas in terms of numeracy learning, remediation provision as well as to improve the numeracy outcomes.

2.5.2 The Systemic Evaluation (SE)

Systemic evaluation is a national learner assessment programme conducted by the South African Department of Education (DoE). The assessment programme focused on tracking learner performance across the Grades particularly in Grade 3. The primary objective of Systemic Evaluations was to benchmark the country’s achievement levels in numeracy. The findings in Table 2 below suggests that the performance of FP learners in the Systemic tests for Grade 3 (the exit level of FP schooling phase) were poor and remained extremely low over the period of time (DoE, 2009; Moloi and Chetty, 2010). The Grade

3 average scores in Limpopo where this study was undertaken were 26% in 2001 and 24% in 2007. According to Fleisch (2008:7), the average FP learners in Table 2 struggle the most with numeracy among the Learning Programmes assessed. The Systemic Evaluation findings confirmed the findings from the regional and international studies, highlighting the constant underperformance of the South African numeracy learners across the grades and also across the country (DBE, 2011; Fleisch, 2008; Systemic evaluation, 2003). The results of Grade 3 and 6 are reflected in Table 2.

Table 2: average percentage scores attained in the 2001 Grade 3 and 2004 Grade 6 systemic evaluations

Grade 3: 2001	Percentage
Literacy	54%
Numeracy	26%
Life skills	54%
Grade 3 2001	
Literacy	36%
Numeracy	24%
Grade 6: 2004	Percentage
Language	38%
Mathematics	27%
Natural sciences	41%

Source: Department of Education, 2003c and 2005d

The Systemic Evaluation findings in my opinion suggests that problems with regards to numeracy learning should be identified timeously in Grade R where the foundations for learning are laid. This should assist the teachers to develop continuous intervention

programmes for improving teaching and learning numeracy outcomes in the South African Grade R classrooms, and assist to close the achievement gaps (Atweh et al. 2014; Fleisch, 2008; Hoadley, 2012).

2.5.3 The Southern and Eastern Consortium for Monitoring Education Quality (SACMEQ)

SACMEQ is a collaborative network of education ministries in Southern and Eastern Africa. South Africa participated in the regional SACMEQ II and III studies in 2000 and 2002. The project was aimed at measuring the mathematics skills of Grade 6 learners involving fifteen member countries (DBE, 2011; Moloï and Strauss, 2005). The SACMEQ findings studies have shown „unacceptable“ results regarding mathematics achievement (DoE, 2008). The results confirmed various study patterns which highlighted that South Africa’s learners, particularly from disadvantaged communities, enroll for secondary education without adequate mathematics competence. This often hindered them from succeeding at more demanding levels of schooling (DBE, 2009; Moloï and Chetty, 2010).

Table 2 reflects that the mathematics score for South Africa in 2000 was 486.1 which was lower than the SACMEQ average score of 500 (Moloï and Chetty, 2010; UNESCO, 2011). The SACMEQ II findings suggests that most South African learners need focused intervention in order to improve numeracy outcomes.

Shabalala (2005: 225) concurred and indicated that there is an alarming percentage of South African learners who are classified as non-numerate because they are operating at the lowest levels of numeracy competence (“pre-numeracy” and “emergent numeracy”). In this sense Moloï and Chetty (2010) found that the exposure of South African learners in Grade R programmes with adequate numeracy skills determines positive results for numeracy learners in subsequent grades. Shabalala (2005) emphasized that learners who were exposed to Grade R learning (preschool) achieved a high score in mathematics in the 2007 Grade 6 achievement studies.

The SACMEQ scores are described in Table 3 as shown in the next page.

Table 3: Mean reading and Mathematics scores of all participating countries in the SACMEQ II project.

	Reading	Mathematics
Botswana	521.1	512.9
Kenya	546.5	563.3
Lesotho	451.2	447.2
Malawi	428.9	432.9
Mauritius	536.4	584.6
Mozambique	516.7	530.0
Namibia	488.8	430.9
Seychelles	582.0	554.3
South Africa	492.3	486.1
Swaziland	529.6	516.5
Tanzania	545.9	522.4
Uganda	482.4	506.3
Zambia	440.1	435.2
Zanzibar	478.2	478.1
SACMEQ	500.0	500.0

Source: SACMEQ 2005

In my opinion, the SACMEQ II findings clearly indicate the need to expose South African learners to Grade R programmes with which the national curriculum is implemented to assist learners develop numeracy knowledge and skills. This will ensure that learners can cope with more demanding mathematics teaching and learning outcomes in subsequent levels of schooling. Grade R teachers should thus receive training in this regard through

professional development programmes to ensure that they are able to design age appropriate LPs to assist learners to develop numeracy concepts (Killen, 2006; Meier & Marais, 2007; Othmar & Kadir, 2004).

2.5.4 The Trends in International Mathematics and Science Studies (TIMSS)

TIMSS is an international study managed by the International Association for the Evaluation of Educational Achievement (IEA) and Human Sciences Research Council (HSRC) which assesses learner achievement in Mathematics and Science (DBE, 2011; Reddy, 2011). South Africa participated in the 1995, 1999 and 2003 studies to assess mathematics achievement in particular at Grade 8 level. The 1995 - 2003 TIMMS findings also revealed that the lack of appropriate teaching and learning resources as well as the classroom context where learners experience numeracy learning, amongst others, influence learner achievement (DBE, 2009; Shabalala, 2005).

Table 3 shows that South African learners generally perform poorly in numeracy outcomes because their average scores measured significantly lower against the 1999 and 2003 in international benchmarks (UNESCO, 2006). This implies that there is a need to compare the content being taught through the South African national curriculum against that of the participating countries to examine the reason South African learners are performing below the international average scores. The TIMMS findings also revealed that the relationship between mathematics achievements across the grades and learner performance should be initiated from the early years of the schooling system. This can assist Grade R teachers to utilize the 1999 and 2003 TIMMS findings to identify the areas of weaknesses experienced from the topics that are covered in the Grade R numeracy LP, as well as for the development of remedial strategies. The scores for SA's participation in TIMMS participation are shown in Table 4 below

Table 3: Average scores in TIMSS 1999 and 2003 Grade 8 mathematics and Science achievement tests

	Mathematics	Science
	TIMMS 1999	

SA average score	275	243
International average score	487	488
	TIMMS 2003	
SA average score	264	244
International average scores	467	474

Source: Human Sciences Research Council, 2005

Grade R learners can become school ready and initiate their numeracy learning based upon a strong foundation, in order to close the achievement gaps with regards to teaching and learning numeracy at the initial stage of schooling. In this sense, stake holders in the South African FP schools should support Grade R teachers in order to provide suitable teaching and learning opportunities which should be aligned to the Grade R mathematics curriculum.

2.6 Implications of Research on Teaching and Learning Numeracy in South African Grade R Classrooms

The National Education and Development Unit (NEEDU), (2012); and Kühne et al. (2013) found that the South African schooling system indicates that the national mathematics achievement average scores are low and need to improve. Bloch (2007) and Fleisch (2008) highlight in agreement with NEEDU and Kühne, et al., that mathematics performance continues to be low for low-performing schools. South Africa has thus gone through an educational crisis for an extended period of time. Much is however not known regarding why learners are performing below their potential achievement (DoE, 2009; Chisholm, 2011; Martin et al. 2012).

According to the DoE (2009); Chisholm (2011); and Martin et al. (2012) the national average mathematics achievement for different grade levels across the schooling system is similar and remain stable.

Previous studies of Atweh, Bose, Gravern, Subramanian and Venkat (2014); Reddy, Van der Berg, van Rensberg and Taylor (2011) have highlighted that high levels of attention should be paid to early childhood learning from rural communities. The researchers further indicated that teachers in the early years should provide well-resourced classrooms in order to break the cycle of poor numeracy performance. In addition, literature from a growing body of research, Atweh et al. (2014); Umek, Kranj, Fekonja, and Bajc (2008, 2005) showed that earlier performance and solid foundational knowledge of numeracy concepts form the basis for subsequent learning.

In this sense Atweh et al. and Umek et al. recognized the significance of exposing learners to Grade R learning experiences that have the potential of closing the numeracy achievement gaps between Grade R and the subsequent grades. This is confirmed by DBE (2012), emphasizing that the impact of Grade R needs to be maintained through subsequent school experience. The Organization for Economic Cooperation and Development findings (OECD, 2012) similarly recognized that access to Grade R LPs “help create solid foundations for life-long learning and also provide quality education particularly in SA” (OECD, 2012:4). The implications of these research findings is that the South African schooling system should raise the numeracy scores in the FP (particularly in Grade R) as it is often too late to improve matric mathematics performance at a secondary school level (Reddy, 2011).

This suggests that Grade R teachers should set up classroom environments that provide learners ample opportunities to know and understand numeracy concepts in order to progress and develop their own numeracy knowledge (Naudé & Meier, 2014; Van de Walle, 2007). According to Naudé and Meier (2014) effective teaching in Grade R depends on the physical arrangement of the classroom. In this sense, the study on the role of Grade R teachers in creating a conducive environment for learning numeracy is well-suited and suggests strategies to familiarize Grade R teachers with well-organized classrooms that provide learners prospects to participate in active learning. This ensures that Grade R learners can achieve numeracy outcomes effectively.

In response to the research findings from studies conducted with regards to teaching and learning numeracy outcomes in Grade R South African classrooms, Davin and van Staden (2004); Naudé and Meier (2014); Van de Walle et al. (2010); the National

curriculum framework (2005) among others, suggested strategies that teachers should utilize to create conducive Grade R classroom environments for learning numeracy. The South African Grade R classrooms should reflect the characteristics stated below.

2.6.1 Classroom space

- Improving the layout of the physical classroom space in Grade R and provision of a flexible well-organized classroom environment with activity areas to facilitate learning through play.
- Minimizing the activity areas and changing them weekly or bi-weekly to engage groups of learners alternatively in structured play throughout the week, in order to address the challenge of classroom size that limits teachers from creating activity areas.
- Recognizing that a verandah (balcony) can be used as an additional space outdoors for involving learners in active learning if the classroom is too small.
- Providing learners with the opportunity to explore their classroom environment, handling the concrete learning materials in the various activity areas and discover numerous possibilities of solving their everyday numerical problems.
- Creating multiple uses of furniture; for example, using extra tables as room dividers when designing activity areas, or removing pieces of furniture that aren't being used including the teacher's desk that takes up space and is usually not necessary in Grade R classrooms.
- Arranging the furniture intentionally to foster socialization and the development of numeracy competencies through sitting Grade R learners at tables rather than desks.

2.6.2 Teaching, Learning and Support Materials

- Grade R teachers should recognize that numeracy learning begins with the handling and exploration of TLMs such as building blocks, card games and educational toys (for example dolls and beads).

- Recognizing that numeracy is better learned and taught through TLSM and providing learners with a variety of TLSM (concrete and visual), which can be bought or teacher-made.
- Creating ample opportunities for learners to handle, play and explore (for example sorting and matching) the TLSM in order to construct their own knowledge of numeracy concepts, as well as solving problems in their everyday lives to achieve numeracy outcomes.

2.6.3 Teaching Approaches

- Developing professional development programmes to train Grade R teachers in order to create opportunities for teaching and learning (in Grade R) through „exploration and play“ (for example, counting, ordering, comparing) amongst others, to achieve numeracy outcomes.
- Creating opportunities for teaching and learning opportunities through play-based, whole-class and small-group teaching approaches in order to assist learners develop their own numeracy knowledge and skills.
- Creating opportunities for learners to discover numeracy concepts through playbased approaches (purposeful or structured play) as there is an opportunity to enjoy the learning activities and repeat the concepts until they understand them.
- Constructing learning opportunities through play (for example through block play, card games and fantasy play amongst others) in order to assist learners to develop their own numeracy knowledge.
- Recognizing the whole-class teaching approach as an essential resource in Grade R classrooms as it affords the teacher an opportunity to provide the whole class with clear instructions of what is expected of them in the daily activities.
- Asking open-ended questions during whole-class teaching in order to encourage learners to engage actively in numeracy learning.
- Recognizing that group work sessions assist Grade R teachers to provide emotional and practical support that learners need in order to understand and identify possible ways of engaging in the task at hand.

- Recognizing that group work sessions should be interactive and that learners should be encouraged to „do“ and „talk“ about numeracy concepts.
- Recognizing that during small-group sessions, teachers should work practically or orally with a group of 8-10 learners on the mat using counters, dot cards, and 100 charts, amongst others.

2.6.4 Displays

- Recognizing that displays can be an important source which assist learners to develop numeracy knowledge and skills.
- Utilizing most of the wall space to display items that learners have made (own pictures or drawings representing numbers) or teachers“ charts (numbers, shapes, days of the week).
- Positioning displays at locations and heights that are physically and visually accessible to all learners in the classroom. The charts can be bought or teacher-made and must be replaced from time to time in order to be aligned with themes taught.

2.7 Chapter Summary

The purpose of this chapter was to discuss what other scholars have indicated about the role of Grade R teachers in creating a conducive environment for learning numeracy. Firstly, the theories of teaching and learning numeracy in Grade R classrooms (theoretical framework) that guided this study and its implications on numeracy learning is discussed, followed by an examination of the extent to which teachers create a conducive environment to facilitate numeracy learning in Grade R.

The next chapter will present the research design and methodology utilized for conducting this study in FP schools of Vhuronga in the Vhembe District, in the Limpopo Province.

CHAPTER 3 RESEARCH DESIGN AND METHODOLOGY

3.1 Research Methodology

In this chapter, the methodology utilized to investigate the role of Grade R teachers in creating a conducive environment for learning numeracy is outlined in five sections. The first section presents the research design, followed by the description of the instruments, namely: the interviews, classroom observations, and document analysis as well as field notes in the second section. The third section described the participants and the sampled schools. The validity and reliability are discussed in section four.

Lastly, the ethical consideration and data analysis are also presented.

3.2 Research Design

The study adopted a qualitative research design from an interpretive paradigm and assumed a multiple case-study approach. Multiple case-studies are achieved when the researcher used multiple sources of evidence or triangulation to represent thick descriptions (Babbie & Mouton, 2011; Denzin, 2005). The current study utilized six Grade R teachers to collect rich data on classroom environment for learning numeracy. Qualitative research designs investigate behaviour as it occurs in the natural settings from the participants' perspective; hence, there is no manipulation of experience (Babbie, 2010; Babbie & Mouton, 2011). The data consists of words in the form of verbal descriptions, rather than numbers (MacMillan & Schumacher, 2010). Qualitative research design fitted well with the current study because thick descriptions of data within a naturalistic inquiry related to what extent Grade R teachers in the four public Foundation Phase schools in the Vhuronga circuit created a classroom environment for teaching numeracy lessons was elicited.

MacMillan and Schumacher (2010) argued that a case study design is an intensive investigation of a single unit which the researchers select to seek an in-depth understanding. A case study was employed in this study to understand the influence of the classroom environment on learner achievement. The strength of a case study approach lies in its ability to provide thick descriptions of a phenomenon under investigation (Denzin & Lincoln, 2005; Yin, 1994, 2003a). In addition, Yin (2004) highlighted that a case study approach is most suitable when data collection involves direct observations in natural settings. The choice of the design in this study was informed by literature review (Babbie, 2010; Babbie & Mouton; 2011; de Vos et al, 2005; Merriam, 1989; Yin, 2003a; 2003b).

3.3 Instrumentation

The data collection instruments used in the current study were self-developed and informed by existing literature. The self-developed instruments were the interview guides - both initial and final interview guides, as well as lesson observation guides, document analysis and hand written field notes. The development of the interview guides was informed by the Mental models (Krauss, Hamzah, Omar, Suandi, Ishmail, Zahari & Nor,

2009) while the observation guide was informed by the Stallings snapshot observation manual (Venalainen, 2008). The research instruments were well suited for this study because they elicited “rich” and “in-depth” (Geertz, 1973) data from the primary sources, namely the Grade R teachers of the participating schools.

The interview guide is a list of questions that the researcher intends to ask in an interview (Merriam, 1998). The interview guide ensures that the researcher covers all the terrain in the same order for each respondent (McCracken & Grants, 1988). In the current study, the interview guide was developed to evaluate how Foundation Phase school teachers used their time in the classrooms. The Stallings Snapshot observation guide records the environment and the participants in the classroom. It records every person in the classroom and in the activity in which they are engaged and shows with whom they are engaging. In this study, the snapshot observation guide was developed to provide data for assessing the teaching and the learning activities, the materials being used and the grouping patterns of the learners (Venalainen, 2008).

3.3.1 Description of Data Collection Instruments

3.3.1.1 Interview Guides

Two interview guides were developed, the pre-lesson and post-lesson interview guides to collect data regarding numeracy taught. The pre-lesson interview was developed to assist the researcher to establish the topic of the lessons to be taught. The instrument also enabled the researcher to establish what objectives were to be achieved in the lessons and what learning materials should be available and can be utilized in class during the lessons to be taught (Appendix B). In addition, the instrument helped the researcher establish what the teachers would be doing during the lessons. Merriam and Simpson (2000) state that interviewing is essential when the required information such as perceptions and behaviour are sought and cannot be directly observed. The pre-lesson interview guide comprised of six questions which helped the researcher establish

the meaning of teachers' behaviour (what they did and said) in numeracy classrooms (McMillan & Schumacher, 2010).

The post-lesson interview guide (Appendix D) was developed to assist the researcher to follow-up issues that emerged during lesson observations as well as from the initial interviews. The instrument also enabled the researcher to establish the rationale behind the lessons designed for whole-class, small group and individual teachings. It further assisted the researcher to ascertain the reason the physical learning materials were not displayed in class during the lessons taught. The interview guide had five questions which enabled the researcher to collect information regarding the numeracy lessons taught in Grade R classrooms.

3.3.1.2 Lesson Observation Guide

The purpose of this instrument was to make the observation more focused. Items in the observation guides helped the researcher to determine how teachers organized classroom space, whether it was adequate or crowded, whether the arrangement of desks facilitated or inhibited interaction. The instrument also helped the researcher determine if the classrooms were adequately or poorly equipped with physical and visual learning materials. The observation guide also enabled the researcher to establish how the lessons were presented, whether as whole-class, in small groups or individually. The instrument also focused on how written work was facilitated and monitored, including if teachers marked the written tasks and gave feedback or not (Appendix C).

3.3.1.3 Document Analysis

A Document Analysis in this study was carried out to evaluate the curriculum materials which teachers used when teaching numeracy, namely: the Curriculum and Assessment Policy Statement, at the Foundation Phase in Grade R. At the time the field work was carried out, all Public Grade R classrooms were required by the Department of Basic Education (DBE) to implement „The Laying Solid Foundations for Learning programme“, which includes the teachers' guide, weekly plans, and Grade R

workbooks for learners amongst others. These materials describe the official perspective adopted by the South African DBE, of which teachers are required to implement in Grade R classrooms. The analysis of the curriculum documents assisted the researcher to determine whether numeracy lessons in the sampled schools were aligned to the principles of the curriculum documents (Appendix E).

(a) The Curriculum and Assessment Policy Statement, Foundation Phase Grade R.

Curriculum and Assessment Policy Statement, Foundation Phase Grade R, was implemented in Grade R of all Public Grade R classrooms, through curriculum materials included in the “Laying solid Foundations for learning” programme. This is an intervention programme Grade R teachers implemented to improve learner achievement in literacy and numeracy (DBE, 2009). The programme is organized into themes, with each theme containing enough work to last over a span of two weeks. The programme also involves the weekly CAPS aligned lesson plans and Grade R Rainbow Workbooks for learners amongst others. The curriculum documents analysed in the study are described below.

(b) The weekly CAPS aligned lesson plans

The weekly lesson plans described how the planning for Grade R lessons are organized. The planning is described in themes within a period of two weeks. The document also creates a sense of predictability which assisted learners to feel secured in the classroom environment because they knew what to expect in their numeracy lessons (DBE, 2009). The evaluation of the curriculum document helped the researcher to determine what was currently being taught in Grade R, the resources (posters, worksheets, and numeracy tasks) utilized, as well as an indication of how the tasks were to be assessed.

