EXPLORING THE USE OF MANIPULATIVES IN TEACHING NUMBER SENSE IN GRADE 2: OSHANA REGION, NAMIBIA

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DECLARATIONS

I, Elsabé Christina Hermana Potgieter, declare hereby that this study is a true reflection of my own research, and that this work, or part thereof has not been submitted for a degree in any other institution of higher education.

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Elsabé C.H. Potgieter Date

ABSTRACT

The main purpose of this study was to establish how selected Grade 2 teachers in the Oshana Region used manipulatives when teaching number sense aspects in mathematics. The study wanted to establish in what way the teachers' understanding of number sense and use of manipulatives influenced the Grade 2 learners' performance in selected number sense skills. The target population was all government schools with Grade 2 classes in the Oshana Region. The sample for the study was purposively selected. Four urban schools using English as medium of instruction in the Lower Primary phase were selected. A total of eight teachers and eight Grade 2 classes were the respondents of the study. This study used both quantitative and qualitative methods for collecting the data. Data collection tools included a pre – observation interview with the Grade 2 teachers, a classroom observation form rating teacher behaviour by using a Likert scale, field notes taken during lesson observation, a post-observation questionnaire to be completed by teachers after each lesson taught and finally a test with a Likert scale to evaluate each Grade 2 class' performance in selected number sense skills. The findings revealed that the Grade 2 teachers included in this study did not have a proper understanding of a) number sense and b) the effective use of appropriate manipulatives for teaching number sense skills. Their learners also performed poorly in the number sense skills. The study therefore recommends that the Ministry of Education should make Lower Primary teachers thoroughly aware of the importance of developing a solid number sense during the early years of schooling and to equip Lower Primary teachers with the necessary skills on the use of manipulatives in their lessons. It is also recommended that a comparative study between educational regions should be carried out to establish if the poor understanding of number sense and use of manipulatives is a general occurrence among Grade 2 teachers in all educational regions throughout the country.

LIST OF ABBREVIATIONS AND ACRONYMS

BETD	Basic Education Teacher Diploma
ETSIP	Education and Training Sector Improvement Plan
HPS	High Performing School
LCE	Learner Centered Education
LPS	Low Performing School
MASTEP	Mathematics and Science Extension Programme
MBEC	Ministry of Basic Education and Culture
MEC	Ministry of Education and Culture
MoE	Ministry of Education
NCTM	National Council of the Teachers of Mathematics
NSAT	National Standardized Achievement Tests
SACMEQ	Southern African Consortium for Monitoring Educational Quality
ZPD	Zone of Proximal Development

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This thesis is dedicated to the following persons:

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"I hear and I forget.
I see and I remember.
I do and I understand."
- Confucius (551–479 BC)

1.1. Orientation to the study

"Competence in mathematics is crucial to the workforce in science, technology and engineering" (Jordan, Glutting & Ramineni, 2009, p.1). This quote has relevance for Namibia in acquiring Vision 2030 which aims at developing Namibia into an industrialized country with a knowledge based society. In order to achieve Vision 2030, the Namibian government implemented education as a key factor. The Education and Training Sector Improvement Programme (ETSIP) document of 2007, which the Namibian government adopted in order to create a knowledge based society, states the importance of having a good quality of general education as it determines the quality of tertiary education where future teachers are trained. Furthermore, the Broad Curriculum document of the Basic Education Teacher Diploma (BETD) in Namibia outlines the Ministry of Education's expectations from teachers with regard to Learner Centered Education (LCE) and the usage of teaching aids in schools:

Teachers should be able to select content and methods on the basis of the learners' needs, use local and natural resources as an alternative or supplement to readymade study materials and thus develop their own and the learners' creativity. A learner-centred approach demands a high degree of learner participation, contribution and production. (Ministry of Education [MoE], 2009, p. 2).

According to the above statement, it is expected of the Namibian teacher to lead the teaching and learning process by encouraging active involvement and participation of learners. However, it is almost two decades after the original policy document on education spelled out the Ministry of Education's expectations for quality education in Namibia, and the question arise: How successful has the proposed teaching methods been in creating an educational environment where quality and effective learning and teaching are inspired in schools? In my past experience as a Lower Primary Advisory teacher in the former Ondangwa West Education Region, I often found, when visiting Lower Primary teachers that the majority of teachers had difficulty in using teaching aids creatively, especially when teaching number sense. Furthermore, Maduna (2002) found that when teachers are not adequately prepared during their teacher training on how to use teaching aids in mathematics lessons, it will negatively influence the effective use of teaching aids in the mathematics lesson. As a result, learners might not acquire a good and solid understanding of the mathematics taught in the lesson. This situation resulted in a critical gap between theory and practice, and this was the motivation for me to carry out a study on the use of manipulatives in teaching number sense in the Namibian context.

1.2 Statement of the problem

The Namibian Ministry of Education has implemented several strategies to strengthen mathematics teaching in schools in order to improve the learning outcomes in this subject. The Mathematics and Science Extension Programme (MASTEP) (as cited in Peters, 2006) was a programme implemented in 2001 to improve the teaching skills of mathematics and

science teachers at secondary school level with the purpose to improve the mathematics results of learners.

The intention was that the MASTEP programme will tackle the mathematics teaching problem at secondary school level because improvement in mathematics at this level will feed into the tertiary level where future mathematics teachers are trained. Well trained mathematics teachers in turn will have a positive outcome in mathematics teaching at the primary school level. This expectation was not achieved as many of the mathematics teachers trained under the MASTEP programme ended up as either school principals or advisory teachers, their teaching skills lost to the school system (Peters, 2006).

The Southern African Consortium for Measuring Educational Quality (SACMEQ) III project of 2007 to 2011 has found that Namibia, among the other countries that participated in this study, has the highest proportion of functionally innumerate learners at Grade 6 level. The Grade 6 learners who took part in the SACMEQ study, performed below level 4, which is Beginning Numeracy (Nakashole, Shikongo, Miranda & Dengeinge, 2012). This means that the Grade 6 learners found it difficult to solve simple arithmetic problems which include calculating with whole numbers. Although the Oshana Education Region was one of the regions which showed an improvement in both reading and mathematics skills between SACMEQ II and SACMEQ III, it was still among the regions that performed at a lower level in mathematics skills, compared to Khomas and Erongo regions who were identified as the regions who performed best in both reading and mathematics skills (Nakashole et al., 2012). In addition to the SACMEQ III results, the National Standardized Achievement Tests (NSAT) of 2009 (as cited by Courtney-Clarke, 2012) also showed that 46% of Grade 5 learners who took part in the study that was

conducted nationwide, performed below the basic level which means that the learners showed very little or no skills in doing basic mathematics (Courtney-Clarke, 2012).

Clegg and Courtney-Clarke's report of 2009 on the teaching of mathematics in Namibian schools stated that many of the problems associated with the mathematics performance of learners originate in the Lower Primary phase. They gave the following reasons for this statement: the Lower Primary syllabus is very difficult, Lower Primary teachers find it difficult to interpret and teach the syllabus, the teaching methods and quality of teaching in Lower Primary classes varies from school to school, number sense is not developed in this phase and teachers make very little use of concrete teaching aids when they teach mathematics (Clegg & Courtney-Clarke, 2009). A study carried out by Haufiku (2008) who investigated the level of mathematics content knowledge of some Lower Primary teachers in the Ohangwena Region in Northern Namibia, supports Clegg and Courtney-Clarke's (2009) study. Haufiku (2008) found that the Lower Primary teachers who participated in the study had limited knowledge of number concept, measures and mensuration. It was found that their mathematical knowledge content was at the level of Grade 4 and Grade 5, according to the Namibian mathematics school syllabus. This is well below internationally acceptable standards (Haufiku, 2008). The need to improve the general understanding of basic concepts and academic performance in mathematics cannot be ignored. To this end, classroom teachers have been urged "to improve the techniques to help learners learn mathematical concepts and symbols by calling for greater use of concrete objects in lesson delivery" (Uttal, Scudder & DeLoache, 1997, p. 38).

The purpose of this research is thus to investigate the use of manipulatives in teaching number sense at Grade 2 level. Grade 2 is chosen because the important concept of place value is introduced at this grade level.

1.3 Research questions

This research will be guided by the following questions:

i. To what extend do Grade 2 teachers in Oshana Region use manipulatives to teach number sense to the learners?
ii. What perceptions do Grade 2 teachers in the Oshana Region have of number sense and how it develops in young children?
iii. What is the relationship between the findings of the above two questions and the Grade 2 learners' mathematics performance?

1.4 Significance of the study

It is the responsibility of the teachers teaching in the Pre – and Lower Primary phase to make sure that the learners develop good numeracy skills at the start of their education. The findings of this study might help teachers and educationalists in the country to understand why developing good number sense is so important during the first years of formal schooling. It will also shed light on how the use of manipulatives can influence the development of number sense either positively or negatively. The expectation is that this study might show that an inadequate development of number sense in the Lower Primary results in poor performance in mathematics later on in the learner's school career. The findings of the study will be able to either support or challenge the findings by previous research done in mathematics teaching in the Lower Primary phase in Namibian schools

such as the study by Clegg and Courtney-Clarke (2007) and Haufiku (2008). These studies claim that one of the causes for poor performance in mathematics at upper primary and secondary phase levels of schooling is the fact that the Lower Primary teachers do not develop a correct functual number sense in learners for the following two reasons. Firstly, they do not know how to teach numbers sense as they have not yet mastered the skills in teaching numbers sense. A second point might be that they do not know why it is important for learners at this phase to have a good and functual understanding of number sense.

1.5 Limitations of the study

This study has certain limitations. The findings of this study is not applicable to the whole Lower Primary phase as the study only focused on four schools in the Oshana Region. Another limitation is the fact that teaching in Grade 2 is done in mother tongue. This means that mathematics is taught in either Oshindonga or Oshikwanyama. Since I do not speak the local languages used in the Oshana region, I decided to carry out the study in four urban schools in Oshana region that use English as medium of instruction in Grade 2. This will not give a clear picture of how teachers in Grade 2 teach number sense using manipulatives as the sample does not represent the whole population as such, neither will it give an indication of how Grade 2 teachers in the rural area teach number sense using manipulatives and whether there is a difference in performance between rural and urban schools in the region. Another limitation is that I did not test the learners' achievement of selected number sense skills through a structured test, but rather through an informal type of testing since I did not want the teacher and the learners to feel that I was evaluating them.

1.6 Delimitation of study

Delimitation in research is defined as statements that indicate what the researcher does not want to achieve through the study (Leedy & Ormrod, 2005). The focus of the study was not to compare the learners' performance in terms of number sense development in order to identify the best performing school. Neither was the focus on identifying the Grade 2 teacher with the best teaching practice regarding the teaching of number sense. The study was also not conducted to identify the best teaching practices for teaching number sense and place value with the use of manipulatives either. The focus was rather to understand how teachers teach number sense and place value using manipulatives in order to understand how teaching practices in these two crucial areas might contribute to the learners' achievement of a good number sense.

1.7 Definition of terms

Algorithm: A step – by – step procedure or formula to solve a problem.

Education and Training Sector Improvement Programme (ETSIP): A programme implemented by the Namibian Government in 2006 to uplift training and education quality to achieve Vision 2013 which aim to make Namibia a developed country with a knowledge – based society (Republic of Namibia, 2007).

Knowledge based society: A type of society that can compete and succeed in the changing economic and political dynamics of the modern world. This type of society is well educated and relies on the knowledge of its citizens to drive innovation, entrepreneurship and the society's economy (Republic of Namibia, 2007).

Learner Centered Education (LCE): A method of teaching in which the point of departure is what the learner knows and can do already. This teaching method allows for learning through relevant and meaningful ways (Ministry of Education and Culture, 2003)

Manipulatives: Concrete objects that are designed specifically to help children learn mathematics (Uttal, Scudder & DeLoache, 1997).

National Standardized Achievement Tests (NSAT): A nationwide formal examination done at Grades 7, 10 and 12 for promotion purposes. This is carried out every year in line with the ETSIP programme to test if learners achieved key competencies in language and mathematics in the selected grade levels (Courtney-Clarke, 2012).

Numeracy: The ability to use and apply aspects of mathematics (Haylock, 2010).

Number Sense: An understanding of number including counting, numeral recognition, understanding the following about numbers: more and less relationship, the role of special numbers such as five and ten, connections between numbers and quantities, computation with whole numbers, fractions, decimals and being able to do different representations of numbers, identifying set value (Griffin, 2004; Van De Walle, Karp & Bay-Williams, 2013)

Southern African Consortium for Monitoring Educational Quality (SACMEQ): A Non – Governmental Organization (NGO) representing the Ministries of Education of fifteen Southern African countries. These countries are Botswana, Kenya, Lesotho, Malawi, Mauritius, Tanzania (Main land & Zanzibar), Uganda, Zambia, South Africa and Zimbabwe. This organization's mission is to conduct research and training activities in Language and Mathematics which will improve the quality of education in the member countries (Hungi, Makuwa, Ross, Saito, Dolata, Van Cappelle, Paviot, Vellien, 2010)

Talk and chalk method: A conventional teaching method which is teacher driven. The teacher talks most of the time, make use of whole class instruction and activities. Learning is based on memorization and not understanding.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter will focus on reviewing the literature to determine what research has already been done that relates to this study. Quite a lot of studies have been done internationally regarding the teaching of number sense and the use of manipulatives in teaching mathematics, but not many studies had been carried out in Namibia, especially in the Lower Primary phase, on this topic. The first section will look at the theoretical framework for this study while the second section will lead to a review of current research focusing on manipulatives and how it can be used to teach number sense in the Lower Primary phase. It will also highlight the precaution Lower Primary teachers have to bear in mind when using manipulatives in lessons on number sense.

2.2 Theoretical framework

The main purpose of this section of the literature review is to provide a theoretical framework for the learning theory underpinning Learner-Centred Education (LCE) and how it relates to the use of teaching aids in a mathematics lesson at the Lower Primary phase. A number of related theoretical ideas will be explored, including constructivism, social constructivism, the Zone of Proximal Development (ZPD), and the notion of scaffolding.

As stated in the previous chapter, Learner Centered Education (LCE) was introduced in 1991 as the preferred teaching strategy in the Namibian education system. Learner-Centred Education (LCE) is defined as an approach where “teachers put the needs of learners at the

centre of what they do in the classroom, rather than the learner being made to fit whatever needs the teacher has decided upon" (Ministry of Education 2005, p. 7). The concept of LCE has its roots in social constructivism which stresses the importance of the nature of the learner's social interaction with knowledgeable members of the society. The learning theory of constructivism is historically attributed to Piaget who argued that "children construct their own understanding through interaction with their environment – that is, through their actions on objects in the world" (McInerney & McInerney, 2006, p. 37). In order to understand LCE and implement it effectively in the classroom, the teacher needs to have an in depth understanding of the Constructivist theory.