(c) The Grade R DBE Rainbow Workbooks for Learners

The Grade R DBE Rainbow Workbooks provide learners with worksheets to develop numeracy skills they have been taught in class. They further indicated the nature of the

numeracy tasks learners were currently working on. The workbooks also described the instruction that informed learners on how to complete the tasks. The workbooks further helped teachers track the progress of learners and highlighted whether teachers gave feedback when marking the tasks or not. They are a simple way to structure learning activities for learners. In the next section the data collection procedure that was followed is presented.

3.3.2 Data Collection Procedure

The sampled schools were visited and consent forms for the teachers (see Appendix I: consent forms for teachers), were hand delivered. The teachers in each school were requested to sign the consent forms. During the first visit, a briefing meeting to explain the purpose of the study was conducted to establish rapport and trust with the participants. Participants showed interest and were not forced to take part in the research project. They then signed the consent forms and data was collected.

Data collection was triangulated to ensure validity. Comprehensive field notes were taken in order to describe what the researcher saw and heard during the fieldwork in order to answer the questions below:

1. Whatkind of classroom environment do Grade R teachers create for learning numeracy?
2. How are Grade R teachers implementing the numeracy curriculum?
3. What classroom factors encourage the approaches teachers employ during numeracy teaching?

The data collection for this study was undertaken in three stages, namely; stage1: interviews, stage 2: classroom observations and stage 3: document analysis. These stages are inter-related and overlapping.

3.3.2.1 Interview Guides

Interviews with six selected teachers were conducted for two weeks during the first stage of data collection. The pre-lesson interview guide had five questions which were translated into Tshivenda at the teachers' request during the pilot study; Tshivenda happens to be the language of teaching and learning (LoLT) in the sampled schools. The teachers indicated that they felt more comfortable to speak in the LoLT rather than speaking in English. Each teacher was interviewed twice, i.e. they participated in two sets of interviews: the pre-lesson and post-lesson interviews. In the pre-lesson interview protocol, the researcher requested teachers to respond to five questions concerning the structuring of lesson observations in the sampled schools (Appendix B).

The questions covered the following issues:

- (a) The topic of the lessons to be taught;
- (b) The objectives to be achieved;
- (c) The arrangement of the classroom space; (d) Learning materials to be used during the lesson; (e) The structure of the teaching activities.

After the lesson observations, the researcher also requested teachers to respond to questions regarding the lessons taught (Appendix D). The final interview guide had five questions as well, in order to assist the researcher to follow-up on issues that emerged during classroom observations as well as from the pre-lesson interviews. Field notes were taken during the interviews to describe the interaction between the researcher and the participants. Teachers responded to questions regarding the following issues:

- (a) How the lesson unfolded;
- (b) Whether the objectives of the lessons were achieved;
- (c) Explaining the learner involvement in the teaching and learning activities?
- (d) What challenges did learners experience during the teaching and learning numeracy?
- (e) What changes will be implemented in lessons, in order to improve numeracy learning?

The interviews were conducted during school hours in order to capture data on how numeracy lessons were taught in Grade R classrooms. These interviews lasted between thirty (30) to forty-five (45) minutes, depending on the individual teacher's engagement with the questions. Interview probes were provided to elicit further explanation and clarification on responses from the participants and to ensure validity.

3.3.2.2 Lesson Observations

In the second stage; the observation guide was utilized to give direction to the classroom observation protocol (Appendix C). Each teacher in the sampled schools was observed twice teaching numeracy lessons. Field notes were written from each school during this phase. The purpose was to understand:

- (a) The design of the classroom space;
- (b) How the classroom was equipped with physical and visual learning materials;
- (c) The structure of the teaching activities;
- (d) How the numeracy lessons were taught; (e) The utilization of methods of teaching; and (f) What numeracy tasks were done?

Maree (2007) pointed out that through observations, the researcher is able to document the behaviour of participants in their natural environment, communicating ideas both verbally and non-verbally responding through language and using symbols. In addition, Merriam and Simpson (2000) indicated that observation is considered as a research tool if it is intentionally designed, appropriately recorded, and exposed to issues of validity and reliability. Creswell (2003) agreed by highlighting that the observation schedule is an appropriate tool for recording notes because behaviour can be recorded as it occurs naturally. In this study, the researcher used an observation schedule to determine how numeracy lessons were taught. The researcher observed every lesson for about 30 to 45 minutes.

3.3.2.3 Document Analysis

In the third stage, the researcher requested the teachers in the sampled schools to provide the curriculum materials and studied them carefully (Appendix E). The intention was to determine if the teachers aligned their lesson with the Curriculum and Assessment Policy statement (CAPS). In this study, the six selected teachers provided the “laying solid Foundations for learning Grade R resource kit”. The analysis of the curriculum materials was also done to assist the researcher to confirm evidence sought from lesson observations and interviews. The curriculum documents analysed in this study are described below.

(a) Curriculum materials in the Laying Foundations for Learning Grade R resource kit

The researcher asked the six teachers to provide curriculum materials through which the Grade numeracy curriculum was being implemented. The rationale for doing this was to establish if the lessons taught were guided by the themes proposed in the programme. The weekly CAPS aligned lesson plans included in the grade R resource kit, and learners’ work books were also analysed so that the researcher could determine how the curriculum materials were used in Grade R classrooms.

(b) Weekly CAPS aligned Lesson Plans

The researcher also requested the participants to provide the weekly lesson plans and studied them carefully. The aim was to determine the content currently being taught in Grade R, including the resources (posters, worksheets, songs and numeracy tasks) that were being utilized.

(c) The Grade R DBE Rainbow Workbooks

The researcher also surveyed the learners’ workbooks with permission from principals and teachers, in order to determine the nature of numeracy tasks learners were currently working on, as well as the instructions that were being issued to learners to inform them

on how to complete the task. In addition, the researcher studied the workbooks to determine whether the learners understood the given tasks and whether teachers marked the written activities and provided feedback when marking the tasks or not.

3.4 Sampling

Four Foundation Phase schools at Vhuronga; A, B, C and D were purposefully selected. Purposeful sampling occurs when a researcher wants to identify unique cases for in-depth investigation (Neuman, 2000; Patton, 2002). The results from the 2011 Annual National Assessments (ANA) were used as selection criteria for identification of appropriate samples. The sampled schools were selected due to the fact that they performed below the fifty Percent (50%) average score in the numeracy Learning Programme suggested by the South African DoE. School A obtained (29%) pass rate, school B obtained (13.7%), while school C obtained (0.7) and school D obtained (0.2%) pass rate.

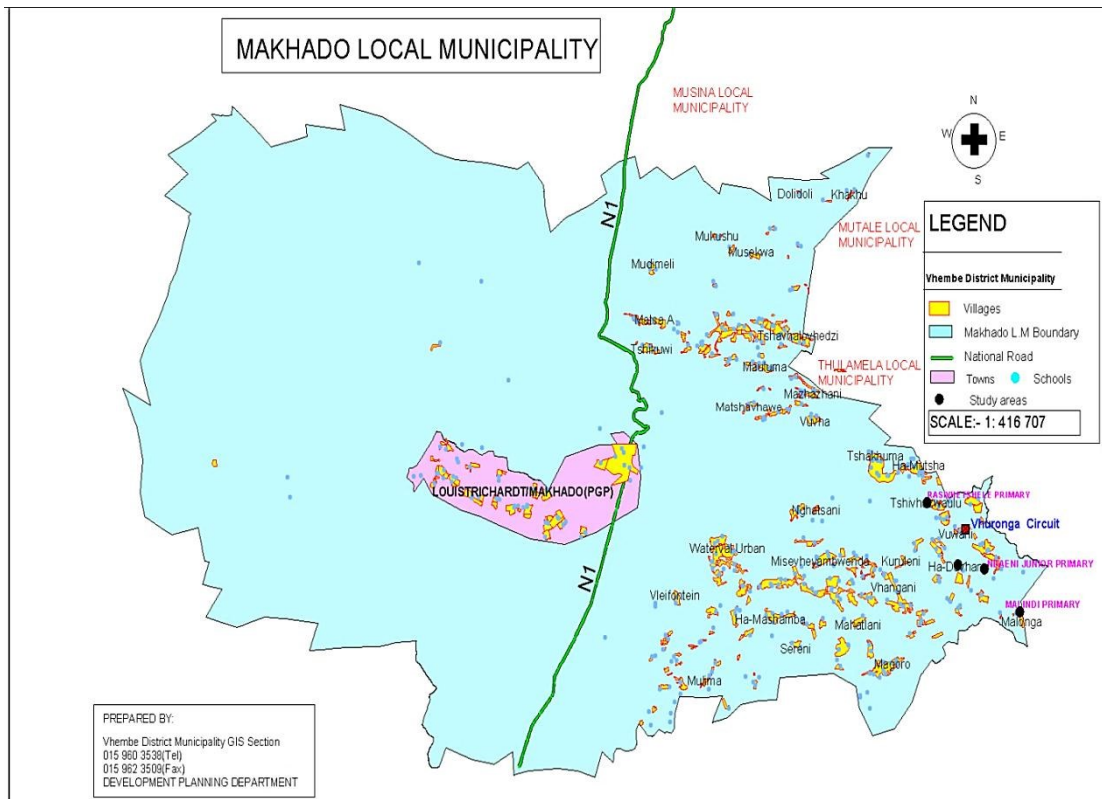
The sampled schools were thus selected to explain why learners were not performing to the best of their ability as shown in the 2011 ANA's results. The teachers in these schools were regarded to be knowledgeable and informative because they possessed extensive Grade R teaching experience. They were also chosen due to the fact that they teach in rural communities. They also have expert knowledge regarding the influence of the classroom environment on learner achievement (McMillan & Schumacher, 2006). The schools were reasonably accessible (within a convenient travelling distance from the researchers' institution). Pseudo-names have been used instead of real names to identify the sampled schools in order to adhere to ethical principles of anonymity.

A total of six teachers, one male and five female teachers were purposefully selected; one Grade R teacher from each of school A, B, and two teachers from school C and D; because there were two Grade R classes. In each sampled school; suitable dates and time for interviews, document analysis and classroom observations were arranged with the school principals.

3.5 Sampled Schools

The four selected schools in which the investigation was conducted were situated in a rural set-up and are shown on the map below

Figure 1: GEOGRAPHICAL LOCATION OF PARTICIPANT SCHOOL



In Figure 3.1 above, Makhado Local Municipality defines the location of the study area; Vhuronga 1 circuit. The land marks on the map are symbolized as follows: (a) Makhado town is situated in the middle of the diagram (b) the square represents Vhuronga 1 circuit office, (c) the circles characterizes the four sampled schools; A, B, C, and D which are approximately seventy kilometres away from Makhado town. The schools were located within a rural setting and were most appropriate in providing “rich” descriptions regarding the environment in which learners are taught numeracy at Vhuronga.

3.5.1 Classroom Space

Grade R classes in schools A, B, and D were taught in a standard classroom set-up. The classrooms were designed for formal primary school learners; and not specifically built for teaching Grade R learners. In each school the Grade R classroom had more than fifty learners, both boys and girls.

School C had a two-classroom building. One class served as the principals' office, store room (resource room) for (all office equipment, garden tools, and utensils for the feeding scheme) purpose and other valuable teaching and learning resource materials were also kept in this classroom. The Grade R class was sometimes taught in the classroom that served as the resource room for the whole school. The school occasionally had temporary teachers. Whenever the temporary teachers were available at the school, Grade R learners were taught in a nearby church building.

At the time of investigation (the first observation, T3), the Grade R class was taught by a temporary teacher in the church building. The church building was spacious because there were only six Grade R learners in the school. There were also six Grade 1 learners in the same class because the school implemented multi-grade teaching. Multi-grade describes a school in which different grades are taught in the same classroom by one teacher.

3.5.2 Resource materials

The physical resource materials in the sampled schools were stored in the Grade R resource kit (large plastic containers or utility bins) provided by the Department of Basic Education. These resource materials were not displayed in the classrooms because there was no space to display them. They were only displayed accordingly to suit a particular theme presented within the two-week period, to fulfil the needs for structured play. The resource materials were also kept in the Grade R resource kit to keep them safe from being mishandled by the learners and to stop them from being destroyed by thieves. The resource materials in school C and D were shared among the Grade R teachers respectfully because only one resource kit was provided per school.

3.5.3 The Participants

As indicated above, six teachers participated in the study; T1 to T6, one male and five females. Their teaching experience varied. At the time of writing all participants were assigned a full time Grade R class.

T1 a female, with more than 26 years of teaching in various schools, taught Grade R in school A. T2 and T6 both females, with 20 to 25 years of teaching in different schools, taught in schools B and D respectively. The two teachers obtained their Early Childhood Education Diploma (ECD) in a local teacher training college. T3 and T5 both females as well as T4 a male had 0 to 5 years of teaching experience, and taught in schools C and D individually.

All of the participants were Tshivenda language speakers. T1, T2, T5 and T6 taught fifty-two learners, comprising of both boys and girls. However, T3 and T4 in School C taught only six Grade R and six Grade 1 learners because this was a multigrade school.

The teachers participated in the interviews and lesson observations and described how they set up a conducive environment that allows learning through play-based activities and also help learners construct their own numeracy knowledge.

3.6 Validity and Trustworthiness of Data

3.6.1 Validity

Validity in qualitative research describes measure that accurately reflects the concept it is intended to measure (Babbie, 2010; De Vos et.al, 2005). Three criteria were considered to determine the external validity of the research instruments employed in this study.

3.6.1.1 Transferability

This refers to the extent to which the findings can be applied in other contexts or with other respondents (Babbie & Mouton, 2011). Several data collection techniques were used in this study in order to guarantee triangulation, reduce threats to reliability, as well as to enhance the validity of the data, namely observation, interviewing and documents analysis (MacMillan & Schumacher, 2010).

During observation, examples of how numeracy lessons are taught in various settings (Grade R classrooms) guided by the research questions were examined. Furthermore, the interactions between teachers and learners, as well as among learners themselves in a numeracy classroom setting were also examined. The final conclusions of how numeracy lessons are facilitated in Grade R classrooms were the same over a majority of contexts and are seen as applicable in other contexts as well.

The interview questions ensured the validity of contextual data obtained regarding the environment teachers created for teaching numeracy in Grade R classrooms of Vhuronga which were the same over a majority of contexts.

3.6.1.2 Dependability

Dependability describes the degree of accuracy in which interview questions address the research objectives. Babbie and Mouton (2011) confirm that the term “dependability” refers to obtaining similar findings with similar participants in the same setting if the inquiry were to be repeated by other independent researchers. Merriam and Simpson (2000) highlighted that interviewing is necessary when information required in answering the research questions cannot be observed. Questions set for the interview schedule were directly linked to items in the observation protocol. In this study, the six selected teachers interviewed had similar experience of teaching Grade R in the same geographical area i.e. rural schools in Vhuronga South Africa. This confirmed that the results were dependable and similar results can be obtained when the inquiry is repeated.

The methodology of conducting numeracy lessons in the Foundation Phase of Vhuronga circuit, was observed under similar conditions and context i.e. Grade R classrooms with similar participants, as well as the Grade R teachers. The results were dependable and

it can be confirmed that other independent researchers would get similar results when the inquiry is repeated.

3.6.1.3 Conformability

This is the degree to which the findings are the product of the focus of the investigation and not the biases of the researcher (Babbie and Mouton, 2011).

The interview schedules in this study were pilot tested to reduce bias and questions adjusted accordingly to suit the linguistic requirements of the participants. The researcher sought responses from various Grade R teachers in the initial and final interview to confirm the validity and credibility of the responses obtained from the participants.

In this investigation, the researcher cross-checked the data obtained through classroom observation against the responses received from the interviews and document analysis to verify the responses and reduce prejudice (de Vos et al. 2005; Lincoln & Guba, 2005).

3.6.2 Trustworthiness

Trustworthiness is the extent to which the results of the study are judged to be trustworthy and reasonable (McMillan & Schumacher, 2010). The trustworthiness of the findings in this study was guaranteed through data triangulation (Babbie & Mouton, 2011; Yin, 2004). Triangulation can be defined as the use of numerous methods for data collection (Denzin, 2000; Merriam, 1989). Numerous data sources, classroom observations, interviews and document analysis were used. Merriam and Simpson (2000) highlighted that interviewing is necessary when information required in answering the research questions cannot be observed. Questions set for the interview guide were directly linked to items in the observation protocol in order to guarantee reliability. Triangulation was thus used in this study to ensure validity of the data collected.

The data was also verified through member checking. After the data was analyzed and interpreted, the participants were contacted again in order to verify the accuracy of the data captured. Wherever data was inaccurate, it was corrected.

To further ensure trustworthiness and accuracy of the data, a peer-debriefing was conducted (Babbie & Mouton, 2011). The researcher sought assistance of experts who are colleagues, in the field of numeracy education who are lecturers in the Department of Early Childhood Education at the institution where she works to review the content of the instruments (observation and interview guides) in order to enhance validity. During regular departmental and collaborative research writing workshops conducted at the institution, the data was critiqued. Thereafter minor adjustments were made accordingly to the length and relevance of the instruments in accordance with feedback from colleagues.

3.7 Ethical Considerations

Permission:

Permission to conduct research was approved by the Vhembe District Senior Manager (Department of Education); Circuit Manager of Vhuronga; Grade R teachers. Schools where the research would take place were identified and approved by the District Senior Manager.

Informed consent:

The fieldwork in this study was guided by various ethical considerations. One of the ethical consideration was ensuring the informed consent that guided this study. Informed consent involves making participants aware of the purpose of the study, and obtaining their written permission to participate in research without deception (Neuman, 2000; Babbie, 2010). A letter was written to introduce the researcher and to explain the purpose of the study. The letter also informed participants that they could withdraw their participation at any stage of the research. Participants were also requested to sign the informed consent forms to ensure that they understood what was explained to them regarding the study. The letter was attached on the front cover of the interview guide and read as an introduction of fieldwork sessions.

Right to Privacy:

The right to privacy (Babbie, 2010) is another ethical consideration that guided the fieldwork conducted in this study. The researcher is obliged to uphold the confidentiality of data. Pseudonyms were used in this study to disguise members' names and to guarantee confidentiality and anonymity (Creswell, 2003).

Protection from harm:

In addition, the need to protect participants from harm was also ensued. Babbie (2010) pointed out that protection from harm includes both emotional and psychological discomfort that may be caused to participants. Interview questions in this study were carefully formulated to assist participants to describe their own understandings regarding issues that related to conducive environments for learning numeracy.

3.8 Pilot Study

A pilot study was conducted to fine-tune the instruments used for the main inquiry. Bless and Higson-Smith (2000). Mitchel and Jolley (2000) and Monette, Sullivan, and Dejong (1998) define a pilot study as a small-scale study conducted prior to the main research to determine whether the methodology, sampling, instruments and analysis are adequate and appropriate.

The importance of a pilot study is to offer the researcher an opportunity to investigate the feasibility of the planned project (Higson-Smith, 2000). The pilot study also highlights the possible deficiencies in the measurement of the procedure (Huysamen, 1994).

In the current study, a pilot study was conducted to pre-test the data collection instruments, as well as to identify their flaws on the target group made up of the six selected Grade R teachers (Moser & Kalton, 1973; De Vos, et al., 2005; Bogdan & Biklen, 2003; Bailey, 1994).

The researcher recorded the views of the participants relating to the classroom environment and the participants in the classrooms. This included the learning materials that are used, as well as the pattern in which the lessons are structured. The participants were given a chance to comment on the wording and structuring of the questions. A few challenges with the interview questions occurred during the pilot study. The participants felt that they were not very comfortable in responding to the interview questions in English.

The sampled teachers thus requested that the interview questions to be paraphrased in “Tshivenda” the language of learning and teaching (LoLT) in the sampled schools. The results of the pilot study were used to adjust the questions for the main study accordingly to suit the communication needs of the participants; the questions were translated into “Tshivenda” to assist the teachers to respond to the questions comfortably (De Vos, 2005).

3.9 Data Analysis

Data analysis in this study involved a systematic process of studying, sorting and arranging raw data obtained during fieldwork. After visiting a school, the researcher constantly made summaries to describe her observation during the data collection sessions (Bogdan & Biklen, 2003; Creswell, 20003; Neuman, 2000). The data collected at the initial stage was analysed to identify patterns and primary categories for the next level of data analysis. Data analysis entails organizing, analyzing and interpreting in order to make sense of the information obtained through the fieldwork (McMillan & Schumacher, 2010).

The researcher read the transcripts several times, sorted, and organized the notes according to research questions in order to identify important themes that emerged. During the reading process the researcher also made margin notes to record categories of the general thoughts of the participants. As Marshall and Rossman (1995) put it: “reading, reading, and reading once more through the data forces the researcher to become familiar with these data”. The arrangements of the notes was done depending on the different types of sources; interviews, lesson observation and document analysis

in each school visited. The identified themes were made ready for interpretation, comparing and drawing conclusions.

3.10 Chapter Summary

This chapter has described the research methodology in which qualitative method was adopted to conduct this study. The qualitative approach within the naturalistic and interpretive paradigm was found to be suitable because the study sought to investigate teachers' competence in creating a conducive environment in which numeracy is taught in the learning space. The research instruments; namely, the interviews, classroom observations, as well as the document analysis were described to guarantee triangulation, validity and reliability. Lastly, ethical consideration was presented in the chapter.

The next chapter will present the descriptions, data analyses as well as discussions of the research findings regarding the role of Grade R teachers in creating a conducive environment for learning numeracy.

CHAPTER 4 REPORTING, ANALYSING AND DISCUSSIONS OF THE FINDINGS

4.1 Introduction

The purpose of this chapter is to present an analysis and discussion of the findings on the study that investigated the role of Grade R teachers in creating a conducive environment for learning numeracy. The responses were collected from Grade R teachers through three phases of data collection, namely: interviews, classroom observations and document analysis. The chapter is divided into three sections. The first section presents the teacher's perceptions on the conducive environment for learning numeracy based on their responses from the interviews, followed by the findings from the lesson observations and then the document analysis. Lastly a discussion on the findings from the three phases of data collection.

The following research questions guided the study.

1. What kind of classroom environment do Grade R teachers create for learning numeracy?
2. How are Grade R teachers implementing the numeracy curriculum?
3. What classroom factors influence the approaches that teachers employ during numeracy teaching?

4.2 Presentation and Analysis of Findings

In this section an analysis of interviews with teachers, lesson observations and document analysis of four schools and six teachers are presented. The findings on each research question are presented and discussed below.

4.2.1 Research question 1

What kind of classroom environment do Grade R teachers create for learning numeracy?

Five themes (categories) were used to present the results of how a conducive environment for learning numeracy was created, namely: classroom space, classroom arrangement, physical learning materials, visual learning materials and the description of the lessons the researcher analysed. Some of the responses of from the teachers" interviews regarding classroom space for teaching numeracy are captured below.

4.2.1.1 Classroom Space

The first question asked to the teachers was:

Researcher: *how do you arrange your classroom to encourage play-based learning?*

The participants gave varied responses in the interviews regarding this question depending on issues that emerged during teachers' interviews. Five of the six selected teachers gave similar responses, indicating that the standard-sized foundation phase classroom space was a limitation that hindered interaction between teachers and learners and among learners themselves. This was identified as a challenge that restricted the teachers from implementing play-based teaching in order to create a conducive environment for numeracy learning. The responses of some of the teachers in the interviews are presented as follows:

Teacher 1: *I arrange the desks in rows.*

Researcher: *why is that so?*

T1: *I have many learners in my class and I do not have enough space to set-up activity areas.*

T2: *The desks in my class are arranged in rows.*

Researcher: *Why is that so?*

T2: *I teach fifty-two learners and my class is crowded with learners' desks.*

T3: *I arrange the desks in groups.*

Researcher: *why is that so?*

T3: *I have a big classroom and involve groups of learners in different activities in the activity corners.*

T4: *I arrange the desks in rows.*

Researcher: why is that so?

T4: *My classroom is full of resources for the whole school, such as garden tools, and things for cooking food, books as well as teaching aids.*

T5: *I arrange the desks in rows and there is no space for activity areas in my class.*

Researcher: why so?

T5: *I teach many learners and my classroom is overcrowded with furniture*

T6: *The desks in my classroom are arranged in rows. There is just no space for setting up activity areas.*

Researcher: Why is that so?

T6: *It is difficult to set-up activity areas in the classroom when you have fifty-two learners.*

Following the teachers' responses in the interviews above, it has been shown that, four of the six selected teachers arranged the children's furniture for whole class teaching. The desks were arranged in rows. This kind of seating arrangement inhibited interaction and learning. The teachers did not plan activity areas for stimulating play-based learning because the classroom space was congested with furniture. The study established that two teachers however, sat their learners in groups. T4's classroom was also congested with resources for the whole school and could not plan activity areas as well. The findings of the study established that only one teacher (T3) had adequate classroom space and organized activity areas in order to facilitate learning through play-based activities.

The lesson observations confirmed what some of the teachers highlighted in the interviews. The responses on the issue of classroom space are presented in the summaries of the lesson observations below:

4.2.1.2 Classroom Arrangement

Lessonobservation T1

T1 taught a large class with fifty-two learners in a standard-sized classroom. The classroom had no activity areas to engage learners in play-based activities. Learners in this classroom sat on desks with three learners sharing a desk. The classroom therefore looked congested with desks, as well as child-sized plastic tables and chairs arranged in rows.

The literature review confirmed the findings from classroom observation (see 2.3.2.1) suggesting that the Grade R classroom space should be adequate for the number of learners, because it influences interaction and learning (Donald et al. 2005). Large and overcrowded classrooms (comprising of more than 40 learners) can also affect interaction and the development of emergent numeracy through play-based activities (Meier & Marais, 2007). The literature (see 2.3.1.2) also supported the notion that Grade R learners need well-planned classroom space in order to promote emergent numeracy. A well-planned classroom consists of several activity areas (Gordon & Browne, 2014). Activity areas could therefore assist groups of Grade R learners to engage in a variety of learning activities in order to develop incidental learning.

Meier and Marais (2007) suggested (see 2.3.1.2) that Grade R teachers should realise that the layout of the classroom is not rigid and permanent when implementing activity areas. New and expanded activity areas must be added as learners' interest and play behaviour change. Teachers can thus provide conducive environment for learning numeracy through:

- Planning the classroom creatively, recognizing that even a small classroom can offer sufficient play opportunities to Grade R learners (see 2.3.2.1).
- Accommodating a variety of activity areas if the classroom is too small, the areas can be changed bi-weekly in order to give learners an opportunity to learn through structured play from all possible activities (Naudé & Meier, 2014).
- Providing activity areas to engage learners in learning through exploration and play, in their classroom environment (see 2.3.1.2).

- Providing opportunities for learners to handle and talk about the physical learning materials, in order to develop competence to learn numeracy concepts effectively (see 2.3.1.3).

In view of the above-mentioned considerations, it can therefore be concluded that when learners engage in exploratory and constructive play-based activities, they achieve competency for emergent numeracy effectively. Constructive play assists learners to experiment with physical learning materials while developing incidental learning opportunities (Fox, 2002).

In my opinion, Grade R teachers in the sampled schools who do not create opportunities for setting up activity areas in their classrooms to develop emergent numeracy through play-based activities create obstacles that hamper opportunities to create a conducive environment for learning numeracy effectively.

4.2.1.3 Visual Learning Materials

Another question asked to the six selected teachers was as follows:

Researcher: *What learning materials do you use for teaching numeracy in your classroom?*

This question required the teachers to indicate the teaching and learning materials they had in their classrooms through which they created an opportunity for incidental learning that assist learners to explore, and identify numeracy concepts such as colour and how many, amongst others in order to develop numeracy knowledge (Gordon & Browne, 2004). The intention for asking this question was to find out if the teachers were able to provide appropriate learning materials that stimulated learning through play-based learning to develop numeracy knowledge.

Some of the teachers' responses are as follows:

Teacher 1: Number charts showing numbers 1-10 such as number 1 and a picture of one goat, number 2 and a picture of two goats. There is a weather chart, birthday chart, and days of the week as well as seasons of the year.

Teacher 2: Posters with counting pictures indicating one object and the number 1, two objects showing the number 2. I draw the pictures or cut and paste pictures of people, fish, the number and the word to help them learn. A weather chart, days of the week

Teacher 3: A calendar, posters describing numbers 1-10 represented in pictures, number symbols, number names and dominoes. There is a weather chart, days of the week.

Teacher 6: There are pictures for counting numbers 1-10. There are also pictures of fruit, numbers and words. A chart for advanced numbers 1-20. We have another chart with shapes to teach learners to know the shapes.

When further probed on "what else do you have?" the teachers also highlighted that there were also physical learning materials in their classrooms.

The findings from the lesson observations however indicated that four of the six selected teachers, did not display the concrete learning materials in their classrooms, and as such, learners did not use them in the numeracy lessons the researcher observed. The physical learning materials were kept in the resource kit either in the principals' office, the storeroom or at the back of the classroom. When asked why they did not display the

physical learning materials during the lessons observed, the teachers gave several reasons.

Firstly, five teachers (T1, 2, 4, 5 and 6) indicated that they kept the learning materials in the resource kit due to space constraints in the classrooms.

Secondly, the teachers stated that they kept the learning materials in the resource kit because they were scared that thieves from the community could vandalize the classrooms and steal them or that learners could take the learning materials home to play with.

The teachers further emphasized that the supply of the physical learning materials such as (counting cubes) are barely enough if they should be shared among the large classes they are teaching. The teachers therefore choose alternative means such a fingers, sticks and pebbles to support object counting activities. T1 explicitly described the situation of inadequate physical learning materials as follows:

When engaging learners in whole-class counting activities, each learner could only get five cubes, this would mean that learners could only count 1-5.

The teachers' responses from the interviews revealed that only one teacher, T3 responded to the 2nd question on the interview protocol/guide differently.

4.2.1.4 Physical learning Materials

The participants were also asked to respond to the following question:

Researcher: *What physical learning materials do you have for teaching numeracy in your classroom?*

T3 indicated that she displayed the physical learning materials distributed by the DBE in the various learning areas in order to involve learners in play-based activities at the same time, based on the theme of the week. This is how T3 responded to the question:

I display the physical learning materials such as number puzzles, abacus and building blocks distributed by the DBE in the various activity areas to involve learners in playbased learning. I also display the concrete learning materials like bottle tops (caps), empty plastic bottles, cereal and milk boxes, empty soft drink (beverage) tins, as well as paper cups (recycled learning materials) which learners bring from home in the various activity areas.

The literature review (see 2.3.2.1), highlights that numeracy learning begins with the handling and exploration of the physical learning materials (Charlesworth & Lind, 2013). Physical teaching and learning support materials further help make teaching and learning numeracy interesting for learners (National Curriculum Framework, 2005). Many Grade R teachers believe that the ability to manage and solve numerical problems is best done through the use of learning materials which are specifically designed to assist children learn numeracy. Physical teaching and learning materials also support active learning and achievement of numeracy outcomes.

According to Morgan and Harmon (1984), access to both visual and physical learning materials is essential because it has a positive influence on the teaching and learning of numeracy. Morgan and Harmon (1984) further highlighted that when learners engage in numeracy activities, they integrate the use of the physical, written symbols and pictures in order to learn numeracy effectively (Charlesworth & Lind, 2003). Constraints such as lack of adequate learning materials can however, create passive and unhappy learners due to boredom.

This is in line with the constructivists who encourage discovery learning through which learners are given an opportunity to explore the physical learning materials in their classroom environment in order to construct their own learning (Van de Walle, 2007). Discovery learning occurs when teachers create opportunities for learners to explore the physical learning materials in the classroom in order to learn numeracy concepts and

skills with understanding (Naudé & Marais, 2014). The physical learning materials therefore support the development of numerical concepts (Lukong & Reaves, 2007).

The lesson observations and teachers' responses from the interviews regarding the visual learning materials are in line with Drew's iconic mode of representing numerical ideas (2.3.1.3). The iconic mode of learning suggests that the representation of numbers through pictures and written symbols assist learners to understand and participate in numeracy conversations in order to learn the abstract concepts (Drew's, 2007). The study of Kennedy and Tipps (1994) also agreed with this notion suggesting that the concrete learning materials could make the most difficult numerical concepts easier to understand because they assist learners to connect abstract concepts to real objects. Early research (see 2.3.2.3) in South Africa, DoE (2001, 2007) established that learners in schools with more teaching and learning materials obtained higher scores than learners in schools with less learning materials.

In order to achieve a conducive environment for learning numeracy, Grade R teachers should:

- i) Provide posters and charts in order to assist learners to develop age-appropriate numeracy knowledge (see Jennings, 1993).
- ii) Provide concrete learning materials in order to assist learners to construct their own numeracy knowledge and skills (see Van de Walle, 2007).
- iii) Create a network of physical learning materials, pictures and written symbols to assist learners to understand age-appropriate numeracy concepts (see Bodrova & Leong, 2003).
- iv) Improvise and make their own teaching and learning materials from recycled materials when the schools are not in a position to provide, in order to facilitate learning through exploration of a range of child-centred activities during free play to enable the learning of numeracy concepts, (Miller, 2002).
- v) Several learning materials and activities can be used to enrich teaching and learning numeracy (see Bergen, 2002).

4.2.1.5 Implications of Research Question 1

From the ongoing discussions it can be concluded that the teachers' interviews regarding research question 1 demonstrated that two types of classroom environment Grade R teachers created emerged. The two environments are highlighted as follows:

i) Teachers who viewed the layout of the classroom environment as permanent or rigid, restraining them from implementing activity areas. This view also hindered them from providing appropriate teaching and learning resource materials that promoted learning through play-based learning. In view of, the findings highlighted above, it can be argued that the physical layout of Grade R classrooms in the sampled schools hindered teachers from creating a conducive environment for learning.

ii) Teachers who viewed the layout of the classroom environment as flexible and this assisted them to become creative through the implementation of activity areas through which learners are actively afforded an opportunity to explore age-appropriate teaching and learning resource materials in order to stimulate and maximise learning through exploration as well as play-based learning. These teachers however, were experienced in teaching Grade R classrooms and reflected on their insight and became resourceful in order to create a conducive environment for learning numeracy.

These findings are validated by the literature study (see 2.3.1), which highlights on one hand that teachers should create a conducive classroom environment that will meet the child's needs to learn numeracy adequately through incidental or emergent learning. Joubert et al (2008) on the other hand suggested that Grade R teachers should organize activity areas (see 2.3.1.2) in their classrooms in order to engage learners in active learning. Brookovers' and Jouberts' studies therefore support the findings of the study regarding research question 1. The participants lacked insight and creativity to create a conducive environment for learning numeracy. They viewed the layout of the classroom as rigid and permanent and as such they did not organize activity areas in their classrooms. They gave various reasons that restricted them from doing so in order to validate their conduct.

Firstly, some of the participants indicated that due to the constraints in terms of classroom space, there was little room for interaction and learning. Some of the teachers taught in large and crowded classrooms with more than fifty learners. The teaching and learning resource materials, including furniture, and books also inhibited interaction. In addition,

the classroom space limited the teachers to offer activity areas and adequate learning materials to stimulate learning through play opportunities that arise spontaneously during child-centred activities such as block construction and sand play amongst others.

Secondly, some participants indicated that although their classrooms were adequately equipped with the physical learning materials, they could not display them in their classrooms and learners did not use them in the lessons that the researcher observed. The physical learning materials were however, kept in the Grade R resource kit (utility bin) either at the back of the classroom, in the principals' office or in the storeroom (they were actually hidden). The teachers feared that the learning materials could be stolen by thieves from the community who vandalized the classrooms and were also cautious of the possibility of some of the learners taking them home to play with.

In addition, the participants highlighted that they had inadequate supply of the physical learning materials that could be shared among learners in the large classes they are teaching. The physical learning materials distributed to their schools were rather kept in the resource kit in the respective classrooms. The teachers also did not know how to utilize the amount of physical learning materials in such situations.

The teachers' responses from interviews and classroom observations revealed that of the six selected teachers, only one teacher, T3 created a conducive classroom for learning numeracy. The classroom setting differed vastly from the rest - a church building with one big room without partitions. There was therefore adequate classroom space to design activity areas for engaging learners actively in play-based activities. Learners had an opportunity to work as pairs and in groups while learning through doing. In this sense adequate learning occurred. When one group was in the activity area of their choice, such as sequencing objects, sorting and measuring among others, T3 sat with one group and explained to them how the written work should be done. This sort of classroom setting enabled her to provide learning activities that helped learners to develop numeracy concepts and skills including playing with educational games, numeracy and big construction areas in order to stimulate emergent numeracy.

At the beginning of each week, T3 pushed the furniture around which the congregants used on Sundays with the help of stronger boys in her classroom and then stack them properly in the corners in order to create adequate classroom space which facilitated

interaction. She therefore created a classroom environment through which she implemented activity areas and displayed the physical learning materials in order to stimulate learning through play-based activities.

The literature review (DBE, 2011) highlights that the Grade R classroom environment should promote opportunities for incidental or emergent numeracy that arise spontaneously through learner-centred activities. Teachers should therefore adopt a flexible approach when arranging the classroom environment because the layout of the Grade R classroom is supposed to be flexible in order to accommodate a range of learner-centred activities such as fantasy play and construction block play. When designing the classroom environment as well as the physical space that strengthens teaching and learning, the Grade R teachers should be adequately trained in order to acquire strategies to organize conducive Grade R classrooms.

Considering the discussions above, it can be concluded that most of the teachers in the sampled schools lack insight and capacity to create a conducive environment for learning numeracy. The teachers regard the physical layout of Grade R classrooms as a barrier that limits them from organizing the Grade R classroom, making adequate learning materials accessible to learners and arranging adequate furniture for facilitating small-group teaching. The teachers could therefore not make modifications to the large and overcrowded classes they are teaching. It can further be concluded that a few teachers however were more experienced in teaching Grade R sought strategies to create conducive environment for learning numeracy. This includes planning various activity areas, arrange furniture adequately for small-group teaching and offer adequate learning materials to assist the teachers create conducive environment for learning numeracy.

4.2.2 Research Question 2

How Grade R teachers are implementing the numeracy curriculum?

This section presents the findings regarding research question 2, guided by teachers' responses in the interviews followed by lesson observations and document analysis.

4.2.2.1 Interviews

The participants responded to the interview questions from the pre-lesson and postlesson observation interview guides. The interview guides were used to ask questions from the teachers in order to increase the validity and credibility of the data collected. The main activities of learners in the lessons were presented in three categories such as oral work, discussions and written work. Teachers were asked to respond to the following question:

Researcher: *How do you teach numeracy in your classroom?*

The summaries described below highlight how some of the teachers responded to the interview question.