Constructivism is defined as an active process in which "learners construct and internalise new concepts, ideas and knowledge based on their own present and past knowledge and experiences" (Cohen, Manion & Morrison, 2010, p. 181). Constructivism therefore suggests that the learners construct knowledge out of their own experiences rather than receiving it, and this in turn is a fundamental precept of LCE. The learner acts on stimulus within his/her environment and through this process gains an understanding and associates meaning to objects and events in the environment. Cognitive skills are thus fully developed through active participation and engagement in the learning process.

According to Cohen et al. (2010) there are two strands within the Constructivist theory namely cognitive constructivism and social constructivism, both of which share the common view that knowledge is constructed through "the learner's cognitive structures and processing, through active and participative learning and through recognition that learning is

not fixed and inert, but is continually developing" (p. 181). These two strands show strong overlaps with each other. Cohen et al. (2010) further state that Jean Piaget's early studies on an individual's thinking and learning initiated the theory of cognitive constructivism while social constructivism owes much of its development to the writings of Lev Vygotsky (p. 182). The ideas of Jean Piaget and Lev Vygotsky will be discussed in order to explain these two strands within the theory.

2.2.1 Cognitive Constructivism according to Jean Piaget

Jean Piaget (1896 – 1980) was a Swiss psychologist who believed that all people go through a series of fixed stages of cognitive development. He believed that the quantity as well as the quality of knowledge and understanding increase during each stage of development. Piaget's stages of cognitive development are as follows:

Stage 1: Sensori – motor stage: birth – 3 years.

Stage 2: Pre – operational stage: 3 – 6 years.

Stage 3: Concrete operational stage: 6 – 12 years.

Stage 4: Formal operational stage: 12 to 20 years (Feldman, 2003).

Learners in the Lower Primary school phase will fall within the Concrete operational stage of Piaget's theory. For this reason, only the Concrete operational stage of Piaget's theory will be discussed.

Feldman (2003) summarises the key points of the Concrete operational stage as follow: learners in this stage of development make quite big advances with regards to their cognitive development. This stage is characterized by the learner being active in his/her

learning by making appropriate use of logic. The learner is able to apply logical operations to a concrete problem e.g. when the learner has to determine if liquid which is poured from one container into another container of a different shape will fit, the learner will use logical processes in order to find the answer. The learner is no longer fooled by the physical appearance of objects and is able to take multiple aspects of a situation into account. For instance, the learner is able to identify that the containers look different, therefore s/he will probably experiment by pouring the liquid from one container to another in order to find out whether these two containers keep the same amount of liquid or not. This is known as *decentration.*

Learners furthermore, make the shift from the Pre- operational stage (3 – 6 years) to the Concrete operational stage (6 – 12 years) gradually. They are however, still not able to reason in an abstract way as adults do. During this stage, the learner is also capable of *reversibility*, which means that the learner is able to follow a step-by-step approach in which steps can be reversed from the last to the first. The learner is able to understand for example, that a ball of clay rolled into a snake- like form can be returned to its original state and form. Reversibility also enables the learner to understand that mathematical concepts such as 3 + 5 and 5 + 3 are the same and both equals eight. Reversibility therefore enables the learner to learn and apply the *inverse operations* as it applies to addition and subtraction.

Learners in the concrete operational stage of cognitive development are still limited in their thinking as they can still not reason abstractly. They are still dependent on concrete and physical objects in order to understand abstract concepts (Feldman, 2003). It is for this

reason that mathematical concepts should be taught with concrete objects in the Lower Primary phase, by using the principle of "concrete to abstract" teaching.

2.2.2 Social Constructivism according to Lev Vygotsky

Social constructivism, as promoted by Lev Vygotsky a Russian developmental psychologist, who lived from 1896 – 1934, extends the concept of constructivism by incorporating the role of the society and culture into the process of an individual's cognitive development. A central theme in Vygotsky social constructivist theory is that it encourages the learner to arrive at his or her version of truth influenced by his/her background and culture. This social-cultural milieu is not restricted to the classroom, but also incorporates parents, teachers and peers interacting with the learner through social engagement. Learners grow intellectually because of the assistance they receive from peers and adults (Feldman, 2003). Social constructivism puts greater emphasis on the importance of the learners being actively involved in the learning process, thereby encouraging motivation. Vygotsky (1978) argues that "learning and development are interrelated from the child's very first day of life" (p. 84). The Ministry of Education and Culture (MEC) (2003, p.21) stresses that the main principle of LCE is to "use the social context of the learner as a resource, and to relate learning to the social context". The MEC (2003, p. 26) points out that in a learner-centred approach there should be a strong triangular relationship between three elements: teachers, learners, and the teaching aids.

Vygotsky's constructivist theory is well-known for its contribution to the development of modern learning theories in education especially through his concept of the Zone of Proximal Development (ZPD). Vygotsky (1978) in his own words defines the ZPD as:

…the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. (p. 86)

The assistance and guidance that teachers, parents and sometimes even peers provide to the learner in developing the ZPD, is referred to by Bredekamp (2011) as scaffolding. Bredekamp, (2011) explains that scaffolding does not mean that the teacher or adult control learning. The learner constructs knowledge collaboratively with others when s/he solves problems together with the teacher and peers in the classroom situation. This is also referred to sometimes as the social construction of knowledge. In this type of knowledge acquiring, learners work together, challenge each other's ideas and change their perceptions and ideas about something. The importance of the ZPD in the learning process is further explained by Vygotsky (1978) as it defines "those functions that have not yet matured but are in the process of maturation, functions that will mature tomorrow but are currently in an embryonic state" (p. 86).

Dzambara (2012) points out that the teacher in a learner-centred approach serves as a facilitator in the learning process as the learners are guided to arrive at their own conclusions. The use of teaching aids in mathematics might promote the ZPD concept through interaction between more competent and less competent learners in classroom discussions as well as provide the necessary guidance and direction towards independent thinking. Mathematics teachers might therefore make use of the ZPD concept in their lessons to identify and use teaching aids to promote co-operative learning activities in their lessons and ensure that learners at different levels assist each other in the learning process. Reid-Griffin and Carter (2004) indicated however, that the process of scaffolding is

complicated in the classroom context because too little help leads to frustration and failure while too much assistance removes the challenge from the learner. Vygotsky furthermore believed that speech is a very important tool for learning, since learning depends on interactions with others. Self-regulation is also important in the learning process as the learner needs to take the responsibility to control him/her in terms of behaviour, emotions and thinking. Self-regulation enables a person to start doing something that is needed, as well as to control impulses that might cause a person to do something unnecessary (Bredekamp, 2011).

As can be observed from the above, the theory of Constructivism blends very well with the Learner Centered Education (LCE) approach which is used as a teaching strategy in Namibian schools. Some of the main indicators of the LCE approach are that learning begins by finding out the learner's existing knowledge and connect it to the new knowledge to be learnt. Learners should be partners in the learning process and should be active in the lesson and should take responsibility for their own learning as well as the learning of others (Ministry of Education, 2005).