T1: *In the morning I ask the whole class to count numbers orally from 1-10 while seating at desks and chairs. They also discuss the weather and the birthday charts. I teach the number for the day, for example three. I ask learners to count from 1-3, from the wall chart. I give them small boards and ask the learners to draw three objects. Some learners use workbooks (scribblers) because the small boards are not enough for the whole class. I then take one group of ten learners to work with me. We look at pictures displayed on the wall and I ask them questions to learn numbers from 1-10. I ask learners to count objects in the picture and then to tell how many objects are there, then identifying a number and number name that match the number of pictures counted in order to learn counting the numbers from 1-10.*

T6: *for whole class in the morning I go to the green board and show them the number that we are learning. I show them what we are learning when we are in groups, it is not all learners who are able to understand. I then write the number on the green board in dotted lines. I show learners how to trace over the dotted lines in order to learn how to write the number. I give advanced work to learners who understand and remain with those who are struggling in order to help them (reinforcing the concept taught).*

The findings from the teachers' responses in the interviews established a pattern that emerged from all numeracy lessons of the participants the researcher observed. This included oral work, discussion and written work. The findings from the lesson observations validated what the teachers said in the summaries below:

4.2.2.2 Lesson Observations

The lesson observation validates the teachers' responses from the interviews, recognizing that the lesson presentations the researcher observed from the participating teachers have shown a pattern with three major activities, such as oral work, discussion activities and written work as discussed in the outlines in the next page.

□ Oral work activities

The summaries on how some of the teachers' implemented oral work are described as follows:

T2: *kha ri ime rothe u mona na dzidesike, ri vhande zwanda kafumi ri tshi kho vhalala 1-10* (stand along the desks and clap your hands ten times while counting 1-10). The whole class clapped their hands ten times while counting 1-10. She further said:

T2: *kha ri thobie rothe nga mulenzhe muthihi kafumi ri vhale 1-10* (hop on one leg ten times and count 1-10).

The whole class hopped on one leg while counting 1-10.

Learners practiced counting 1-10 while clapping hands, galloping or clicking fingers with groups of boys and girls counting alternating turns for about five minutes in order to reinforce the concept of rational counting.

T5: *kha ri vhale rothe 1-10 nga u sielisana, hu thome vhasidzana hu kone u da vhatukana* (count 1-10 alternating turns, with girls counting first and boys also counting).

The whole class drilled counting numbers 1-10 alternating turns for five minutes.

The lesson observation also confirmed the findings from the teachers' responses in the interviews with regards to discussion activities.

In my opinion, the repetition of these activities where children were learning through doing, hopping and clapping, suggests a conducive classroom environment through which children learn counting by drilling and repetition of similar activities in a variety of modes. The implementation of whole class approach during the oral activities was confirmed in the discussion activities as described in the summaries of some of the teachers' lessons below:

□ Discussion activities

The following discussion activities describe how some of the teachers engaged learners in the discussion activities.

T3 engaged her class in a discussion/problem solving activity regarding the topic „describing, comparing and ordering“ numbers. She told her class:

Vhalani dzibola dzi re kha tshibogisi tsha u thoma na tsha vhuvhili. Sumbedzani tshibogisi tshi re na bola nnzhi na tshibogisi tshi re na bola thukhu (count the balls in the two boxes and indicate which box has more and which box has less balls).

Learners counted five balls in the first box and nine balls in the second box. The whole class involved in the same activity at the same time. T3 asked learners to indicate which

box has more balls and which box has less balls. Learners compared and described that there are less balls in the first box and more balls in the second box.

T4 engaged the whole class in two verbally-stated problem solving summaries. In the first problem he stated that

Hayani hu na nwana muthihi, ha da khonani dzawe mbili u tamba nae, hu na vhana vhangana? (there is one child at home, two more friends come to play. How many children are there?)

T4 requested one learner to stand in front of the classroom and two more learners were also requested to stand one by one next to each other. The whole class was requested to count each learner as they were standing one by one next to each other in order to solve the problem „how many children are there?

T4 further posed another story sum indicating that

Mulweli u na maswiri mana. Baba vho vhuya na manwe maswiri mana. Hu na maswiri mangana? (Mulweli has four oranges. Dad brings four more oranges. How many oranges are there?)

T4 additionally asked learners to count four fingers to represent four oranges and to further count four more fingers. He then asked learners to count all the fingers. The counting activities were repeated several times with individual learners given an opportunity to respond to various questions in order to solve the problem sums.

□ **Written work activities**

The classroom observations established that teachers in the selected schools engaged learners in written work activities. The following summaries of the lessons describe how some of the teachers presented written work activities in their Grade R classrooms:

T1 involved the whole class in a written activity during which learners were required to copy the number formation 1-5 in their workbooks individually. She demonstrated how learners were required to carry out the written task. She wrote the numbers on the big chalk board to demonstrate the number formation, the pattern, as well as the correct spacing between the numbers. She involved the whole class in copying the numbers individually in their workbooks. She requested learners to write and fill half a page of the workbook with the activity. The purpose of the written activity was to assist learners to develop the fine motor coordination skills. T1 walked around in class and identified learners who for instance could not follow the correct spacing and those who wrote numbers in the reversed form. She requested them to copy fewer lines in order to help them complete their written activity correctly.

In the third activity of the lesson, T6 requested learners to complete a written activity from a worksheet. She first engaged the whole class in a demonstration lesson through which learners were asked to look at the pictures of containers in each row, identify containers as „full“ or „empty“ and mark their choice with a tick in the relevant box. The whole class completed four sums each individually in their workbooks. T6 observed learners while they completed the task and assisted learners who had challenges of completing the task correctly. She assisted a learner to realize that he only needed to shade the empty container in order to demonstrate that it was full.

The lesson observations confirmed what the teachers said in their interview responses; indicating that all the lessons the researcher observed followed a particular pattern such as oral, demonstration as well as written work activities. This pattern was recommended by the DBE (2011) because a number concept is taught and reinforced through the three stages of the major lesson. According to the DBE (2011) there is need for learners to go through all the stages of number concept development, such as oral, demonstration and written activities in order to assist learners understand the number concept taught effectively.

In view of the major activities of all numeracy lessons of the six selected teachers the researcher observed, a pattern emerged reflecting oral work, discussion and written work. This highlights that teachers in the sampled schools facilitated the various lesson activities to create a conducive environment through which numeracy was learned.

4.2.2.3 Lesson Descriptions

In this section six lessons from the participants in the study are presented. The teachers have taught more than one lesson. Only six lessons, one from each teacher was however selected to make the study manageable. The lessons are presented according to five categories, such as classroom space, arrangement of the classroom, visual learning materials, physical learning materials and the lesson descriptions.

TEACHER 1: **Topic:** Number symbols and number names from 1-5.

Classroom space

The Grade R classroom in school A was taught in a standard-sized classroom. T1 taught fifty-two Grade R learners (19 boys and 33 girls). There was no adequate space to design activity areas in this classroom in order to create conducive environment to engage learners in play-based activities.

Classroom arrangement

Learners sat at formal desks, with three learners sharing a desk meant to sit two children. The desks were arranged in rows to form a u-shaped style with a medium sized table and a chair for the teacher positioned in front of the classroom. Some of the learners sat at child-sized plastic chairs and tables that were consistently arranged alongside the desks in the middle of the classroom. A large chalkboard occupied almost the entire front wall of the classroom and there were no cupboards in the classroom. The classroom looked heavily congested with furniture; and there was also no space for mat work activities

(small group work through which a group of eight to ten learners work with the teacher on the mat in an open space to consolidate the number concept taught).

Physical teaching and learning resources materials (TLMS)

The physical learning materials (manipulatives) in school A were not displayed in the classroom, and learners did not have access to them and as a result, they also did not utilise them during the lessons observed. The concrete learning materials disseminated by the Department of Basic Education were however located in the Grade R resource kit at the back of the classroom. T1 however, kept a few of the concrete learning materials (for example, slates and pieces of chalk, crayons and exercise books) in a small shelf along the wall for quick reference when teaching the lessons observed.

Visual learning materials

There were colourful posters; green, red, blue and yellow (primary colours) displayed on the wall of the classroom in school A. The posters showed pictures (mathematical ideas that teachers and/or learners draw or finds in books) of animals, fruit (for example, apples, oranges) and vegetables (such as tomatoes, cabbage and potatoes, which learners used in various ways, namely counting, sorting and comparing the pictures to recognise the relationships between numbers). The posters were displayed at a reasonable level of vision, (where learners could have easy access on the information displayed). There were also charts displayed on the classroom walls showing pictures of geometric shapes (square, circle and so on to enable the learners to identify the shapes according to number of sides and corners); and the weather (to allow learners to establish the order and the sequencing of the seasons amongst others).

There were number charts representing numbers 1-10, describing number names and symbols displayed on the walls. Days of the week, months of the year, and children's birthday dates were printed clearly on the charts shown on the wall (learners placed their names on the birthday chart to identify their birthdays and the class sang them a birthday song). Learners further used the number chart to count and match number names with the relevant number symbols. The number charts assisted learners to identify various numbers represented in various modes with the teacher's guidance.

Lesson description

T1 was observed twice teaching numeracy and she presented her first lesson with three main activities. The first activity was on oral counting of numbers from 1-10, the second activity was on number recognition from 1-5, and the last activity was written work to reinforce number recognition from 1-5.

The aim of the first activity observed was to teach learners to learn counting numbers 1-10 by rote. Rote counting means that learners say the number names almost as a rhyme. T1 introduced the lesson by asking the whole class to sing a counting rhyme in their home language Tshivenda “*mabodelo a fumi ntha ha luvhondo*” (ten green bottles) appendix F. Learners sang the rhyme showing all their fingers from the left and the right hand to represent ten fingers. The whole class was involved in the same counting activity at the same time, bending one finger at a time to represent nine bottles then two fingers to represent eight bottles and so on. The learners repeated this activity for almost five minutes, to reinforce the rhyme learnt, with groups of boys and girls alternating turns when reciting the rhyme.

The second activity was a discussion lesson. T1 requested learners to identify the number of buses, cars, bicycles, aeroplanes and motorbikes on the big poster. The whole class was engaged in same activity, identifying and counting the number of each mode of transport. T1 further requested learners to recognize numbers 1-5 from posters and charts displayed in the classroom (to support learning). She also requested learners to count the objects that represented the numbers 1-5 in order to verify the value of each number. Learners also traced the number formation from 1-5 with fingers. This was a revision lesson through which learners identified number symbols 1-5 represented in number names, objects and dominoes. In addition, T1 randomly distributed number cards to individual learners which described number symbols and number names. She called out numbers 1-5 in the correct sequence and learners were given opportunity to arrange the components of numbers in the correct sequence. The whole class drilled the activity of recognising and identifying number symbols and number names 1-5 for 10 minutes.

The third activity required the whole class to trace the dotted numbers 1-5 to complete a written task in work their workbooks individually. The aim of the activity was to develop the fine-motor co-ordination (functioning of the small muscles) of the learners. The work books were not enough for the whole class, therefore learners shared the books in order to practice identifying and tracing the numbers learnt. T1 copied and pasted the worksheet with numbers 1-5 in A 5 exercise books. The activity had five sums and the teacher explained what learners were required to do in order to complete the written activity shown in their workbooks. Learners completed the written activity. (See Appendix E)

During the lesson T1 walked around in the classroom, to observe how learners performed in the written task. Some learners did well however, other learners did not trace on the dotted numbers. They nevertheless copied the numbers in the blank spaces between the dotted numbers. T1 then identified individual learners who struggled to complete their task adequately; for example, the learners who wrote five in the reversed form (facing the wrong direction). She assisted these learners to repeat the activity in order to complete it correctly. To conclude the lesson, she pitched the counting rhyme “ten green bottles” which learners sang at the beginning of the lesson. The finger rhyme in this section of the lesson was to reinforce the lesson and indicate the end of the lesson. Learners sang along as they were sending back the workbooks to the teacher.

Post-lesson observation interview.

The participants’ responses in the post-lesson observation interviews and document analysis demonstrated how Grade R teachers are implementing the numeracy curriculum. The conversation between the researcher and T1 is described as follows:

Researcher: *I enjoyed observing your class. How did the lesson go?*

T1 *I think my lesson went well. Although this lesson was presented to reinforce the counting of numbers from 1-5; I think there are learners who did not understand the lesson and would need support in order to achieve the lesson objective.*

Researcher: *Were the objectives of the lesson achieved?"*

T1: *Yes, the objectives were achieved".*

Researcher: *Why do you say so?*

T1: *Most of the learners in the classes were able to identify and count numbers 1-5 satisfactorily. The learners also traced the dotted numbers 1-5 adequately.*

Researcher: *What challenges did your learners have in the lesson?*

T1: *There were a few learners who did not understand that they were required to trace the dotted lines instead of writing their own numbers.*

Researcher: *What are you going to do to address this problem?*

T1: *I need to identify learners who did not understand the instructions as soon as they start writing the activity and assist them complete the activity correctly.*

Classroom space

- The teachers' responses in the interview showed that there was a strong agreement on the issue of classroom space, most of the respondents T1, T2, T5 and T6 taught in an overcrowded classroom with fifty-two learners in each school.
- This type of classroom is not conducive for learning numeracy because it hinders the participants from organizing activity areas in order to engage learners actively in the learning process and help them construct their own knowledge.
- This is validated in teachers' interviews as follows:

T1: *I have many learners in my class and I do not have enough space to set-up activity areas.*

T6: *I have many learners in my class and do not have enough space to set-up activity areas.*

In my opinion, overcrowded classrooms hinder Grade R teachers from creating a conducive classroom for learning numeracy. Teachers should be resourceful in order to design a classroom that would assist learners to participate actively in the learning process and construct their own knowledge of mathematical concepts (2.2)

TEACHER 2:

Topic: Geometric patterns

Classroom space

T2's classroom was located near two empty mobile classrooms, one on the Eastern side and the other one on the Southern side of the classroom. She taught fifty two Grade R learners (20 boys and 32 girls) in a standard-sized classroom. The classroom had no activity areas to engage learners in play-based learning.

Classroom arrangement

The desks in T2's class were arranged in formal rows (for whole-class teaching). Three learners shared a desk designed for two learners. A few plastic tables and chairs were also arranged in the middle of the classroom and four learners sat around each table. A big teachers' table was positioned at the front of the classroom facing learners' desks. The classroom seemed crowded with furniture.

Physical learning materials

Physical learning materials such as educational toys were placed in a resource kit distributed by the Department of Basic Education. The learning materials were kept in the store room and learners did not use them during the numeracy lessons observed. The manipulatives in the resource kit included, skipping ropes, plastic counters, and number cards (1-10 number chart, flard cards, dot cards, number symbols and number names, as well as number lines) among others. A few Lego pieces and puzzles (construction

toys) were nevertheless, placed on a small table in the classroom and learners did not make use of them as they were otherwise occupied during the lessons. Sticks and small pebbles (indigenous materials) to solve mathematical problems were kept in the childrens" bags and in recycled ice-cream containers.

Visual learning materials

There were posters displayed on the classroom walls in school B. The posters described animals, fruit and vegetables (objects), number symbols, dot cards and number names. The posters were placed high on the walls, and they were out of the childrens" line of vision. Wall charts defining shapes, days of the week, months of the year and seasons of the year were also displayed on classroom walls.

Lesson description

The first lesson T2 taught had three major activities. She was observed twice teaching numeracy lessons. The first activity taught was on oral work. To introduce her lesson, she engaged the whole class in rote counting numbers 1-10. T2 requested learners "kha ri ime ri mone na dzi desike; ri vhale ri tshi vhanda zwanda kafumi ri tshi kho vhala u bva kha 1 u swika kha 10" (to stand along the desks and clap hands 10 times while counting 1-10). Learners clapped their hands 10 times while counting from 1-10. She also asked them "kha ri thobiye nga mulenzhe muthihi kafumi ri dovhe ri vhale u bva kha 1 u swika 10" (to hop on 1 leg 10 times and count 1-10). Learners hopped on 1 leg 10 times while counting from 1-10". Learners practised counting 1-10 while clapping hands, galloping and clicking fingers with groups of boys and girls alternating turns for 5 minutes. T2 also requested learners to arrange the number cards 1-10 in the correct sequence to reinforce counting 1-10. T2 created a conducive environment for learning numeracy effectively through activities through which children learned through doing experiencing the concepts with their bodies to help them understand what they learned.

The second activity was a continuation on geometric patterns but the focus was on the discussion of pattern making using shapes and colours of geometric shapes. The objective of the activity was to teach learners to read, copy and extend simple patterns by using shapes and colours to create patterns. Learners identified shapes and colours

from a poster shown on the board. T2 she said “kha ri ambe zwivhumbeo zwi re kha tshifanyiso na mivhala yazwo” (identify shapes and colours from this poster). Learners identified shapes and colours such as red and black square, blue and yellow triangles, orange and green circles and so on.

In addition, T2 presented a pattern to the whole class which comprised of a green square and a red circle. She repeated the pattern, green square and red circle, green square and asked learners to continue with the pattern. Learners continued with the green square and red circle and so on. The whole class was engaged in pattern-making using various shapes and colours identified from the poster and wall charts in the classroom for about 10 minutes.

In the third activity T2 involved the whole class in a written task. The worksheets were copied from the workbook supplied to schools by the DBE and pasted in the exercise books due to the fact that there were not enough copies of the workbooks for all learners. The activity had four sums and learners were expected to trace and colour in the shapes to complete the patterns. She first gave a demonstration lesson to the whole class to ensure that learners complete the written activity satisfactorily. Fifteen to twenty minutes before the end of the lesson, learners completed the written activity individually.

The activity had four sums.

T2 walked around the classroom marking learners’ work and assisting those who experienced problems in completing the activity. Most of the learners managed to complete the written activity correctly. A few learners however, could not complete the written activity satisfactorily. For example, L10 (Learner 10) had coloured in the second set of ovals as two red instead of orange and red ovals. T2 helped L10 to look carefully in the third row, identify the colour of the first oval then the second oval followed by the third oval. L10 then looked at the third row carefully again in order to correct her mistake and submit the work to the teacher. Learners finally sang the counting rhyme “thihi, mbili, raru, vhatuku and so on” (one, two buckle my shoes, and so on) to conclude the lesson, see appendix F. Learners sang the rhyme to mark the end of the lesson.

Post-lesson observation interview

When reflecting on the lessons observed, the following discussion emerged between T2 and the researcher. The researcher highlighted to T2 that she had noticed that wholeclass teaching dominated her lessons. T2 indicated that the classroom space was a constraint that hindered her from designing adequate activity areas to involve learners in small-group teaching in order to support play-based learning.

When the issue of the whole-class teaching was probed further, the researcher requested T2 to explain the rationale behind learners being mainly involved in wholeclass teaching. T2 explained that she taught a large class with more than fifty learners. She thus did not have adequate classroom space to set up numerous activity centres to engage groups of learners in different activities at the same time.

Classroom arrangement

- The issue of classroom arrangement clustered most of the participants together. It was revealed that the desks and chairs wherein T1, T2, T5, and T6 taught were arranged in rows. This arrangement hinders learners and teachers from interacting and moving around comfortably in the classroom.
- The participants therefore could not arrange the furniture in group clusters to offer learners opportunity to participate in play-based activities such as threading beads and measuring capacity among others.
- Teacher's responses in the interviews below corroborates the findings regarding classroom arrangement:

T2: The desks in my class are arranged in rows.

T5: I arrange the desks in rows and there is no space for activity areas in my class.

In view of the responses above, it is necessary for Grade R teachers to use furniture in various ways in order to afford learners opportunity to interact with the learning materials in various activity areas in order to discover new knowledge (2.3.1.2 and

2.3.1.3).

TEACHER 3 Topic: describe, compare and order numbers 1-9

Classroom space

The Grade R class for T3 were taught in a church building which only had one big room without partitions. T3 used the whole church building in order to engage learners in playbased activities at the various activity centres. At the time of investigating, T3 explained that she created space for her learners in the classroom by stacking the plastic chairs which the worshipers used on Sundays into a corner at the beginning of each week. In this sense all learners were involved in learning through play. The classroom was organized according to activity areas; (these are times when the teacher plans and involves groups of learners in different activities at the same time in the classroom environment). Learners had a variety of activities to choose from and could decide in which order they are going to tackle them.