2.2.3 The implications of Piaget's and Vygotsky's theories for Mathematics instruction

Van De Walle, Karp and Bay-Williams (2013) are of the opinion that learning theories, such as Constructivism, provides the lens for interpreting how a person learns. They are also in agreement with McInerney and McInerney (2006, p. 37) in explaining that cognitive constructivism and social constructivism share the same viewpoints about how

knowledge is constructed and that the view on cognitive development from both Vygotsky and Piaget

emphasizes the importance of active involvement of learners in the learning process as well as the peer interaction in real world experiences. Therefore, Van De Walle et al. (2013) are proposing that the ideas of Piaget and Vygotsky have the following implications for teaching mathematics:

- Teachers should build or connect new knowledge on the prior knowledge the learners have about the content or topic being taught.
- Learners should be given the opportunity to talk about mathematics during the lesson.
- Learners should be given the opportunity to reflect on what they do to solve mathematical problems.
- Teachers should encourage learners to use a variety of approaches and methods when solving mathematical problems.
- Allow learners to struggle productively with mathematical problems.
- Teachers should use the mistakes made by the learners as opportunities for learning.
- New content should be scaffold.
- Teachers should honour the diverse cognitive abilities of the learners they teach.

Finally, in applying scaffolding in the teaching of mathematics, Bliss, Askew and Macrae (1996) suggest that "teachers need to believe that learners can learn difficult and complex ideas; this is what school is about" (p. 60).

2.3 What are manipulatives?

In 1837, German educator Friedrich Froebel introduced the world's first kindergarten. "He designed the educational play materials known as Froebel Gifts, or *Frobelgaben*, which included geometric building blocks and pattern activity blocks"(Smith, 2009, p. 20). Then in the early 1900s, Italian educator Maria Montessori continued with the idea that manipulatives are important to education. She designed several materials to help teach primary school learners the basic ideas of math. "Since the 1900s, manipulatives have come to be considered essential in teaching mathematics at the primary school level" (Smith, 2009, p.20). In fact, the National Council of Teachers of Mathematics (NCTM), (2000, as cited by Smith, 2009) has recommended the use of manipulatives in teaching mathematical concepts at all grade levels. Manipulatives can come in a variety of forms and they are often defined as "physical objects that are used as teaching tools to enhance learners' understanding of concepts and relations and can be used to explore mathematical ideas by using a hands-on approach. Manipulatives can be bought, brought from home, or hand made by teachers and learners. The manipulatives can range from dried beans and bottle caps to Unifix cubes and base-ten blocks. They are used to introduce, practice, or remediate a math concept. "A good manipulative bridges the gap between informal math and formal math. To accomplish this objective, the manipulative must fit the developmental level of the child or it is useless" (Smith, 2009, p. 20). Mathematics manipulatives, according to White, Swann and Marshall (2009), are objects that can be "handled by an individual in a sensory manner during which conscious and unconscious mathematical thinking will be fostered" (p.14). Furthermore, mathematics manipulatives have "the potential to lead to an awareness and development of concepts" (White et al.,

2009, p. 14) because hands-on learning builds a better understanding. The need for every learner to be provided with an opportunity to play with manipulatives in the teaching and learning process, rather than just concentrating on the teachers' demonstrations, is underscored (White et al., 2009).

2.3.1 Using manipulatives effectively in mathematics lessons.

Manipulatives can be extremely helpful for young children, but they must be used correctly.

Learners must understand the mathematical concept being taught rather than simply moving the manipulatives around. Smith (2009) stated that there are probably as many wrong ways to teach with manipulatives as there are to teach without them. The math manipulatives should be appropriate for the learners and selected to meet the specific goals and objectives of the mathematical lesson. "The complexity of the materials provided will increase as learners thinking and understanding of mathematical concepts increase" (Seefeldt & Wasik, 2006, p. 93).

It is also important for teachers to allow their learners to have free time to play with the manipulatives. After the learners have explored the manipulatives, "the materials cease to be toys and assume their rightful place in the curriculum" (Smith, 2009, p.17).

Additional studies have shown that learners who use "manipulatives in specific mathematical subjects are more likely to achieve success than learners who don't have the opportunity to work with manipulatives" (Seefeldt & Wasik, 2006, p. 252). Concrete manipulatives have proven to be an essential tool to engage learners in learning

mathematics. Piaget as cited in Moyer (2002) suggested that learners do not have the mental maturity to grasp abstract mathematical concepts present in words or symbols alone and need many experiences with concrete materials and drawings for learning to occur. In order for learners to have valuable mathematical learning experiences they need to construct their own meaning of understanding by learning actively through the use of manipulatives in the classroom (Seefeldt & Wasik, 2006, p. 252). However to accomplish this objective, the manipulative must fit the developmental level of the learner" (Smith, 2009). Some learners need to use manipulatives to learn to count, while other learners' understanding of place value increases with the use of manipulatives. Research also indicates that using manipulatives is especially useful for teaching low-achievers with learning disabilities. The importance of providing learners with direct experiences with concrete materials is supported by evidence from the classroom and an understanding of how learning takes place. While learners can remember information taught through books and lectures, studies show that deep understanding and the ability to transfer and apply knowledge to new situations requires learning that is founded in direct, concrete experience. An important justification for hands-on learning, then, is that it allows learners to become independent learners and thinkers. It is also important to note that learners cannot learn math simply by manipulating physical objects. When using manipulatives, teachers should closely monitor learners to help them discover and focus on the mathematical concepts involved and help them build bridges from concrete work to corresponding work with symbols. Uttal, Schudder and DeLoache (1997) suggest that extensive teaching, guidance, demonstration and practice with manipulatives will make the mathematics lesson more effective.

The following figure illustrates their view of how manipulatives can in fact cause misconceptions about the mathematical concept learnt.

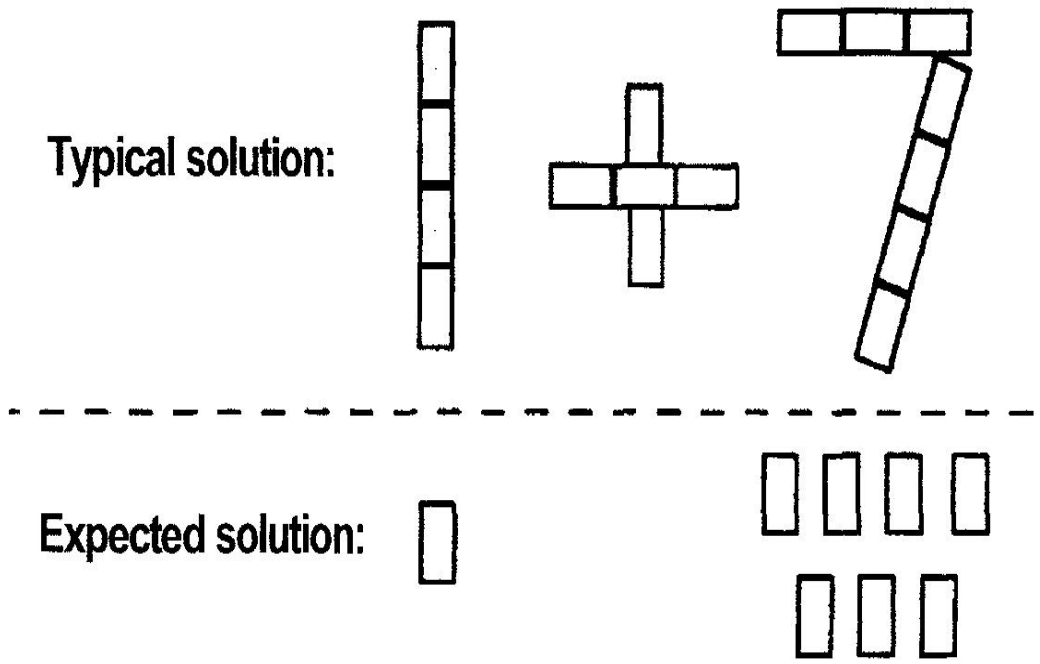


Figure 1: Hypothetical example of learners'' use of blocks to represent arithmetic problems (Adapted from Hughes,1986 in Uttal, Scudder & DeLouche, 1997)

The above illustration shows how learners can misinterpret the use of counters to represent 1 + 7 if the teacher did not explain how the counters should be used to represent 1 + 7. Instead of packing out 1 + 7 as illustrated in the "expected outcome", the learner might use it to represent the symbols of one and seven as illustrated in the "typical solution". The learner then clearly misunderstood how to use the manipulatives in helping him/ her to find the answer.

There is no single best way to teach math. However, research done on the use of manipulatives (Kanima & Iyer, 2009; Scheyer, 2000) shows that using manipulatives in

conjunction with other methods can deepen learners' understanding of abstract concepts. Appropriate use of manipulatives should be one component of a comprehensive mathematics curriculum. An important aspect in the teaching of mathematics, which is often overlooked by teachers, is the fact that mathematics should **make sense**. The use of manipulatives can play an important role in helping learners to make sense of mathematical concepts. Scheyer (2000) suggests that learners could make better sense of mathematics when they are allowed to investigate problems in real life contexts. This could help them to understand mathematics in a real life situation and to solve problems. The use of manipulatives can help learners to solve problem situations and to demonstrate how they solve a specific problem. Effective use of manipulatives in the mathematics lesson will require a connectivist approach in the teaching of mathematics (Delaney, 2010). This implies that the teacher will make connections between different aspects of mathematics e.g. addition and subtraction, connections between symbols, words, diagrams, concrete objects and that they will connect all of these with the learners' methods of solving mathematical problems. Effective use of manipulatives further implies that the teacher will have two distinctive views of the manipulatives used in the lesson i.e. 1. *manipulatives used for demonstration purposes* and 2. *manipulatives used for engagement purposes.* Manipulatives used for demonstration purposes will direct, model, instruct, explain, illustrate and clarify the learners' misconceptions about the mathematical concept that is being learnt while manipulatives used for engagement purposes will help learners to visualise, see relationships, describe, discuss, ask questions and practice the mathematical concept that is learnt (Delaney, 2010).

2.3.2. Advantages of using manipulatives in mathematics lessons.

Manipulative materials can be used to represent numbers and operations with numbers (Mustafa al-Absi & Nofal, 2010). The use of manipulatives are however not limited to the teaching of number and number operations only, but is useful in teaching a variety of mathematical concepts such as place value, decimal numbers, fractions, measurement, to name a few, provided that it is used to provide learners with opportunities to practice these concepts in a meaningful manner. The use of manipulatives provides learners with a concrete basis from which abstract thinking will develop (Lambert, n.d.). However, research has shown that the use of manipulatives does not guarantee that learners will learn mathematics with understanding (Clements, 1999, Lambert, n.d., Uttal et al., 1997). On the other hand, the majority of studies that were conducted on the use of manipulatives in learning mathematics showed that learners achieve better in mathematics when they use concrete or manipulative materials well (Boggan, Harper & Whitmire, n.d.).

The use of manipulatives will help learners to acquire different types of knowledge. There are basically two types of knowledge learners can acquire from the use of manipulatives: (1) *Integrated – concrete knowledge*: this is a type of knowledge that is connected in special ways. Separate ideas are connected to acquire knowledge or understanding of a concept e.g. in order to solve ¾ meters + ¾ meters a learner can use ideas such as ¾ meters = 75cm, thus 75 + 75 = 1 ½ meters. The learner thus needs to know about measurement with standard units as well as fractions in order to solve this problem. Different mathematical ideas are thus interconnected to find the correct answer. (2) *Sensory – concrete knowledge:* this kind of knowledge is created with the use of sensory materials e.g. using counters to make sense of an idea or concept. Young learners for instance cannot

count, add and subtract in a meaningful way without using concrete materials such as an abacus, stones, sticks, seeds etc. (Clements, 1999). Therefore, it is also important for the teachers of young learners to consider the three steps that learners use to create knowledge. These steps follow each other in stages and the learner cannot move to the next stage without following the steps in the right order. The steps of creating knowledge are as follows: 1. *Enactive or concrete level*: the learner uses concrete objects to interpret and understand mathematical symbols and concepts e.g. count five fingers and show how many it is.

2. *Iconic or Semi- concrete level*: At this level, the learner is able to interpret mathematical concepts through pictures and sets e.g.

 = five.

3. *Symbolic or abstract level*: At this level, a learner is able to use abstract symbols to represent a mathematical idea or concept thus, reading and understanding a number sentence e.g. 2 + 3 = 5 (Lambert, n.d.)

2.3.3 Guidelines for choosing appropriate manipulatives.

Understanding and successful learning depends on how manipulatives are chosen and used in lessons (Baroody, 1993 in Lambert, n.d.). There are guidelines that teachers can follow to ensure that the use of manipulative materials will help learners to learn and understand mathematics better. Teachers must therefore bear the following in mind regarding the use of manipulatives:

1. The manipulatives must support the lesson objectives.

2. The manipulatives used must illustrate the actual mathematical processes or concepts taught. 3. It must be used individually by each learner.
4. Teachers must provide learners with opportunities to work with the manipulatives in order to explore and generate a variety of answers.
5. There must be clear rules set for using manipulatives (Lambert, n.d., Kelly, 2006; Mustafa-al Absi & Nofal, 2010).

Furthermore, the teacher must ensure that the manipulatives used in the lesson, will contribute to a better understanding of the concept(s) being taught. Therefore, the teacher needs to have a good pedagogical content knowledge in order to choose the appropriate manipulatives for the lesson and to use it effectively for learners to understand and learn (White et al., 2009). Pedagogical content knowledge according to Shulman (1986) is a type of knowledge that goes beyond the subject matter. It includes the know-how of representing ideas that is taught by using illustrations, examples, explanations and demonstrations. Pedagogical content knowledge also includes an understanding of why a specific topic in mathematics is easy or difficult to understand and what strategies can be used to make learners understand it better (Shulman, 1986).

2.3.4 Zoltan Dienes' view on mathematics teaching and the use of manipulatives.

Hungarian mathematician, Zoltan Paul Dienes (1916 – 2014) developed a quite effective theory of how mathematics learning takes place in young learners (Hirstein, 2007). Dienes is perhaps better known for developing the Base 10 blocks (see Fig. 2 p.41) for teaching place value concepts. This is also known as the Dienes blocks. His theory on mathematics learning is perhaps not so well known as the Dienes Blocks, but is quite appropriate for mathematics teaching at the Pre- and Lower Primary school level. Dienes' theory is very

much in line with Bruner's ideas on how learners learn namely enactive (concrete), iconic (semi – concrete) and symbolic (abstract).

The mathematics learning theory of Dienes involves six stages. The use of games, manipulative materials, free play and even dance play a big role in the learning of mathematics concepts (Hirstein, 2007; May, 2010). The different stages can be explained as follows:

Stage 1: *Free play:* This is a trial and error phase in which learners are presented with concrete materials with which they can play to discover what they can do with it.

Stage 2: *Games:* Learners now invent their own games to play with the concrete materials. These games must have clear rules which the learners will develop themselves.

Stage 3: *Search for communalities:* After playing the games with rules which they have invented themselves, learners now discuss the different games they have played with each other to find similarities.

Stage 4: *Representation:* During this stage learners now represent these similarities they have found with pictures and diagrams to show the common aspects between the games.

Stage 5: *Symbolisation:* The learners now develop symbols or learn about existing symbols that represent the mathematical idea they are learning about.