The learners in T3's classroom in my opinion were privileged because adequate learning occurred in their classroom. She adjusted furniture in the classroom to create a conducive environment for learning numeracy. She further displayed both visual and concrete objects in particular (bought and recycled) to create opportunities for learners to engage in learning experiences, activities and discussions which challenged them to understand numeracy concepts and skills.

This was asserted by T3's response in the interviews indicating that:

T3: *I display the physical learning materials provided by the DBE such as (number puzzles, abacus and building blocks) in the various activity areas to involve learners in play-based learning. I also display the physical learning materials like bottle tops (caps) empty plastic bottles, cereal and milk boxes, empty soft drink (beverage) tins, as well as paper cups (recycled learning materials) which learners bring from home. The physical learning materials support the development of numeracy concepts and the achievement of numeracy outcomes (4.2.1.4).*

Classroom arrangement

There was no teacher's desk and chair in this class and moreover, there were no child-sized plastic chairs and tables for learners. Learners sat on formal desks (fixed structure of a bench and table designed into one permanent structure) in groups of six. Two groups of desks were placed facing each other to accommodate six learners in each group.

Physical learning materials

There was a variety of concrete learning materials which included recycled materials which learners had brought from home, such as soft drink containers in the games activity area, paper cups labelled number names and symbols in the numeracy activity area and cereal boxes in the construction play, among others. There were educational toys too comprised of beads, building blocks, counters, play money (notes and coins), number charts 1-10, number line strips, skipping ropes, abacus, measuring cups, among others, were set out in the relevant activity areas to involve learners in active play. The educational toys were provided by the DBE and positioned in the Grade R resource kit (resource kit) which was carried to and from the school building in the principal's office to the church building where the Grade R class was taught. The principal's office served as a general resource room for all the equipment of the school and a classroom where the Grade R and 1 were taught. The resource kit was carried back to the resource room at the end of school day as a safety measure from theft by community delinquents. T3 and T4 shared the learning materials provided by the DBE.

They therefore had similar resources in both classrooms which were kept in one classroom and alternated turns to use them when a need arose.

Visual learning resource materials

A collection of brightly coloured posters (red, blue, green and yellow) were displayed on the wall of the Grade R classroom in school C. The posters depicted farm animals (such

as cows, goats, sheep and so on), as well as wild animals (such as zebras, giraffe, and elephants, etc.) and fruits (apples, oranges and grapes). The posters also showed vegetables (potatoes, tomatoes and onions) which learners identified, counted and sorted out, for example according to colour and size. The posters also displayed geometric shapes (square, rectangle and so on) which learners identified and described.

There were charts and posters displayed on the wall, showing days of the week, months of the year (in order to familiarize the children with the concept of time). Learners can learn which day of the week was first and which day came last among others. There were number names, number symbols and dot cards well printed on colourful charts with which learners matched the number names and number symbols (to suggest mathematical ideas to learners). The number names were written in home language (Tshivenda). Number charts presenting numbers from 1-10 printed on the soft pink paper and were placed at a reasonable level of vision for learners to recognise and work with the information. The learning materials were also similar in both classrooms, T3" and T4"s as stated above.

Lesson description

T3 taught Grade R and was observed twice teaching numeracy lessons. Her lessons always had three major activities. The first activity of the lesson observation was rational counting numbers 1-10, followed by a discussion and a written activity last. Rational counting refers to knowing number sequence and applying it to objects or body parts.

On the first day of lesson observations, learners sang a counting rhyme "nthisi, mbili nda vuwa (one two buckle my shoe, and so on) to introduce the lesson. The whole class was involved in singing the counting rhyme with body movements, for example, showing body movement when putting on their clothes. The whole class practised rational counting (matching number names with body parts objects) for five minutes.

T3 asked learners how many fingers they have. She further asked them to show fingers from both left and right hand as well as counting their fingers to represent 1-10. She said "kha ri vhale u bva kha 1, u swika 10 ri tshi kho sumbedzela nga minwe yashu nga muthihi nga muthihi" (Counting 1-10 showing finger strategies to indicate the numbers).

The whole class counted the required numbers in chorus. T3 also said “kha ri vhale u bva kha 1 u swika 10 nga u sielisana; hu thome vhatukana hu kone u da vhasidzana” (take turns counting from 1-10; boys counting first and then the girls taking a turn thereafter). The whole class alternated turns to practice counting from 1-10; with groups of boys counting first and then girls counting for ten minutes thereafter.

In the second activity; T3 asked learners to sit at their desks in groups because there was no provision for a mat. There were only three groups of four learners each. She explained to her learners that they should identify kinds of fruit on the big poster and count the total number of each type. Learners identified the fruits and counted how many oranges, bananas, pawpaw"s, apples and so on. During the discussion activity three groups of learners were engaged in different activity areas to reinforce the identification and ordering of numbers 1-9. The first group of learners identified sets of numbers 1-9 from number posters and compared which set had more and which group had less fruit. The second group identified and sequenced paper cups with wax crayons and number names to represent numbers 1-9. Learners also compared the paper cups and identified which paper cup had more and which one had less wax crayons. The third group were building number puzzles to identify and sequence the numbers learnt. T3 engaged the rest of the learners in class in identifying and sequencing number cards describing number 1-9 in number symbols, number names and pictures of fruit. Learners worked in the different groups describing and ordering numbers 1-9 for ten minutes.

Fifteen to twenty minutes before the end of the lesson, learners were involved in the 3rd activity, written work. T3 first explained how the written activity was to be completed. Learners identified and counted sets of objects in two boxes from each row. Learners compared the sets of objects and indicated which set had more and which set had less objects. She said “*sedzani zwigwada zwa zwithu zwi re kha zwifanyiso. Bulani uri ndi sete ifhio i re na zwithu zwinzhi na sete i re na zwithu zwituku*” (learners were requested to describe, compare and order sets of pictures). Learners counted sets of objects in each box and traced the correct number. There were six sums in the activity through which learners identified, ordered, compared and traced the dotted number to indicate the correct number of objects in sets of numbers 1-9. Learners completed the written activity. T3 walked around in the class observing and marking the work while learners wrote the activity highlighted in their workbooks (see Appendix E).

Post-lesson observation interview

During the follow-up discussion with the researcher, T3 indicated that she considered small-group work activities to be the vital part of her numeracy activities. She highlighted that group work activities assists her to engage learners in active (playbased) learning and to assess the needs of individual learners in numeracy activities. She further indicated that she provided various learning activities that are ageappropriate, since she had appropriate classroom space for small-group work. She was therefore able to involve learners in different activities simultaneously, such as identifying sets of numbers 1-9 from number posters, building a number puzzle, counting and matching number names as well as number symbols identified and sequenced paper cups with wax crayons to represent numbers 1-9 without interfering with one another.

In addition, she indicated that she was particularly pleased with the small-group work because she could rotate different groups of learners handling and working with the concrete material in order to learn numeracy with understanding. When she was asked if her lesson objective were achieved, she indicated that she was satisfied that the lesson objectives were achieved because the identification of numbers 1-9 was reinforced in various situations.

Physical learning support materials

- There was a strong agreement on the way in which the physical teaching and learning support materials (TLSM) were used in Grade R classrooms of the sampled schools.
- The physical learning materials included plastic counters (unifix blocks), counting frames (abacus), plastic balls, hoops, and mini clocks.
- Teachers were supposed to use the teaching and learning support materials in order to engage learners in play-based activities. Learners were also supposed to explore and discover how they can use the TLSM in order to learn numeracy concepts.

- It was revealed that the participants could not use the physical TLSM in order to create a conducive environment for learning numeracy because they did not have adequate space to display them. The participants explained that the TLSM were at risk of being stolen or vandalized. The TLSM were kept in the Grade R resource kit and concealed in a safe place in each school, either, in the cupboard, store room, the principal's office or at the back in the classroom.
- This suggests that the participants could not create opportunities to promote adequate learning of numeracy concepts and skills, since active engagement was hindered (4.2.1.4).

TEACHER 4: Topic: solves verbally-stated addition problems 1-10

Classroom space

T4's Grade R was taught in a standard-sized foundation phase classroom. The principal's office served as the general resource room for keeping all the equipment's of the school. T4 did not implement activity areas. The Grade R and Grade 1 classroom were taught in the first classroom of the two-roomed school building.

Classroom arrangement

There was no teacher's desk and chair in this class and there were no child-sized plastic chairs and tables for learners. Learners sat at formal desks (fixed structures of a bench and table designed into one permanent structure) in groups of six. Two groups of desks were placed facing the opposite direction to accommodate six learners in each group. There were no cupboards in the classroom.

Visual learning resource materials

There were posters displayed on the wall of T4's classroom. The posters showed farm animals (cows, goats, sheep and so on), and wild animals (zebras, giraffe, elephants etc.), fruit (apples, oranges and grapes). The posters also showed vegetables (potatoes,

tomatoes and onions) which learners identified, counted and sorted out, for example according to their colour and size. The posters also displayed geometric shapes (square, rectangle and so on) which learners identified and described.

There were charts and posters displayed on the wall, showing days of the week, as well as the months of the year. There were number names, number symbols and dot cards printed on wallcharts through which learners matched the number names and number symbols. Number charts showing numbers 1-10 were also placed at a reasonable level of vision for the learners.

Physical learning materials

The physical materials in the Grade R resource kit were not displayed in the classroom nor used by the learners. The resource kit was kept in the principal's office (resource room) since there was no space to display them. This was also to prevent it from being stolen by thieves from the community and to prevent learners from taking them home to play with.

Lesson description

The first lesson T4 taught had three main activities. She was observed two times teaching numeracy lessons. The first activity was on rote counting 1-10. She asked learners to rote count numbers 1-10 with body percussion (actions) such as nodding head, snapping fingers, tapping their knees and clapping hands. She demonstrated the counting patterns. She said "*vhandani zwanda ni tshi kho vhalala 1 u swika kha 10*" (clap your hands and count 1-10). The activity was then repeated with learners nodding their heads. The whole class counted numbers 1-10 clapping their hands and nodding their heads and so on for about five minutes.

In the second activity, T4 taught verbally-stated addition problems with single digit numbers. The aim of the activity was to teach learners to count objects in order to solve verbally-stated problems. She involved the whole class in a practical demonstration. She

created two different scenarios with questions regarding real life problems in order to solve verbally-stated problems posed by the teacher.

In the first problem T4 said “*Hayani hu na nwana muthihi, ha da khonani dzawe mbili u tamba nae, hu na vhana vhangana?*” (There is one child at home. two friends come to play with the child. How many children are there in total?). One learner stands in front of the classroom and two more learners come forward. The whole class counted each learner as they stood one by one next to each other in order to solve the first problem. In the second problem she said “*Mulweli u na maswiri mana. Baba vho vhuya na manwe maswiri mana. Hu na maswiri mangana?*” (Mulweli has four oranges. Dad brings four more oranges. How many oranges are there?). T4 asked learners to put up four fingers (to represent oranges) and four more fingers. She then asked them to count all the fingers together. The counting activity was repeated several times to ensure that all learners were able to solve the story sums.

The written task (completing a task by writing something down and then submitting the task) was the third activity of the first lesson observed. Learners were to write numbers to indicate the total number of animals in the box. The task had five addition sums with single digit numbers and solutions to eight. Learners were to (assist the game park ranger count the animals in the park). T4 guided them with questions such as “*phakhani hu na ndou nthihi, ha da inwe u toda zwiliwa. Hu na ndou nngana?*” to practice counting objects in order to solve problem sums. Learners completed the written activity with five sums. T4 monitored learners writing to determine if they were able to count the animals in order to solve the problems presented. Almost all learners in the class were able to complete the written task successfully, because they counted the animals in the pictures to solve the problem.

When learners were submitting their workbooks, T4 involved them in singing a counting rhyme “*mbevha hedzi tharu, dzi gidima hani?*” (Three blind mice, three blind mice.... and so forth) Appendix F. Learners sang the songs in this class to reinforce the number concept learned and to mark the end of the lesson.

Post- lesson observation interview

During the lesson reflection the researcher asked T4 if the lesson objectives were achieved. T4 responded that she was satisfied that the lesson objectives were achieved. The researcher asked T4 to explain what makes her believe so? T4 indicated that most of the learners seemed to have understood the work, such as counting objects in order to solve verbally-stated problems. The researcher however asked T4 to further explain why learners were not utilizing concrete learning materials to help them solve the problem sums. T4 responded that the learners did not use the physical learning materials because they were set aside in the principal's office due to lack of space in the crowded classroom with school resources. As a result, the learners could not utilise them.

Visual learning materials

- The participants similarly created adequate wall space in the classrooms comprised of visual TLSM such as posters, wall and number charts.
- The visual TLSM were displayed at a reasonable level of vision which provide learners with the opportunity of constructing their own numeracy knowledge.

In my opinion the visual TLSM helped all the participants to engage learners in learning by doing through counting number of objects from posters, matching number names with numerals, and sorting objects from wall charts according to colour or size.

TEACHER 5:

Topic: ordinal counting of 1-10

Classroom space

T5 taught fifty-two (52) Grade R learners in a standard-sized classroom. The classroom looked crowded with many learners. The teachers could therefore not create a conducive environment for learning numeracy.

Classroom management

Learners in this class sat at medium-sized tables and small plastic chairs. The furniture was arranged in a traditional style (rows). Each table was designed for two learners; however, three learners shared one table. The researcher observed that learners sat with legs hanging and they could not work with ease from these tables. Some of the learners sat at child-sized plastic tables and chairs arranged alongside the desks in the middle of the classroom; and four learners sat around each table. Learners sitting at child-sized tables and chairs seemed to work with ease because they sat comfortably with their feet resting on the floor. A large teacher's table and chair were positioned in the front corner of the classroom. There was a large chalk board situated on the front wall of the classroom and occupied almost the entire wall. The classroom looked congested with furniture squeezed against each other. There was limited space for learners to move around in the classroom.

Physical learning materials

A variety of concrete learning materials in this class were kept in steel shelves along the eastern side of the classroom wall, for example, building and counting blocks. There was also a resource kit (Grade R resource kit), with curriculum materials such as educational toys provided by the Department of Basic Education. Most of these toys were kept in sealed packages and learners did not use them in the lessons observed; for example, plastic counters (unifix blocks), counting frames (abacus), beads, hoops, plastic balls, posters as well as mini clocks. Teachers were supposed to use these concrete materials to engage learners in active learning. Learners were in turn supposed to handle the educational toys to learn numeracy concepts, including sorting and ordering through play.

Visual learning materials

T5's classroom walls looked dull and bare (undecorated). There were no pictures on the walls instead, only one A4 size photocopied picture related to the lesson observed was displayed on the chalkboard. This was used during the practical demonstration (involving

presentation of a skill to complete a task). The whole class was involved in rational counting of five figures standing in a row using ordinal numbers (1st, 2nd next and last). The whole class sat on the improvised mat (an old soft bedspread). (Fifty-two) 52 learners squeezed themselves uncomfortably on a very small space right in front of the chalk board. Some learners tried to push their way closer to the chalkboard to view the picture clearly. Most learners did not pay attention during the lesson observed because they were struggling to get some space to sit on the mat. Only a few wall charts were positioned high on the wall. The one chart showed numbers 1-10 among others.

Lesson description

T5 taught her first lesson during which she had three major activities and was observed twice teaching numeracy lessons. During the first activity she asked learners to count numbers 1-10 in ones. T5 guided the counting process and said “*kha ri vhale rothe u bva kha 1 u swika kha 10*” (count together 1-10). Learners counted 1–10 in chorus. She also said “*kha ri vhale u bva kha 1, 2, 3, u swika kha 10 nga u sielisana; hu thome vhasidzana hu kone u vhala vhatukana*” (count 1-10; taking alternating turns; having the girls counting 1st then followed by the boys subsequently). Learners drilled (counting the required numbers); taking alternate turns for both the girls and boys for five minutes. T5 asked the learners to clap their hands rhythmically (following a particular pattern) such as clapping hands loudly as they counted from one and softly when they counted to two and so on from 1-10. The whole class counted from 1-10 rhythmically taking alternating turns.

In the second activity T5 involved the whole class in a demonstration lesson to teach ordinal counting. The objective of the activity was to develop an awareness of ordinal numbers from (1-5) 1st, 2nd and so on up to the last. She requested 5 learners to stand in a row to demonstrate ordinal counting. She involved the whole class in discussing the five learners standing in a row. She asked learners questions to help them practice ordinal counting. She asked “*ri kho vhona mini afha?*” (What do you see in the picture?)

The whole class responded in chorus “*vhathu*” (figures). She also asked “*ndi vhathu vhangana?*” (How many figures are there?) The whole class responded in chorus “*vhathu vhatanu*” (five figures). Soon thereafter, she pointed to 1 learner at a time and counted “*hoyu ndi muthu wa u thoma, a tevhelaho ndi wa vhuvhili, ha tevhela wa vhararu, ha tevhela, wa u fhedza* (1st, then 2nd, 3rd, 4th, and 5th”). She asked “*ndi vhathu vhangana*”

(how many figures are there?). The whole class answered in chorus, stating that there are five figures. T5 pointed at the five figures standing in a row and asked the whole class to repeat counting in ordinals indicating “*hoyu muthu wa u thoma, ha tevhela wa vhuvhili*” and so on. They repeated the counting process for about 10-15 minutes.

The written work was the 3rd activity of the lesson observed and was a continuation of ordinal counting. Learners were required to complete a written task with five (5) sums. T5 distributed workbooks for learners to share looking at pictures as groups because they were not enough for all the learners in class. T5 explained the written activity to the whole class. She asked open-ended questions in order to guide learners in identifying the correct order of hats with questions such as “*muthu wa u thoma o ambara minadzi mingana?*” (How many hats is the 1st figure wearing?) Learner 40 (L40) said “1 hat” and so on. Learners completed a worksheet copied from the learners’ workbooks showing 5 figures standing in a row with blank boxes below each figure. Learners wrote the correct number name and symbol to match the number of hats each figure is wearing. She guided learners on how to complete the task. Thereafter, she monitored the learners while they were writing.

This was a visual discrimination (ability of the eye to see the differences and similarities of objects) as well as a counting task. Some learners were not able to write the number names correctly. She asked them to draw a line to match the label at the bottom with numerals and number names with figures standing in a row. T5 requested learners to sing a counting rhyme “1, 2, 3 *vhana vhatuku*” (1, 2, buckle my shoe) and so on to conclude the lesson. Learners sang the rhyme with much enjoyment. This was evidenced by the body movements they showed as they were singing, such as pointing at each finger counted and clapping hands when they said the last number counted.

Post-lesson observation interview

During the interviews, the researcher asked T5 if the objectives of the lesson were achieved. T5 indicated that she was satisfied that the lesson objectives were achieved. The researcher further indicated T5 that she was concerned that a large group of learners were made to share a few copies of the workbook in order to participate in the activity.

Some of the learners did not get an opportunity to participate effectively in the activity. T5 responded that she does not have enough workbooks for all learners in the large class, and they need to share in order to facilitate the activities. The researcher wanted to find out from T5 how she can improve the situation. T5 indicated that she needed professional assistance in order to deal with the challenge she experienced in working effectively with inadequate resources within a large class environment.

TEACHER 6:

Topic: Capacity ‘full and empty

Classroom space: T6 taught her Grade R in a standard-sized classroom. 52 learners were taught in this class, comprising of 21 boys as well as 31 girls. The classroom did not have adequate space to create activity areas.

Classroom arrangement:

Most learners in this class sat at big learners’ tables and small plastic chairs. The big tables were not suitable for the young Grade R learners. Learners sat with their small feet dangling in the air and they struggled to reach the tables properly in order to work on the tables. The rest of the learners sat on child-sized plastic chairs and tables arranged in the middle of the classroom, where there was a big table and chair for the teacher positioned close to the eastern side window. A large chalk board occupied almost the entire wall in the front, while the whole eastern side wall had large „opening” windows which supplied light and ventilation to the learners.