Stage 6: *Formalisation:* This stage deals with the learning of mathematical rules and truths. Here, the learners have to provide proof for their answers and statements (May, 2010).

Dienes' theory is furthermore based on four principles.

1. Dynamic principle: The play stage enables the learner to form a true understanding of a mathematical concept as play is a natural activity for a young learner. The play stage introduces the learner to the mathematical concept to be learnt.

2. Perceptual Variability Principle: This principle suggests that learners learn mathematical concepts effectively when they are presented with a variety of physical contexts and materials. This helps learners to learn the specific mathematical concepts in context.

3. The Mathematical Variability principle: This principle suggest that learners learn about mathematical concepts in a variety of ways e.g. through games. Abstraction and generalization are crucial aspects in this stage for developing an understanding of mathematical concepts.

4. Constructivity Principle: Children could either be constructive or analytical thinkers. Both types of thinker need concrete materials to get the thinking process going. This principle thus implies that concrete materials help learners to construct knowledge and to analyse what they are learning about (Post, 1981).

It is thus clear from the discussion that Dienes' theory supports the use of manipulative materials in mathematics lessons. Learners need to be actively, physically and mentally involved in the learning situation and the use of manipulative materials could achieve that when it is used correctly.

Now that I have given an extensive review of what manipulatives are and how to use it in the grade classes, I will move over to the question of number sense.

What does it mean to suggest that an individual possesses good number sense? One often hear that children enter pre-school with a well-developed understanding of approximation and counting, does it mean that they have a good number sense?

2.4 Number Sense

2.4.1 Defining Number Sense

It is important to have a good understanding of what number sense means and involves. When teachers have a good understanding of what number sense is, they might be in a better position to stimulate and teach number sense development effectively at the Lower Primary level. Therefore, it is important to explore different definitions about number sense and then draw a conclusion from these definitions. It is however necessary at this stage to point out that the Lower Primary Mathematics curriculum used in Namibian schools does not mention number sense at all, but has a component "number concept development" as one of the six key mathematical skills to develop in this phase. Hence, it is therefore also important to make a clear distinction between *number sense* and *number concept* as there is an assumption that teachers view these two concepts as the same.

Howden (1989) (in Van De Walle et al., 2013, p. 135) defines number sense as a "good intuition about numbers and their relationships. Number sense develops gradually as a result of exploring numbers, visualizing them in a variety of contexts and relating them in ways that are not limited by traditional algorithms." In addition to this, Kennedy and Tipps (2000, p. 188) see number sense as "the ability to think with and about numbers." According to this particular definition, number sense develops as learners think about and represent numbers in different ways e.g. the number 27 can be thought about as the same as 30-3 or two groups of ten plus seven units.

Kennedy and Tipps (2000) further explains that number sense provide the basis for studying numbers, that number sense is in fact an attitude and way of thinking about numbers. Their definition supports the definition of Van De Walle et al. (2013) in the sense that both definitions support the idea that number sense develops as a result of visualising and thinking about numbers in different ways.

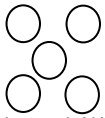
Griffin (2004) is of the opinion that many teachers have a different view of number sense as defined by Van De Walle et al. (2013) and Kennedy & Tipps (2000). According to Griffin (2004), many teachers view number sense as a "fixed body of knowledge involving numbers and their manipulation through rules and algorithms (Griffin, 2004 p. 39). This shows that teachers view number sense as something that is dependent on how one understands mathematical rules and apply it. It is in direct contradiction with the definitions discussed in the previous paragraph. Griffin (2004) further explains that learners do not learn about number by applying rules to find correct answers, but that they construct knowledge about numbers by discovering relationships between quantities and numbers and find appropriate ways to describe and record these relationships.

Lee (2011) sees number sense as an understanding of numbers which develops as a result of counting, numeral recognition, understanding more and less relationships, part-whole relationships, the role of special numbers such as 5 and 10, connections between numbers and real quantities and measures in the environment. According to his view, development of number sense starts with counting activities.

Tsao and Lin (n.d.) states that number sense refers to a person's general understanding of numbers and operations as well as the ability to use this understanding to make mathematical judgments, develop and use effective strategies for managing mathematical

situations. The National Council for the Teachers of Mathematics (NCTM) elaborates further on this definition by explaining that number sense involves the following: understanding and representing numbers in different ways, understanding the relationships between numbers and the number system, understanding meaning of the operations and how they relate to each other and to compute fluently and make reasonable estimations (NCTM, 2000, in Tsao & Lin, n.d.)

Looking at the above definitions, it is clear that these definitions have a common thread weaved through it with regard to defining number sense. This common idea is that number sense means the following:

- The ability to visualize and represent numbers in different ways e.g. ooo oo / oo ooo and  all represent number five.
- The ability to understand the relationship between quantity, thus knowing "how many" and the symbol that represent that number.
- To understand the relationship between numbers i.e. more, less and the same.
- Understanding how numbers are affected by operations.
- Understanding the place value of numbers.

Number concept, on the other hand, is not so easy to define. It seems to develop as a result of having a good sense of numbers. Number concept seems to have more to do with the understanding that numbers have specific functions such as cardinal, ordinal, decimal, odd and even, to name a few. Numbers have different functions and meaning depending on the context in which it is used. Brannan and Van De Walle (2001, in Cayton, 2008) sees number concept as having two important aspects, namely cardinality and the ability to

represent ordinal relationships between numbers. Cayton (2008) supports the idea that number concept is not easy to define and sees number concept as the ability to represent number internally. It would seem that the two concepts *number sense* and *number concept* are entwined and that one cannot fully develop without the other.

2.4.2 The development of number sense in the young child

Many scholars in the field of mathematics development are in agreement that number sense develops in certain stages during the early childhood years. They however do not see the stages in which number sense develop from the same viewpoint.

Van De Walle et al. (2013) outline the development of number sense along two clearly distinguished stages. These stages can be divided as follows: **stage 1**: **Number core:** this deals with quantity, counting and knowing "how many". **Stage 2**: **Relationship core:** this deals with the concepts "more, less and the same".

Stage 1: Number Core: Learners explore quantity before they can count e.g. they are able to identify a bigger cup, plate, a bag with more sweets, when they are presented with two choices. Number core is supported by subitising, which refers to the instant recognition of an amount without counting. It can be stimulated as from a very young age by exposing learners to patterned sets of numbers and through the playing of games. Early counting can be developed when the learner first learn verbal counting skills and then to attach meaning to the counting of objects.

This is achieved by applying the cardinal principle. The cardinal principle is understood if the learner realizes that the last number said indicates the amount in the set. The learner is thus able to match counting words with an object through one to one correspondence. This

helps the child to know that the last number said represent the whole set. Counting on and counting back helps the child to understand addition and subtraction later on. When counting forward, it means the same as to "add" while counting back means to "minus". Fosnot and Dolk (2001, in Van De Walle, et al., 2013) see the ability to count on and backwards as a landmark on the path to acquire number sense.