There were no cupboards in this classroom. The books and resource materials were kept on the (spare) learners’ tables at the back of the classroom; for example, ice-cream containers with natural counters (bundled sticks, bottle caps and pebbles which learners brought from home). Learners were encouraged to use the natural resources during numeracy learning to improvise because T6 and T5 shared the learning concrete and visual learning materials in the Grade R resource kit (educational toys). This included plastic counters and building blocks, paper money and coins, abacuses, mini clocks among others, which were stored at a central point (in T5’s classroom). These were

commercially obtained. Learners did not use them during numeracy lessons observed because they were kept in the resource kit (Grade R resource kit) provided by the Department of Education. The classroom appeared crammed with furniture and there was little space for T6 to design activity areas and for learners to move around and for interacting with their peers.

Physical learning materials:

T6 shared concrete learning materials with T5 which were kept in steel shelves along the eastern side of the classroom wall; for example, building and counting blocks. There was also a resource kit (Grade R resource kit), which contained curriculum materials such as educational toys, provided by the Department of Basic Education. Most of these toys such as plastic counters (unifix blocks), counting frames (abacus), beads, hoops, plastic balls, posters and mini clocks were kept in sealed packages and learners did not use them in the lessons observed. Teachers were to use these concrete materials to engage learners in active learning. Learners were to handle the educational toys in order to learn the numeracy concepts, including sorting and ordering through play.

Visual learning materials:

The walls in T6's classroom were brightly decorated with coloured posters (yellow, green, red and blue). The posters showed pictures in the immediate environment of the children; such as trees, children playing, toys, fruit, vegetables and animals. The posters also showed pictures and dot cards. The pictures were displayed within a reasonable level of the children's vision. Number names were neatly printed below the number symbols on a pink chart and then displayed on the wall. They were written in the learner's home language. The displays were located at a reasonable line of vision for learners to see them clearly. There were also flash cards showing number names and symbols for learners to represent numbers in various forms.

Lesson description

T6 presented first lesson which had three (3) main activities. She was observed twice teaching numeracy. She taught a counting rhyme on days of the week in the 1st activity. This was an oral activity. The objective was to teach learners to sequence school days correctly. T6 asked learners to say days of the week (in a rhyme). She said to the learners, “*kha ri ambe maduvha a vhege*”. Learners sang “*Swondaha, Musumbuluwo, Lavhuvhili, Lavhuraru, Lavhuna, Lavhutanu, Mugivhela*” (Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, Saturday) in chorus and showing one finger at a time, in order to experience the sequence of the school days. She guided learners with questions such as “how many days are there in a week?” Learners indicated, “seven days” in chorus. T6 then asked L42 “*Ni nga ri vhudza uri maduvha a u ya tshikoloni ndi mangana?*” (Can you tell me how many school days are there?) Learner 42 (L42) indicated to the teacher that there were, “five (5) days”. She also asked the class, “*duvha la u thoma u ya tshikoloni ndi lifhio?*” (What is the 1st day of school?) Learner 19 (L19) indicated that it was, “*Musumbuluwo*” (Monday). T6 also asked “*duvha la u fhedza u ya tshikoloni ndi lifhio kha vhege?*” (What is the last day of school in the week?)

Learner 3 (L3) indicated that it was “*Lavhutanu*” (Friday). T6 further said, “*kha ri vhale maduvha othe a u da tshikoloni*” (count the total school days). Learners then counted (Monday, Tuesday, Wednesday, Thursday, and Friday, while showing one finger at a time”. T6 asked “how many school days are there?” Learners indicated that there are five school days in chorus. The oral activity was practised for five minutes.

T6 taught the lesson on capacity „full and empty” in the second activity. The aim of the lesson was to teach learners to compare and distinguish between the concepts of „full and empty” informally. She introduced the concepts of „full and empty” by asking questions through which learners were expected to compare the amount of liquids in concrete containers informally (an awareness of the concept using mathematical language to talk about it) such as, „what will happen if you run a bath and forget to close the tap?”

The whole class was involved in a practical demonstration (showing a skill to complete a task). T6 placed two clear tumblers and filled one tumbler (plastic container) with coloured water and told learners that it is full. She then poured the coloured water from a full

tumbler into an empty one. The whole class observed the demonstration that enabled them to distinguish between the concepts of „full and empty“, and to then describe their observations. T6 asked, “*ho itea mini kha bigiri i si na tshithu?*” (What happened to the empty tumbler?) The whole class observed what happens when a glass is filled with water and poured into another and responded to the question posed. The whole class then responded in chorus, that the empty tumbler was then full. She also asked “*ho itea mini kha bigiri yo dalaho?*” (What happened to the full tumbler?). The whole class responded in a chorus again, indicating that the full tumbler was then empty.

In the third activity, learners were expected to complete a written task from a worksheet. They were to look at the pictures in each row and compare the capacity (the amount of liquid a container holds) of the containers shown in pictures. There were four sums to enable the learners to compare and differentiate between the concepts full and empty, more and less. T6 explained to the whole class what they were to do in order to complete the written task. The whole class discussed the containers in each row, compared and determined the capacity of each container. Then they made a tick in the box to indicate their choice.

T6 observed learners completing the written task. She asked questions to guide learners who experienced difficulties in completing the task correctly. She assisted L45 for instance, who described the 2nd bottle in the activity „empty“ instead of „full“. She asked L45 to identify whether the 2nd bottle was full or empty. She also asked L45 to explain what he is required to do in order to make the 2nd bottle appear full. L45 indicated that the bottle was half filled but did not know what should be done to make it full. T6 asked L45 to explain what makes him believe that the bottle was half filled. L45 then indicated that there is a line indicating a shaded area at the bottom half of the bottle. T6 then helped L45 to understand that he could colour the unshaded part of the bottle to make it appear full. The learner understood what was required of him he could then finally complete the written task correctly and submitted it to the teacher. T6 then involved the whole class in the singing the counting rhyme of the days of the week. The whole class continued singing to demonstrate that the activity has been concluded (Appendix F). The written activity is shown in Appendix E

Post-observation interview

During the reflection meeting the researcher asked T6 to explain why the lesson observed mainly focusing on whole-class teaching? T6 explained that her lessons focused on whole-class activities because she could not engage the 52 learners into group activities comfortably. She further explained that the standard-size classroom and the arrangement of the furniture (both desks and chairs), were obstacles for her to implement activity areas for learning numeracy through play-based activities. When the researcher asked if the objectives of the lessons were achieved, T6 was positive that the lesson objectives had been achieved. During the discussion, the researcher probed further, with the intention of wanting to find out how T6 could address the challenge of the constraints of the classroom space in order to create activity areas for engaging learners actively in play-based learning. T6 indicated that she does not have a solution. She further indicated that she needed guidance (in-service training) in order to gain knowledge and skills of implementing activity areas in crowded classrooms. There was need to analyse if curriculum materials were in order to determine what teachers were supposed to have taught in the lesson the researcher observed.

Lesson description

- It was observed that a pattern which comprised of three main activities such as oral work, discussion and written work emerged in the lessons of all the participants.
- During oral work, learners were engaged in active learning because they clapped hands, galloped, hopped on one leg and clicked fingers in order to participate in counting activities. In this observation the participants created a conducive environment for learning numeracy because they designed activities that offered learners opportunity to participate actively in their learning..
- The discussion activity engaged learners in solving verbally-stated problems. All participants discussed pictures in workbooks with children in order to teach them to solve problems. The participants also taught learners to use natural counters such as fingers, sticks and pebbles to solve verbally-stated problems.

- Written activities for the participants in the sampled schools were suitable for Grade learners since they only needed to colour and trace the required number of objects or shapes.

In my opinion this suggests that adequate learning occurred because all participants involved learners in play-based activities (oral and discussions) in order to create conducive environment for learning numeracy which occurred within the three major activities.

4.2.2.3 Document analysis

Weekly CAPS aligned lesson plans

The researcher requested the participants to provide the weekly lesson plans and studied them carefully. The aim was to determine what was currently being taught in Grade R.

Document analysis revealed that the lesson plans were written in English. This was a contradiction of the South African language policy which stipulated that foundation phase learners should be taught in their home languages (Tshivenda in this particular case is the relevant home language in the study). In addition, document analysis has indicated that the policy required that the lesson plans be written in English in order to enable the national as well as provincial officials such as curriculum advisors, to monitor correct curriculum implementation in alignment to the policy requirements. This was a serious challenge due to the fact that teachers were to translate the lessons from English to the first language L1 (Tshivenda) in order to be able to teach (Appendix D).

Since lesson plans in my view were provided to teachers by the DBE and designed to be used as they are, the participants spent most of their time translating learning activities from English to the LOLT in order to help learners understand what they are learning. Learning time was therefore minimized in the process. The researcher could not learn much from observing more than two lesson from each teacher.

Learners' Workbooks

Analysis of the data revealed that the workbooks complied with the curriculum and assessment policy statement (CAPS). The workbooks were distributed to public Grade R classrooms by the DBE. Furthermore, learners' written tasks encouraged the development of emergent numeracy because they were presented in large and colourful prints. Learners were required to either draw lines to match numbers and pictures representing numbers. They were also required to circle or colour pictures to specify their responses in the workbooks in order to complete the written activities. Furthermore, document analysis also revealed that learners used A5 feint and margin (exercise books with lines) and quad (exercise books with square blocks), as well as the English version workbooks to alleviate the shortage of workbooks. Based on the observation above, teachers were faced with challenges of translating the English instructions to the language of learning and teaching (Tshivenda in this study) as well photocopying worksheet and paste in the A5 so that learners could complete the written tasks effectively.

In addition, learners utilized small writing boards with chalk in order to practice number formation. One teacher T1 explained that:

"We use the small boards to create an opportunity for learners to practice writing skills; and to give oral feedback on the written work, in order to facilitate assessment done to help learners improve their writing skills".

On the basis of the lesson observations and teachers' responses in the interviews, the findings established that:

- The participants taught their lessons in Tshivenda the home language of the learners in the sampled schools, and aligned their teaching activities to the language policy, which requires Grade R learners to be taught in their home language. This highlights that the six selected teachers utilized the South African language policy to implement the Grade R numeracy curriculum effectively.
- The emerging pattern from the observed lesson presentations such as oral work, discussion or demonstration and written work, highlights that the six selected teachers

utilized the various components of a lesson to support the acquisition of emergent numeracy (play-based activities) and the related numerical concepts (see DBE, 2012). These aspects are similar to teacher-guided activities, routines and child-initiated activities also utilized to stimulate emergent or play-based learning (see DBE, 2011a).

The literature review (see 2.5.5) confirmed the findings from lesson observations, Naudé and Meier (2014) confirmed that the arrangement of classroom space influences effective teaching and learning. The observations and literature review also confirmed that teachers need an urgent intervention in terms of training through organizing ongoing professional workshops in order to learn strategies to assist them in the planning of well-organized classrooms, to create opportunities for learning through play (Naudé & Meier, 2014; Van de Walle, 2007).

The literature also suggested that the teachers in the South African Grade R classrooms should be accountable for the following:

- Create Grade R classrooms with flexible and well-organized activity areas in order to implement play-based teaching (see 2.3.1.2).
- Provide opportunities for learners to handle concrete learning materials in the various activity areas so that they can develop their own numeracy knowledge (see 2.3.1.3).
- Recognize the need for using concrete and visual learning materials when teaching numeracy lessons (see 2.3.1.3).

It is necessary to recognize the need for capacity building workshops in order to train the Grade R teachers to learn strategies for implementing teaching and learning through exploration and play (2.3.2.2)

4.2.3 Research question 3

What classroom factors influence the approaches teachers employ during numeracy teaching?

This research question was asked in order to identify the factors that influence the approaches Grade R teachers used to teaching numeracy. The research question also sought to determine how these factors affected the outcomes of teaching and learning numeracy. In this section the findings from the lesson observations with regards to research question 3 are presented and discussed using three categories, namely: whole-class, small-group and play-based approaches.

4.2.3.1 Whole-class teaching

Classroom space:

The lesson observations revealed that some participants taught in crowded standardized classrooms with more than fifty learners each. These influenced teachers to resort to whole-class teaching.

Arrangement of the classroom:

The findings also revealed that the arrangement of desks in formal rows in the classrooms of some participants highlighted that whole-class teaching dominated teaching of numeracy lessons the researcher observed. In addition, the document analysis revealed that the arrangement of plastic tables and chairs in the middle of the classroom along the desks confirmed that whole-class teaching was a teaching strategy that was regularly implemented during the numeracy lessons the researcher observed

Written activities:

According to the findings from document analysis it was also highlighted that the participants gave the same written work to the whole class without differentiations and remedial opportunities for learners who were lagging behind (see 2.4.2.2)

The DBE (2011) and Flanagan (1998) nonetheless proposed that the whole-class approach is an advantage in the teaching and learning of Grade R learners. The wholeclass approaches can furthermore be very effective when teaching new numeracy

concepts. Kostelnik et al (2011) emphasized that learners need to access opportunities in order to engage in whole-class teaching. This can be achieved when learners listen to mathematically-orientated stories, see pictures and engage in demonstration activities.

The findings have also shown the advantages of whole-class teaching as supported by Kostelnik et al (2011) indicating that during whole-class teaching the teacher serves as

- The primary conduit of nurturing critical thinking skills.
- A motivator of the learners' participation and emphasizes efficient methods of doing this.
- Point of contact to invite learners to explain their solutions to others as well as to encourage them to listen to their fellow classmates with respect.

In view of the above-mentioned discussions, teachers should be encouraged to familiarize their teaching methods with whole-class approaches in order to improve mathematics achievement of Grade R learners through the following strategies:

- Creating classroom environments that include whole-class teaching (Boaler, 2008, 1999).
- Participating in whole-class teaching which allows them to learn to understand and gain a broader knowledge with regards to mathematical ideas (Hunter, 2005).
- Emphasizing that whole-class teaching is essential in Grade R due to its simulative effect of interaction between the teacher and learners and amongst the learners themselves. Providing direct instructions to the whole class at the same time, and encouraging learners who withdraw themselves from teaching and learning.

4.2.3.2 *Small-group teaching*

Lesson observations have shown that five of the six selected teachers taught large classes. In view of the findings above, the five teachers did not create opportunities to engage groups of learners in different activities at the same time.

The need for small-group teaching in Grade R classrooms has been confirmed and recommended (see 2.4.2.3) as follows:

- Working in small-groups provides the emotional and practical support that learners need and also helps them to understand the tasks at hand and find ways of engaging in the task.
- Learners need the opportunity to work in small groups, sharing ideas and learning from their peers.
- When small groups are designed in Grade R classrooms, behaviour such as wandering, fighting over learning materials and repetition of the same activity many times over are minimized.
- Group work sessions should be highly interactive and afford learners an opportunity to „do and talk“ (Van de Walle, 2010).
- The activity areas in the numeracy classrooms assist learners to play in small groups and discover the number concepts.
- During small-group teaching, six to eight learners sit with the teacher on the carpet in order to engage in mat work activities.
- During this time, the teacher works orally and practically with learners, using counters, dot cards, 100 chart, counting frames as well as play money amongst other things.

4.2.3.3 *Play-based approaches*

The teachers' responses in the interviews and lesson observation have shown that five of the six selected teachers did not implement play-based learning because the classroom hindered interaction. Literature review showed that constraints such as overcrowded classes and lack of access to adequate resource material were obstacles that hindered the implementation of teaching numeracy through play.

Grade R teachers should implement play-based learning methodologies that assist learners to develop their full potential during numeracy lessons.

Classroom space

It is clear from the findings from the teachers' interviews and classroom observations that some of the participants taught in large and over-crowded classroom environments, and as such they could not provide learning activities that would ensure that they create a conducive environment that engaged learners in play-based learning. It is highly recommended that teachers should provide learning activities and materials that stimulate learners' interest in playing, and to make sense of numeracy concepts.

Classroom arrangement

Classroom observations have given light to the suggestion that the arrangement of the desks, tables and chairs in rows restricted opportunities for teachers to provide play-based learning.

Written activities

A careful document analysis has revealed that the teachers gave the same numeracy written activities to the whole class without any variations.

The findings suggested the need for ongoing capacity building workshops which will allow for the training of teachers in order to allow them to enhance their skills and become more innovative in creating opportunities and solutions for play-based learning.

The literature (see 2.4.2.1) therefore confirms the findings of the study based on the teachers' interviews, classroom observations and the document analysis. The literature has indicated that:

- Learners in South African Grade R classrooms are found seated at desks and carrying out formal learning activities like Grade 1 learners.
- Teachers seem to discontinue with informal play-based approaches that are advocated by constructivist theorists such as Piaget and Vygotsky amongst others (Morrison, 2013).
- Teachers in South African Grade R are thus faced with challenges of creating conducive classrooms for learning numeracy through play-based approaches, due to

the fact that they teach in overcrowded classrooms with inadequate access to learning resources.

In view of the findings above, the literature analysed has suggested that in order to create a suitable classroom environment for learning numeracy, teachers need to implement the following approaches:

- Basing Grade R teaching and learning activities on exploration and play-based approaches (Kühne et al., 2013). Classroom observation has shown the need for displaying physical learning materials in activity areas to create a conducive environment to develop numeracy concepts and skills such as counting, sorting, and estimating and compare size among others.
- Planning teaching and learning activities in Grade R to occur naturally (childcentered) with or without the teachers' assistance.
- Allowing the Grade R learners ample time to discover the number concepts activities through specific learning material in order to promote learning through structured play. The participants have shown in classroom observations, and interviews revealed that recycled material such as empty cereal boxes, and soft drink containers can be used creatively to provide teaching and learning activities.
- Realizing that the discontinuity of informal play-based approaches and the rapid move to formal instructional approaches can negatively influence the performance of learners in numeracy (Pengelly, 1997). The participants sat Grade R learners in rows of rigid desks which could not be moved around in class and re-arranged in groups in order to support play-based learning as shown in teachers' interviews and classroom observations.
- Creating play opportunities in the class in order to allow learners to choose the learning materials from a prepared environment that suits their developmental levels. The participants indicated that they could not organise their classrooms into activity areas because they taught in an overcrowded classroom.

The findings from the interviews with the teachers, classroom observations as well as the document analysis in this study revealed the urgent need for ongoing professional workshops to train teachers to create conducive environments for learning numeracy. It

is thus critical that South African Grade R teachers should be innovative in order to create a conducive classroom environment for teaching numeracy through:

Classroom space

- There is need to minimize the number of activity areas and changing them weekly or bi-weekly in order to engage groups of learners in structured play throughout the week. This will go a long way in addressing the challenges that restricts South African Grade R teachers to organize adequate activity areas in their classrooms.
- Furthermore, it is vital to recognize that a verandah (balcony) can serve to provide additional space outdoors for involving learners in active learning if the classroom is too small (Donald et al, 2005; Gerdes et al 2013).
- There's also a need to create multi-functional uses of furniture to provide space for implementing activity areas in order to create an opportunity for active learning. The intentional arrangement of furniture in a manner that fosters interaction among learners, through seating them on tables rather than desks, in an optional intervention as well.

Teaching and learning support materials

Teachers can create ample opportunities for learners to handle, play and explore the learning materials in order to construct their own knowledge of numeracy concepts (Naudé and Meier, 2014; Gerdes et al, 2013).

Teaching approaches

Teachers can create ample opportunities for play-based learning during numeracy lessons.

4.2.3.4 Implications of research question 3

The ongoing discussion has adequately illustrated that whole-class teaching dominated the numeracy lessons that the researcher observed. Of the six teachers observed, five implemented whole-class teaching as the primary source of teaching and learning numeracy. The Department of Basic Education should thus avail opportunities for teachers to attend capacity building workshops to ensure that teachers are adequately trained in the identified interventions for implementing small-group teaching in order to maximize interaction and learning.

The researcher has therefore come to the conclusion that Grade R teachers who do not implement small-group teaching in numeracy classrooms deny learners an opportunity for interaction and learning.