Stage 2: Relationship core: The following is very important in achieving the relationship core: anchoring numbers to numbers 5 and 10, part-part-whole relationships, missing part activities, learning about place value, estimation and measurement. Learners develop an understanding of the relationships between numbers by doing the following: **1. Anchoring numbers to special numbers such as five and ten**. This is done by using five and ten frames. The learner e.g. packs out three counters on a five frame and then discovers that three is two less than five. When learners can "anchor" numbers to five in order to see whether a number is more or less than five, the same is done by using a ten frame and anchoring numbers to ten. **2. Part – part whole relationships:** learners need to understand e.g. if one part is two and the other part is six, what is the whole? They also need to experiment with missing part activities e.g. If the whole is eight and one part is five, what is the other part? Learners first need to develop an understanding of numbers 1 – 10 first and then numbers 10 – 20 will follow. Learners do what Van De Walle et al. (2013) calls "pre-place value" concept e.g. in number fifteen, two ten frames can be used to discover that number fifteen contains one ten and five units by filling up one ten frame to complete the "ten". **3. Place value concepts**: place value concepts are dealt with by first grouping an amount e.g. fifty five in groups of tens to let learners discover the base 10 number system. Tens and units are done first and then hundreds are introduced later. **4. Estimation and**

measurement: measuring real objects give children the opportunity to associate numbers with measurement e.g. the table is six pencils long. Estimation helps learners to reason mathematically and to discover the reason for using standardized units for measuring. Treacy and Willis (2003) stated that many teachers consider counting as being very critical to a learner's understanding of numbers and quantity. Therefore counting is usually the focus of mathematics lessons when children first start school. However, a major hurdle for many children is to attach *meaning* when explaining how many there are in a collection or in a set. According to Treacy and Willis (2003), number sense develops in the following stages:

1. *Counting and understanding the cardinal principle:* Learners learn from a very young age, as young as two and a half that the number said at the end of a counting sequence represent the number in a set. They claim that if children are applying this principle, then they are showing they understand that numbers are representations of quantities (Gelman & Gallistel in Treacy & Willis, 2003).
2. *Protoquantive data:* This indicates that learners develop a sort of data base of quantity knowledge during their pre-school years. This data base forms the basis for later mathematical development. Protoquantive data can be defined as knowledge about quantities without associating it with words (Resnick in Treacy & Williams, 2003).
3. *Subitising:* Subitising precedes the development of counting. Subitising helps learners to quantify sets before they are able to count. It is thus clear from the above discussions that both Van De Walle et al. (2013) and Treacy and Willis (2003) have the same opinion of number sense development, although they are not naming the stages similarly.

Baroody and Wilkins (1999) distinguish between two different views about number sense development, namely the conventional and recent view. According to the conventional view, which was handed down from generation to generation, pre-school learners were seen as blank slates that will only learn mathematics once they are part of a formal classroom situation. The assumptions of this view were that learners are helpless, learning is a passive process and learners are not naturally interested in learning mathematics. The recent view is quite in contrast to the conventional view. According to this view, learners engage in different kinds of activities that involve mathematics such as keeping count of scores when playing soccer. These activities help learners to develop a body of informal mathematical knowledge and to learn about mathematics in a meaningful way.

Ginsburg (1977, in Baroody and Wilkins, 1999) is of the opinion that mathematics knowledge develops in learners in three phases:

*Phase 1***:** concrete knowledge based on appearance,

Phase 2: Concrete knowledge based on everyday experience,

Phase 3: School taught symbolic knowledge, also known as formal knowledge. Number sense thus involves a concrete understanding of numerical relationships such as "the same, more than" and the relative size of numbers i.e. to know that seven is more than five.

Young learners compare numbers to see if they are the same, more, less, bigger or smaller than another. Counting helps the young learner to understand numbers in a concrete and meaningful way. Activities such as subitising, counting and finger counting "drives" number sense development. Subitising helps the learner to distinguish between small sets e.g. a set of two, a set of four. Counting develops as from a very young age. The learner

learns counting by imitating others. Rote counting emerges in which the learner is able to say counting numbers in a correct sequence without understanding "how many". Finger counting and finger patterns help the learner to naturally represent a number and discover that a number e.g. five can be represented with either all the fingers on one hand or two fingers on one hand and three fingers on another hand. Finger counting helps a learner to discover important facts about numbers e.g. two is less than five. These facts will help learners to discover arithmetic knowledge informally. Baroody and Wilkins (1999) furthermore outline three important aspects about number sense that learners should be exposed to as from a young age: (1) Sense of number size which means to develop a "feel" for how big a number is (2) Estimation of set size and (3) Numerical relationships such as "more, less" and "the same."

For Gersten and Chard (1999, in Sousa, 2008) number sense develop in young learners according to five levels. These levels are not necessarily related to a certain age.

Level 1: In this level, learners have not yet developed a sense of quantity and do not know the difference between more, less, fewer, greater.

Level 2: At this level, the learner understands term like "lots of, six, and nine" and begins to understand the concepts "less, more, the same". The learner still does not have basic computation skills.

Level 3: At this level, learners have a concept of computation and use their fingers to apply counting strategies to solve problems.

Errors occur when calculating numbers. Level 4: The learner now relates on the "counting on" process in order to find answers. It is not needed at this stage to count up to five to

know it exists. The learner is now able to solve any digit problem. Level 5: Now learners use strategies they can recall from memory to solve problems. They have automated addition facts and are acquiring basic subtraction facts.

Lee (2011) summarizes number sense development in the pre-school years as follows: Number sense is a process that starts with counting. An early sign of number sense development seems to be the ability to count orally. Oral counting is seen as a way of representing numbers that is essential in mastering future mathematical understandings. Learners begin to use number knowledge when they count objects in a set aloud using one-to-one correspondence. Early schooling therefore should provide rich opportunities for learners to experience with and organize sets of numbers. While working with sets, learners will explore and discover relationships between numbers. Learners use pictures, diagrams and numbers in order to explore the relationships between sets. Physical materials are needed to make sense of quantities. Counters and base 10 blocks help learners to concretely make sense of numbers and number names. The use of the number line in early schooling also helps learners to develop number sense and how to represent numbers (Lee, 2011).

Tsao and Linn (n.d.) are of the opinion that learners of all ages will develop number sense in an environment where they work with concrete materials, discuss and share their discoveries and solutions, compose different arrangements and representations of numbers, investigating the use of numbers in everyday life, explore number patterns and number relationships, create methods for calculation and estimation, solve realistic problems using a variety of methods, calculate with a purpose and gather, organize, display and interpret quantitative information in the form of graphs.

The following summary can thus be made from the reviewed literature on number sense development: (1) Learners acquire mathematical knowledge and number sense before formal schooling, (2) Number sense development in the early years provides a solid foundation for building mathematical knowledge in future years, (3) Counting seems to be the starting point of number sense development in young children, (4) Number sense develops as a result of exploring numbers in different contexts, using concrete materials and discovering relationships between numbers, (5) Working with sets provides meaningful opportunities for young learners to learn about numbers (6) Number sense develops in stages, (7) Learning about place value is an important aspect of number sense development.

In conclusion, Tsao and Lin (n.d.) argue that there is a need to enhance the teacher's understanding of number sense and number sense development during their teacher training years so that number sense can be efficiently integrated in the teaching of mathematics. Courtney-Clarke (2012) is in agreement with this argument. She found that the Basic Education Teachers Diploma (BETD) student – teachers trained for teaching mathematics at primary school level in Namibian schools have a limited knowledge about number sense. She argued that this could be a result of the way mathematics was taught to the student teachers in school. She recommends that more research is needed in the field of mathematics teaching in Namibian schools and that teacher – training institutions should carry out research in this field so that the mathematics that teachers need to know in order to teach it effectively at school level could be identified. Thus, the teacher's pedagogical knowledge of mathematics teaching is an important factor in the development of number sense skills in young children as outlined by Lee (2011) and Treacy and Willis (2003).

2.4.3. The importance of number sense for doing mathematics.

Mathematics development, particularly number sense development, seems to influence learners' performance in mathematics later on. This view is supported by several researchers in the field of mathematics teaching.