4.3 Chapter Summary

On the basis of the findings from teachers' responses in the interviews, classroom observations and document analysis, two types of Grade R teachers have emerged:

1. Teachers who viewed the classroom layout as permanent and thus restricted them from implementing activity areas for providing play-based learning. These teachers in addition lacked the insight to recognize that the classroom layout was not permanent and that it can be adjusted to suit the developmental needs of the learners.
2. Teachers who recognized that the layout of the classroom was flexible and can be adjusted accordingly in order to implement activity areas that allows the facilitation of play-based learning.

Taking all the observations into cognisance, it can be deduced that of the six teachers, only one teacher, T3 had the foresight to understand that the layout of the classroom space in which her Grade R learners were taught was flexible. She therefore created activity areas in order to stimulate play-based learning.

In this chapter, the major findings of the study were presented. Data was analysed and discussed according to each research question.

In chapter five the summary, recommendations, limitations as well as the conclusions of the study are presented.

CHAPTER 5 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

Firstly, a summary of this study that investigated the role of Grade R teachers in creating a conducive environment for learning numeracy is presented in section 5.2.1.15.2.1.5. Secondly, the conclusions and discussions based on the findings followed by the recommendations of the study are also presented in sections 5.2.2.1- 5.2.2.3. The conclusion focuses on the limitations and these are presented as well in sections 5.2.3. - 5.2.3.3.

This study was undertaken as there has been limited research and dialogue previously undertaken to probe whether the classroom environment through which Grade R numeracy was taught is conducive or not. The investigation of the study was guided by the three research questions as outlined below.

- What kind of classroom environment do Grade R teachers create for learning numeracy?
- How are Grade R teachers implementing the numeracy curriculum?
- What classroom factors influence the approaches Grade R teachers

5.2 Summary of the Results

Summary of the results from the empirical study is presented under the three research questions that guided the study.

5.2.1 Research Question 1

What kind of classroom environment do Grade R teachers create for learning numeracy?

5.2.1.1 Discussion

□ Classroom space

The findings of the study established the prevalence of an existing gap in teaching large classes in standard-sized classrooms for example, (see T1 teaching 19 boys and 33 girls, while T2 taught 20 boys and 32 girls, in section 4.2.1.1). In a series of the lessons observed it was evident that this gap created an obstacle that hindered interaction among learners during numeracy lessons. Some of the teachers did not implement activity areas to engage learners in play-based learning due to the prevalent gap. This was in contrast with the principles of the South African national curriculum which recommends that teaching and learning in Grade R numeracy should be done through play-based activities. This is confirmed through the literature in chapter 2 which suggests that a well-planned classroom to implement learning through play activities is needed (see section 2.3.1.2). This was clearly evident from the teachers' responses in the interviews when they accentuated that they had many learners in their classrooms.

Furthermore, the findings from the teachers' responses in the interviews and classroom observations indicated that only two of the selected six teachers taught relatively small classes (see T3 and T4, teaching 2 boys and 4 girls, in section 4.2.1.1). In addition, the classroom observations revealed that T3 taught her Grade R class in a church building and implemented activity areas (see section 2.3.1.2). These findings were supported by literature in chapter 2, (Davin & van Staden (2004); Meier & Marais (2007)). The literature further revealed that there are teachers who consider the layout of Grade R classrooms as a permanent fixture, which they cannot change. This suggests that these teachers do not ponder on alternative strategies for supporting teachers to implement activity areas irrespective of the large classes they taught (see section 4.2.1.5).

In addition, the findings from observations and teachers' responses in interview revealed that although T4 taught a relatively small class, he could not organize activity centres in his classroom. The classroom was crowded with resources for the whole school. It is evident that there is a need to engage the teachers to assist them to change their mind-sets regarding flexibility in implementing activity areas.

□ Classroom arrangement

The consistent pattern of the arrangement of furniture that existed in the classrooms of some of the six selected teachers made it evident that classroom space was an obstacle that hindered learners from exploring their learning environment in order to develop numeracy knowledge (see section, 4.2.1.2). This contradicts the literature review in chapter 2 which suggests that the furniture must be intentionally arranged to foster socialization among learners (Gerdes et al, 2013; Meier & Marais, 2007).

□ Physical learning materials

Due to the fact that five of the classrooms in the sampled schools were poorly equipped with the physical learning materials (see section 4.2.1.4), it highlights the evident challenges of high learner-to-teacher ratio and crowded classrooms that hindered interaction among learners during numeracy lessons observed (Gordon & Browne, 2009; Meier & Marais, 2007), needing an intervention. This situation limits learners from handling the physical objects, and talking about them in order to learn through play (DBE, 2011; Naudé & Marais, 2014). The teachers' responses in the interviews and lesson observations demonstrated that some of the selected teachers are in agreement that the layout of Grade R classroom is flexible and can be modified accordingly to suit the needs of the learners (see section 4.2.1.4). T3 for example implemented activity areas, in order to engage learners in play-based learning activities, such as water play, block play, fantasy play and games corner among others.

□ Visual learning materials

The findings from the observations and teachers' responses from interviews discovered that the classroom walls of Grade R classrooms in the sampled schools were adequately equipped with the visual learning materials, through the display of posters and wall charts, to highlight the value of the learning materials in teaching numeracy (see section 4.2.1.3).

The display of the visual learning materials is a common strategy utilised in all lessons of the selected six teachers (see Uttal et al, 1997; Morgan & Harmon, 1984).

□ Lesson descriptions

The study indicates that all the lessons the researcher observed in this study revealed a unique pattern, namely: involving learners in oral work, followed by discussions, as well as the written work (see section 4.2.2.2). The lesson observations further revealed that whole-class teaching is the primary approach which all teachers implemented in teaching numeracy (Boaler, 2002; DBE, 2011, Kostelnik et al, 2011). This view demonstrated an urgent need for well-planned Grade R classrooms which are inclusive of activity areas in order to involve learners in small-group and facilitate interaction among them to develop numeracy knowledge that makes sense to them (Van de Walle et al. 2010).

This study found on the other hand that some of the six selected teachers regard the layout of Grade R classrooms as particularly fixed, and do not consider potential strategies to alter the classroom set-up to assist them to teach numeracy effectively, irrespective of the large classes they taught. This was articulated from the teachers' responses in the interviews and the lesson observations.

In my view, the Department of Basic Education should create opportunities for teachers to participate in capacity building workshops in order to be trained in strategies of creating the relevant classroom environments conducive for teaching and learning numeracy. This would include creating a conducive environment for teaching numeracy through adequate classroom space with activity areas, provision of adequate physical learning materials in order to stimulate learners' interest in handling and playing with the learning materials in order to develop numeracy concepts.

5.2.1.2 Implications

- a) The stakeholders in teacher training should ensure that teachers are adequately trained during pre-service and in-service training programmes to implement strategies for creating a conducive environment for learning numeracy through play-based learning. This can be done when teachers organize classroom space, furniture and learning resource materials for both whole-class and small-group interaction and learning (Kostelnik et al, 2011).
- b) The DBE could create an opportunity for teachers to register for credit bearing modules of in-service programmes to improve their teaching competence (Naudé& Marais, 2014).

5.2.2 Research Question 2

How are Grade R teachers implementing the numeracy curriculum?

5.2.2.1 Discussion

Document analysis revealed a clear indication that the South African department of Basic Education endorses the notion that teachers in all public Grade R classrooms should implement the national curriculum policy (see section 4.2.2.3). This practice assisted the participants to utilise the curriculum materials provided in the „laying solid foundations for learning“ Grade R resource kit to enhance their numeracy teaching, (DBE, 2011). The participants further used Tshivenda to teach numeracy in order to respond to the South African language policy (see section 4.2.2.3) prescripts. The implementation of the language policy assisted the teachers to create an opportunity for learners to comprehend numeracy learning activities related to their everyday lives (see Meier & Marais, 2007; UNESCO, 2006). The lesson observations additionally indicated an emerging pattern orientated towards the need to demonstrate that all lessons have three major activities, namely: oral, discussion as well as the written work (see section 4.2.2.2).

□ *Weekly CAPS aligned lesson plans*

The findings from document analysis and observations established that the six selected teachers implemented the numeracy curriculum through Caps aligned weekly lesson plans distributed by the department of Basic Education without alterations in order to create a conducive classroom for learning numeracy. The findings from document analysis nevertheless, articulated the challenges facing the participants in the management of weekly lesson plans, which were written in English and then translated into the language of teaching and learning in the sampled schools (Tshivenda). The practice of using the home language as a language of teaching and learning in Grade R was in alignment with the South African language policy (see section 4.2.2.3). Learning using the home language assists Grade R learners to interact with other learners in order to make sense of the numeracy concepts they learn as suggested by constructivism (Killen, 2006; Othman & Kadir, 2004; Van de Walle et al 2010).

□ ***Rainbow Learners' workbooks***

Classroom observations and document analysis established that the participants utilized the workbooks for various purposes when implementing the Grade R mathematics curriculum (see DBE, 2011b). These included opportunities to rehearse content, concepts and skills taught through tasks and activities (see Taylor, 2008a). They further offered opportunities for practising number concept development, through counting, colouring and writing (tracing or matching items) on dotted lines in order to solve their everyday problems. It is however, believed that the workbooks could not offer teachers opportunity to implement differentiated learning opportunities and do not have an index (see section 4.2.2.3). Teachers therefore struggled to guide learners to find the correct page when utilizing the workbooks. In addition, document analysis and lesson observation established that all teachers gave similar written activities to the whole class without differentiated learning and remediation opportunities (see Taylor, 2008a).

5.2.2.2 Implications

- a) Teachers should implement the South African national curriculum policy in order to teach Grade R numeracy effectively (“the Laying Solid foundations for Learning”).
- b) The department of Basic Education should organise in-service training to equip teachers with skills for utilizing the workbooks optimally as tools to support teaching and learning (see Fleisch, 2008).
- c) The use of workbooks (pictures and symbols) should be accompanied by a combination of concrete objects, actions and words to make connections and facilitate learners’ understanding of abstract concepts (see Drew’s, 2007; Haylock, 2010; Harries & Spooner, 2000).
- d) The workbook pages should be sequentially numbered to assist learners access the correct page numbers with ease when using the workbooks.
- e) The sampled schools will display and utilize similar teaching and learning resource materials as well as utilizing similar topics for teaching and learning lessons observed since teachers do not write their own lesson plans but follow the lesson plan distributed to all public Grade R classes by the DBE.

5.2.3 Research question 3

What classroom factors influence the approaches teachers employ during numeracy teaching?

5.2.3.1 Discussion

□ *Whole-class teaching*

The study established that large classes encourage whole-class teaching (see section 4.2.3.1). Whole-class teaching provided the six selected teachers an opportunity to involve all learners in the numeracy lessons including the shy and withdrawn learners. During whole-class teaching, teachers evaluate and establish areas of strengths and weakness of the learners in order to strengthen learning (Boaler, 2002; Hunter, 2005). The teachers' responses from interviews, classroom observations and the document established that whole-class teaching influenced numeracy outcomes.

□ ***Small-group teaching***

The teachers' responses in the interviews and classroom observations points to the conclusion that crowded classrooms restricts teachers from interactions and critically engaging learners in group work activities, through which groups of learners are involved in several learning activities at the same time.

□ ***Play-based learning***

The South African national curriculum policy statements for Grade R explicitly states that young learners should have access to play time to ensure that they can learn numeracy effectively. The policy encourages teachers to implement play-based approaches to teach numeracy in Grade R classrooms (see section 2.4.2.1). Learning through play assists learners to enjoy the numeracy activities and goes a long way in enhancing their self-esteem (Kühne et al., 2013; Naudé & Marais, 2014; van de Walle, 2007). The study established that large and crowded classrooms was a barrier that hindered teachers from implementing play-based learning (see section 4. 2.3.3).

5.2.3.2 Implications

a) Teachers should strive to implement teaching approaches that are recommended for the Grade R classes in the South African curriculum and assessment policy statement. However, since teachers are faced with extreme challenges in the implementation of play-

based approaches in large and crowded classrooms, there is a dire need for presenting capacity building workshops to address the challenges and enhancing teaching and learning numeracy in Grade R.

c) The South African Department of Basic Education and curriculum advisors should thus consider designing capacity building workshops to train teachers in effective strategies for implementing play-based approaches so that they can maximise children's abilities to learn numeracy successfully. The structure of capacity building workshops should therefore comprise of the following components:

- **Professional networks:** this suggests involving teachers from a cluster of primary schools meeting and exchanging ideas and methods about important issues regarding conducive classrooms for teaching and learning numeracy in Grade R (See Wilson, 2003).
- **Credit bearing courses:** involves teachers getting an opportunity to voluntarily participate in attending introductory courses at institutions of higher learning to support the acquisition of mathematical proficiency. This could provide the basis for teachers' learning to grow and evolve and help them become confident in creating conducive classroom space to cater for both whole class and small group teaching (See Stronge et al., 2004). This would include strategies such as:
 - i) Organizing adequate floor space to accommodate numerous activity areas in order motivate learners to participate actively in play-based activities;
 - ii) adequate furniture arrangement to facilitate mobility and interaction; and iii) adequate learning resource materials (visual and physical), to support teaching and learning.

Conducting professional development workshops

Mathematical proficiency cannot be learned within a short space of time such as a few months. The workshops should therefore be conducted on a continuous basis and as a process to be learned and practiced throughout the teacher education development. The teachers should attend a series of demonstrations and hands-on activities in order to promote numeracy achievement in the early grades. The workshops should furthermore be intended to ensure successful teaching and learning of and the development of high level of numeracy skills.

Aspects for professional development workshops

The study recommends that the aspects for professional development workshops should reflect aspects of a well-arranged classroom (Cummings, 2000). This should include the following:

- **Classroom space:** teachers could be given the opportunity to participate in learning how to create clearly defined spaces within the classroom, to accommodate different learning activities such as teacher-guided activities and free play inside the classroom (construction, fantasy and construction play, as well as perceptual games). Teachers could also learn to create areas for large and small group activities and space to store equipment (Quinn, et al., 2000).
- **Furniture:** this aspect could include opportunities for teachers to learn different approaches on how to arrange furniture (desks and chairs) such as clusters to facilitate social interaction, in rows to facilitate teaching and learning and on task behaviour, as well as in a u-shape so that all learners can see the teacher (Naudé& Meier, 2014).

- **Teaching and learning resource materials:** teachers in this section could be trained on how to organise learning materials in the classroom accessible to learners (Visual and concrete) for example, counting blocks, abacus, number puzzles, posters, wall charts and calendar.

5.3 Recommendations

After an analysis of the data, the literature study and empirical investigation, the researcher presents recommendations of the study as stated below.

5.3.1 Recommendations for practice

a) Grade R teachers

The findings of this study, established gaps prevalent in teacher education training programmes particularly for Grade R teachers in the Vhembe District where the study was conducted. On the basis of the findings, the study recommends:

Preservice training

- Pre-service teacher training has been established as a major contributing factor to teaching presentation in South African Grade R classrooms. Teacher education training institutions should select and incorporate schools as venues for practical experiences for their student teachers.
- The training institutions should also rely on selected schools to assist their student teachers to integrate their theoretical training with practical experience from the selected schools in initial teacher training programmes.

- The selected schools (pre-primary and primary) could be utilized for constant and ongoing practical opportunities for student teachers under the guidance of qualified and experienced classroom teachers.
- The practical component should start as early as at the beginning of the training programmes and continue until the student teachers attain the qualification. During preservice training, the student teachers should be given an opportunity for practical experiences through blocks of sessions that emphasize the practical component
- The practical sessions should include an opportunity for students to observe, prepare and teach actual lessons in the selected schools to gain experience with regards to the implementation of appropriate teaching and learning strategies in Grade R (Catron & Allen, 1993; McNaughton & Williams, 2000).

In-service training:

- It is recommended that the DBE should create a platform for teachers to participate in a variety of credible modes of continuous professional development such as workshops, cluster meetings to share ideas and methods collaboratively about best practices in teaching and learning in Grade R.
- Teachers should also participate in professional development programmes such as professional reading including enrolment in credited bearing courses. The courses could last for one week, a semester or a year-long programme for certification within the local institutions of higher learning.

b) Curriculum advisors

The findings of the study will therefore assist curriculum advisors to create opportunities for teachers to participate in capacity building workshops as follows:

- The curriculum advisors should encourage teachers to attend mandatory regular and ongoing workshops to deepen their knowledge regarding curriculum innovation and approaches as well as involving teachers in cluster discussions to strengthen content

knowledge. Regular workshops should be conducted on an ongoing basis in order to train teachers in the implementation of strategies for teaching and learning incorporating play-based teaching. It is therefore advisable for the workshops to be conducted at the beginning of each term, before the teaching season commences in order to avoid the disruption of classes. Teachers should be awarded certificates of attendance to workshops in order to encourage them to value and encourage attendance on a continuous basis.

(c) Lessons learnt from conducting this study

The study established some gaps prevalent in the pre-service and in-service teacher training programmes of the South African education system.

The pre-service training programmes seem to be a major contributing factor to performance of early childhood teachers in South Africa. Pre-service training tends to focus more on the theoretical basis of training and relevant strategies to facilitate the various learning programmes (See McNaughton & Williams, 2000; Meier & Marais, 2007). Student teachers however, are usually exposed to the practical component of teaching in the last year of their teaching qualification. This create gaps for the integration of theory and practice (See Catron & Allen, 1993; McNaughton & Williams, 2000). The in-service training programmes emerged as an important aspect that could inform the gaps prevalent in classroom practices for Grade R teachers.

(d) The contribution of the study to the literature on teacher education for Grade R teachers

The study will contribute a unique literature to explicitly inform teacher training programmes for early childhood education (Grade R teachers). Early research focused on literature that addressed gaps prevalent in teacher training programmes for primary school teachers in general.

5.3.2 Recommendations for Literature

The findings from the literature study and the empirical investigation have shown that the Grade R learners need well-organized classrooms to ensure that they can learn numeracy through play-based activities. On the basis of these findings, teachers should thus plan well-organized classrooms in order to facilitate learning and interaction (Quinn, et al. 2000) through the following strategies:

- Minimizing the number of activity areas and changing them weekly and bi-weekly in order to engage groups of learners alternatively throughout the week in play-based learning (see section 2.3.1.2).
- Recognizing that a verandah (balcony) can be utilised to provide additional space outdoors for involving learners in play-based learning (Perry, 1985).
- Providing multiple use of furniture in order to provide space or implementing activity areas and create adequate opportunities for engaging learners in learning through play-based activities.
- Arranging furniture intentionally to allow for the fostering of interaction through seating learners on tables and chairs rather than rigid desks (Gerdes, et al. 2013).

Teachers should participate in regular and ongoing professional development workshops in order for teachers to get training on the strategies for implementation of play-based learning in numeracy classrooms.

5.3.3 Implications for further research

5.3.3.1 Furniture

The empirical study made it clear that the furniture in Grade R classrooms presented challenges to teachers. They were mostly arranged in neat and orderly rows which could not create a conducive environment for interaction (See Gaurdino & Fullerton, 2010). As a result, the study recommends that further research focusing on furniture problems teachers encounter should be conducted. Teachers could be taught how to arrange furniture in Grade R mathematics classrooms to facilitate movement and interaction. The

study would assist the South African DBE policy makers to design an intervention strategy to address this problem.

5.3.3.2. Learning and teaching support material

Some teachers in this study stated that they were facing challenges of making learning and teaching support materials (visual and physical) accessible to learners. Further study focussing on views of different Grade R teachers with regards to strategies for making the LTSM accessible to learners should be conducted.

5.3.3.3 Teaching Approaches

Further research to specifically address the challenges of implementing play-based teaching in the South African Grade R classrooms is recommended. This is in line with the findings of the study, which established that large and crowded classrooms hindered teachers from implementing play-based learning (see section 4. 2.3.3).

5.3.3.4 Classroom Space

The findings showed that the physical classroom space presented challenges to teachers of organizing a conducive classroom for teaching numeracy (see 4.2.3.4). It is recommended that an investigation on how teachers organize Grade R classrooms conducive for teaching numeracy should be conducted in order to establish strategies that could:

- assist teachers in sampled schools with large classes to arrange desks in semicircles or clusters to open more space for interaction and encourage cooperative learning (Patton, et al., 2000);
- ensure that activities, materials and equipment are physically accessible and usable by all learners.

5.3.4 Limitations of the study

The scope of this study was limited to the Vhembe district only. The research sample of six teachers within the four schools was relatively small enough to generalize the

findingstaking into consideration the distance amongst schools, ranging between 50 to 60 kilometres apart from each other. The fieldwork was narrowed to two interviews and also two lesson observation for each teacher due to firstly, challenging road conditions (dirt and sandy roads with considerable potholes. Secondly, all public Grade R schools used lesson plans from the government that were designed to be used as they were unless individual teachers wanted to add certain aspects or write their own. There was no point for observing more than two lessons from each of the participants because there was no variation in lesson patterns (oral work, discussion and written work).I had reached data saturation since I was observing the same lesson patterns over and over again.

The sources of data were nonetheless triangulated utilising interviews, lesson observations as well as document analysis. In order to obtain thick descriptions of the classroom environments, an empirical investigation was undertaken. The findings of the study nevertheless provided an in-depth reflection of challenges facing teachers in creating conducive environment for teaching numeracy through play-based approaches.

5.4 Conclusion

The purpose of this study was to investigate the role of Grade R teachers in the creation of a conducive environment for learning numeracy in the Vhembe district, South Africa.

The study established that most teachers taught large classes and a result, whole-class teaching dominated the lessons observed. The study further established that most teachers were faced with challenges of organising activity areas to support play-based teaching because teachers lacked capacity and skills to create conducive environment for learning numeracy.

Lack of adequate classroom space, inadequate or a complete absence of physical learning materials, as well as inadequate pre-service and in-service teacher training programmes influenced the approaches teachers employed during lesson observation.

The findings of the study also revealed that teachers further experienced challenges of translating English-generated lessons to the language of learning and teaching in order

to implement the numeracy curriculum. This was contrary to the principles of the South African language policy which recommends that teaching and learning in Grade R should be facilitated in home language. It is hoped that the findings and recommendations in this study will deepen the insight of Grade R teachers in creating a conducive environment for learning numeracy.

5.5 The Final Word

The implications of the findings from this study is that there is need for the South African Department of Basic Education and policy makers to understand the proposition that children in Grade R learn by doing (play-based or hands-on activities). The DBE should also recognise that if the South African Grade R classrooms continue to use formal learning instead of employing play-based approaches in teaching and learning numeracy, the academic performance of students in mathematics might actually worsen. Capacity building is therefore a critical focus to provide Grade R teachers with insight for improving their knowledge and skills to create conducive environment for teaching numeracy. In this sense capacity building for Grade R teachers should be facilitated through the following approaches:

- The pre-service training for Grade R (early childhood education) teachers should be aligned to a field-based Education model which emphasize practical experiences (see Catron & Allen, 1993; McNaughton & Williams, 2000).
- The model should further link teacher training institutions with selected pre-primary or primary schools to offer students an opportunity for integrating their theoretical training with practical experiences (Meier & Marais, 2007).
- In addition, the model should also assist students to participate in block sessions through which they would observe, prepare and teach lessons under the guidance of experienced classroom teachers (Meier & Marais, 2007; Taylor, 2008a).
- The teacher training colleges in the Vhembe District which were closed down after the democratic government, should be reintroduced to specifically offer appropriate

training opportunities for Grade R teachers (Foundation Phase teaches). The training colleges offered teacher training programmes that reflected the principles of the field-based model.

Capacity building for teachers in the early grades childhood is a critical focus to refine and update teachers' skills for creating adequate classroom space for facilitating numeracy learning and attainment of quality education.

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7. APPENDICES

APPENDIX A	PRE- INTERVIEW SCHEDULE
APPENDIX B	LESSON OBSERVATION SCHEDULE
APPENDIX C	POST-INTERVIEW SCHEDULE
APPENDIX D	SAMPLES OF DOCUMENTS FROM TEACHERS
APPENDIX E	ACTIVITIES FOR OBSERVED LESSONS
APPENDIX F	SONGS AND COUNTING RHYMES

APPENDIX G LETTER TO EDUCATION DISTRICT: REQUEST TO CONDUCT RESEARCH

APPENDIX H LETTER FROM EDUCATION DISTRICT: PERMISSION TO CONDUCT RESEARCH

APPENDIX I GEOGRAPHICAL LOCATIONS OF PARTICIPANT SCHOOLS

APPENDIX A: PRE- LESSON OBSEVATION INTERVIEW SCHEDULE

The purpose of the interview is to determine the views of Grade R teachers on conducive classroom environment that influence numeracy competence.

1. What topic are you currently working on?

.....

2. What objectives would be achieved in this lesson?

.....

.....

3. How do you arrange your classroom to encourage learning numeracy through play-based activities?

.....

.....

.....

4. What learning materials do you have for teaching numeracy in your class?

.....
.....

Probe: what else do you have?

.....
.....

5. How do you teach numeracy lessons in your class?

.....
.....
.....

Probe: is that all?

.....
...
.....
...
.....

APPENDIX B: LESSON OBSERVATION SCHEDULE

Name of school:

Grade:

Number learners:

Teachers" gender:

Tick the relevant box

1. Classroom space

Crowded

Adequate space

Comments:.....
.....
...
.....

2. Classroom arrangement

Inhibited interaction

Facilitated interaction

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

3. Physical learning materials

Poorly equipped

Adequately equipped

Comments.....
.....
...

4. Visual learning materials (wall charts and posters)

Poorly equipped

Adequately equipped

Comments.....
.....

4.1. Descriptions of the lesson observed

i) Involved in oral work

- a) Singing counting rhymes whole class at the same time;
- b) Oral counting numbers from 1-20 whole class at the same time;
- c) Object counting numbers names 1-10 whole class alternating;

Comments.....
.....

ii) Involved in discussion activities

- a) as Whole class solving the same problem at the same time;
- b) as Small groups solving individual problems at the same time
- c) as Individuals solving individual problems at the same time.

Comments.....

.....
iii) Involved in written work activities.

a) in work books individually

b) small writing boards in pairs

c) big writing board whole class at intervals.

Comments.....

.....

...

.....

...

APPENDIX C: POST-LESSON INTERVIEW SCHEDULE

The purpose of the Post-Lesson Observation Interviews is to follow-up issues that emerged during lesson observations and from the preliminary interview on conducive environment Grade R teachers create to assist learners develop numeracy proficiency (knowledge and skills).

1. How did the lesson go?

.....

2. Were the objectives of the lesson achieved?

.....

.....

3. How learners were involved in the learning activities?

.....

.....

4. What challenges did your learners have in the lesson?

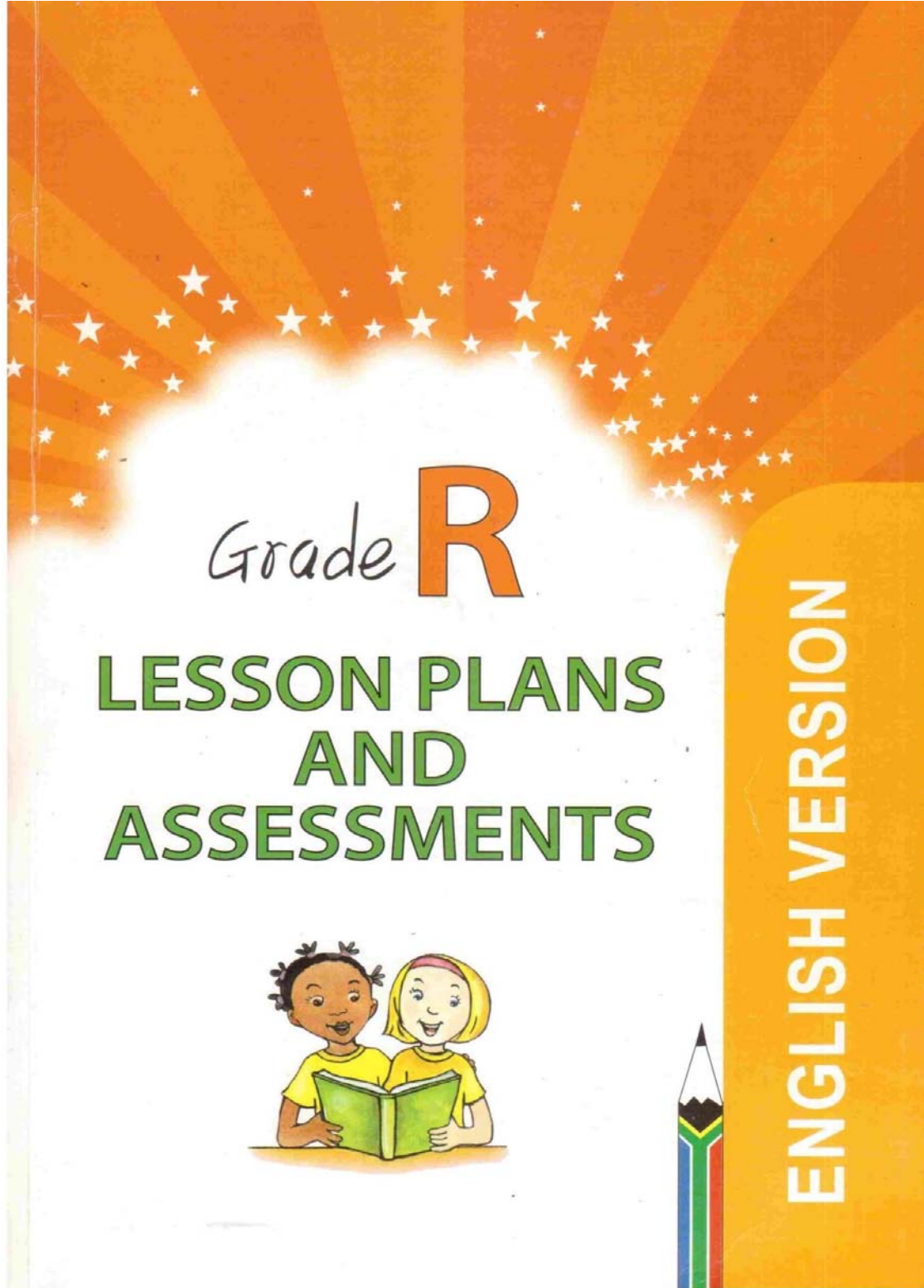
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.....

5. What changes are you going to make in your lessons to provide support numeracy learning?

.....

APPENDIX D: SAMPLES OF CURRICULUM MATERIALS FROM TEACHERS

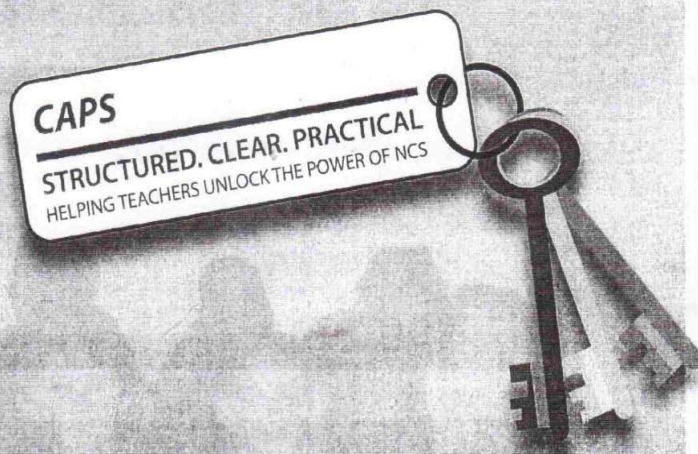


APPENDIX D: SAMPLES OF CURRICULUM MATERIALS FROM TEACHERS APPENDIX D: SAMPLES OF CURRICULUM MATERIALS FROM TEACHERS

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National Curriculum Statement (NCS)

*Curriculum and Assessment
Policy Statement*



*Foundation Phase
Grade R*



basic education


Department:
Basic Education
REPUBLIC OF SOUTH AFRICA



Yo vusuludzwa,
i tevhedza
CAPS

Gireidi ya **R**
BUGU YA I

Dzina:	Kilasi:
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BUGU YA NGA TSHIVENĀ
Bugu ya
Themo 1



Yo
vusuludzwa,
i tevhedza
CAPS

Gireidi ya **R**
BUGU YA 2



Dzina: Kilasi:

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BUGU YA TSHIVENĀ

Bugu ya
2
Themo ya 2

Yo
vusuludzwa,
i tevhedza
CAPS

Gireidi ya **R**
BUGU YA 3

Dzina:	Kilasi:
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BUGU YA TSHIVENĎA

Bugu ya

3

Themo ya 3

Yo vusuludzwa, i tevhedza CAPS

Gireidi ya **R**

BUGU YA 4

Dzina: _____ Kilasi: _____

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BUGU YA TSHIVENDĀ

Bugu ya **4**
 Themo ya 4

APPENDIX D: SAMPLES OF CURRICULUM MATERIALS FROM TEACHERS

APPENDIX E: OBSERVED LESSONS

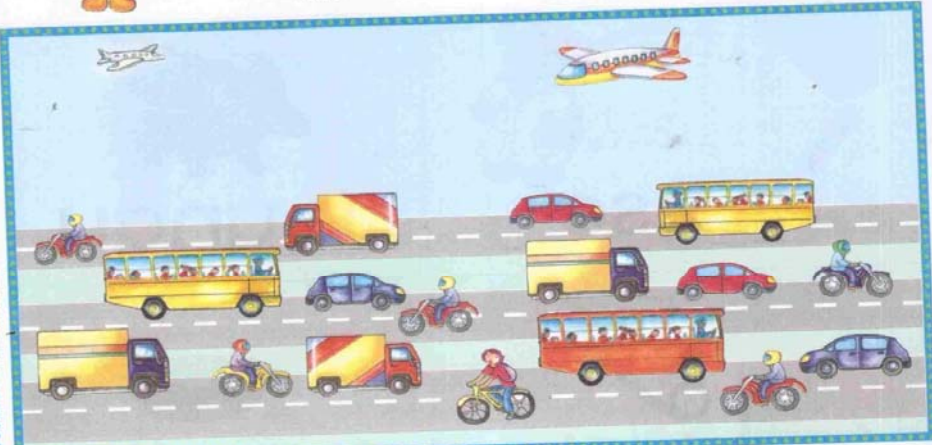
15










Kha ri vhalele

Lavhelesani tshianyiso ni wane uri hu na zwithu zwingana zwi re mabuho. mimodoro, lori, baisigiri, thuthuthu na mabisi. Ni kone u tevhedzela tshivhalo tshone tshi re tsini na tshianyiso.

Themo ya 3 - Vhege dza 1-5



	1	2 	3	4	5
	1	2	3	4	5
	1	2	3	4	5
	1	2	3	4	5
	1	2	3	4	5
	1	2	3	4	5



APPENDIX E: OBSERVED LESSONS. T1, LESSON 1




Vha ri vhalele


Tevhedzelani nomboro ni khajare zwivhumbeo u itela uri zwi vhe 8 kha rou inwe na inwe.

Themo ya 4 - Vhege dza 1-5


8  




8




8




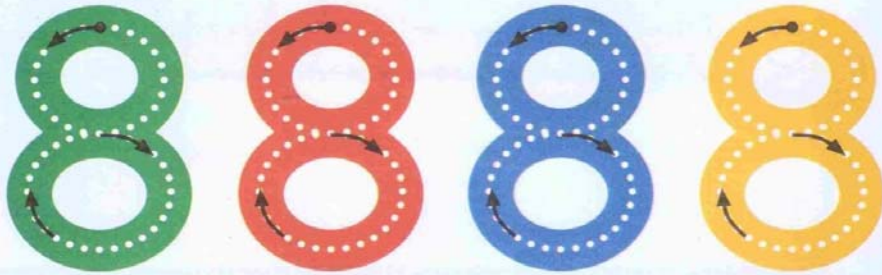
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8





 Itani ndowengowe ya nomboro 8.





Vhara vhalele

Lavhelesani zwifanyiso ni vhudze khonani yanu uri ndi tshibogisi tshifhio tshi re na zwinzhi nahone ndi tshifhio tshi re na zwiṭuku? Hu na zwibogisi zwi no lingana? Ni kone u vhala tshivhalo tsha zwithu ni tevhedzele nomboro i re yone.

	5	6		7	9
	7	8		3	5
	6	8		1	4
	4	5		3	5
	4	6		4	9
	6	7		8	9

Mudededzi: Tsaino

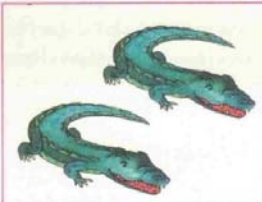

Deithi:

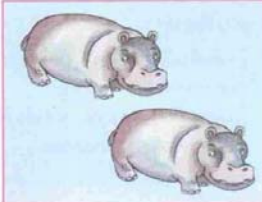



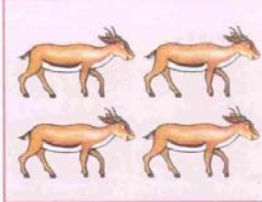
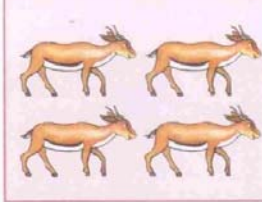
Kha ri vhalele Thusani mulindaphukha a tshi vhala phukha.

	+		=	2
---	---	---	---	----------

	+		=	
---	---	---	---	--

	+		=	
---	---	---	---	--

	+		=	
--	---	--	---	--

	+		=	
---	---	---	---	--

TEACHER: Sign _____ Date _____



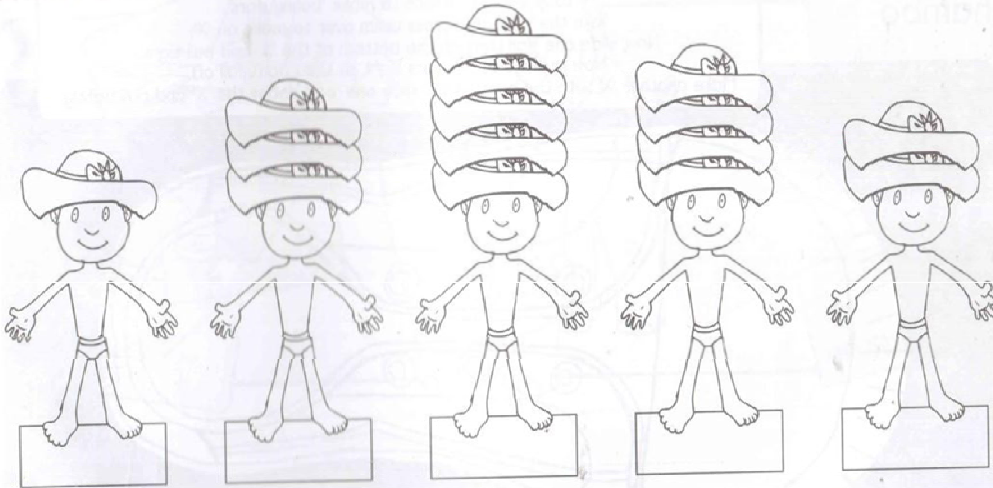
Teacher instruction:

Begin by revising the value of numbers 1 to 5. Learners count to five.

Ask how many fingers are on each hand and count them. Learners can count the hats each figure is wearing. They then write the number and word in the box below each figure. They can use the labels at the bottom of the worksheet to help them.

This is a visual discrimination and counting activity.

Vhalani miñwadzi



1 - thihi

2 - mbili

3 - raru

4 - nna

5 - thanu