Jordan, Glutting and Ramineni (2009) found that number sense is a strong predictor for later mathematics achievement. Weakness in symbolic number sense is the cause for most mathematical learning difficulties. If learners have difficulties with counting, knowing number relationships and doing basic operations, they will have difficulties with mathematics. These are seen as the foundational mathematical skills needed in order to perform well in mathematics at elementary school level (Claessens & Engel, 2013; Geary, Hoard, Nugent & Bailey, 2013). The level of number sense development in learners will predict how they will approach and do applied problem solving.

Competence in more complex mathematical knowledge such as borrowing or carrying over and being able to solve multi-column arithmetic problems contributes to a good number sense. There is a strong relationship between mathematics achievement in kindergarten and mathematics achievement throughout the formal school years (Geary, et al., 2013).

Performance in mathematics includes the following skills: a basic knowledge of numbers, memory for arithmetical facts, understanding mathematical concepts and the ability to follow procedures. Mathematical skills develop in a hierarchical way, thus the achievement of one skill will lead to learning and master the next skill. The learning of basic mathematical skills such as knowing basic facts, counting, doing simple calculations will provide the basis for mastering more complex skills and procedures in mathematics. When

learners start school with good skills and knowledge about mathematics, that knowledge will increase their performance in mathematics over time. A skill that has a definite influence in mathematic performance, is counting. Learners who experience mathematical difficulties also have deficient counting skills. Counting skills are important because they will lead to the automatic use of mathematically related information which will allow for more time to be spent on doing problem solving, following procedures (Aunola, Leskinen, Lerkkanen & Nurmi, 2004).

Learners, who enter school with low mathematical skills, will remain behind those with high mathematical skills. They might benefit from using a different curriculum and teaching methods. Counting ability seems to be a strong predictor of a high level of performance in mathematics. By focusing on numeracy development in the pre-school years, teachers, caregivers and parents can assist children in performing well in mathematics later on. There is also a need to drill and practice basic mathematical facts in order for the child to automatically use mathematical procedures with different kinds of problems (Aunola, et al., 2004).

Jordan, Kaplan, Locuniak and Ramineni (2007) also saw a relationship between early number sense development and mathematics achievement at the end of Grade 1. There is a strong correlation between learners' performance on number combinations and how they solve story problems. This correlation indicates that the use of story sums at pre-school level mathematics lessons will help learners to learn and do mathematics later on. Early development of both informal arithmetic (verbal calculations) and formal arithmetic (number combinations) can predict how learners will perform and achieve in mathematics in later school years.

2.4.4. Place value and its importance in acquiring number sense.

In order to have a good understanding of the concept *place value*, different definitions of place value will be explored first.

Bloomfeld (2003) defines place value as the value of the place a digit occupies in a number e.g. in 57 the number 5 occupies the "tens" place. The concept of place value is furthermore characterized by the following mathematical properties: **(1) Additive:** the quantity represented by the whole numeral e.g. 471 is the sum of the values represented by the individual digits that makes up the number, thus 400 + 70 + 1 = 471. **(2) Positional:** the value given to a digit is given according to its position in a number. This can be illustrated with the following columns:

H	T	E
4	7	1

(3) Base 10: the values of the positions increase in tens from right to left. **(4) Multiplicative:** the value of an individual digit is found by multiplying the face value of the digit by the value assigned to its position e.g. in 471 the number 7 is multiplied by ten because its position is in the column of the tens, thus the value is 70 (Bloomfeld, 2003).

The modern numeration system was developed from an ancient Hindu system. It was developed by Arab traders between the ninth and tenth centuries and its use spread throughout Europe during this time. This numeration system that is used today is called the

Hindu – Arabic number system, better known as the metric system. This is a base 10 number system that has a certain power and elegance that should be appreciated. It has certain value for economical use, because the way numerals are written clearly shows that each numeral in a number e.g. 366 has a certain value. This value is referred to as *place value* (Haylock, 2010). For Thompson (2000, p. 294) the concept place value means "grouping in tens". It refers to the value assigned to a numeral or digit according to its position in a number. It furthermore refers to an understanding of quantity value. Quantity value refers to the actual quantities as represented by each numeral in any given number. To summarize, place value refers to the value each numeral has in a two, three, four or any larger digit number and to have an understanding that place value also has specific mathematical properties such as additive, positional, base 10, multiplicative.

The understanding of place value concepts is very central in developing number sense. It forms the basis for doing the four basic operations. Understanding place value enables children to understand the base 10 number system that is used in our modern society. When the concept of place value is not well developed at the foundational level (in the Namibian context this would be the Pre – and Lower Primary years) learners might experience problems with certain mathematical concepts later on such as doing problem solving and understanding algebra (Nataraj & Thomas, 2007). Furthermore, understanding place value help learners to understand and work with decimal numbers (Sowder, n.d.). The decimal number system is basically an extension of the whole number system. Like whole numbers, decimal numbers are symbolized within a place value system which refers to the placement of digits or numerals. Therefore, before learners can be taught to calculate with decimal numbers, they need a thorough understanding of place value as it is used for

calculating with whole numbers (Sowder, n.d.). For Ross (2002) place value is an important mathematical concept to master in order to achieve a good number sense which includes the ability to estimate as well as understanding multi-digit operations. Developing a true understanding of place value does not occur until later years, although learners are taught about place value from Grade 2 level, in the Namibian school system. If the concept of place value is not well developed during the early years of schooling, learners will have a delayed conceptual understanding of basic arithmetical algorithms which is based on representations which rely on place value (Kamii & Joseph, 1988 in Cooper & Tomayko, 2011). It is thus clear that the teaching of the concept place value helps young learners to understand the base 10 number system, to do basic calculations with multi-digit numbers and that a thorough understanding of units, tens, hundreds and thousands, will prepare the way of understanding and working with decimal numbers later on. Place value concepts should be taught concretely to young learners (Burns, 2000; Haylock, 2005; Kennedy & Tipps, 2000; Van De Walle et al., 2013). The following are important place value concepts which learners should master: sets of 10, the positions of digits or numerals in numbers to determine the value it represents, number patterns, grouping of ones (units), tens and hundreds. Numbers should be taken apart in many different ways e.g. 256 = 200 + 50 + 6 or 250 + 6. Furthermore, the concept of zero as a value and place holder is a very important concept to understand in working with place value. The use of manipulative materials such as Cuisennaire blocks, strings of 10 (these could be beads, beans, bottle tops etc.) base 10 blocks to represent groupings of 10 allows for children to explore place value. The patterns on a hundred chart reveal the characteristics of the base 10 system. Table 1 below illustrates this:

Table 1: Characteristics of base ten systems (Adapted from Burns, 2000)

0	1	2	3	4	5	6	7	8	9
10	11	12	13	14	15	16	17	18	19
20	21	22	23	24	25				

Number patterns can be discovered by asking questions such as: what number will come after 25, where will number 40 be on the chart? The teacher can also point at a square on the chart and ask which number will be there if the chart is to be completed (Burns, 2000). Place value concepts can also be explored by the following activities which could be done with the whole class: counting in large quantities, thus counting using two and three digit numbers, using fingers to solve problems e.g. how many learners is needed to show 95 fingers (this help learners to represent two digit numbers), using money. Learners have a natural interest in money, so it is a useful material to use when exploring place value i.e. how many 10c coins are needed to make N$2.50 (Burns, 2000).

In order for learners to develop a good understanding of place value and the base 10 number system, they need to investigate the nature of number in many ways. Proportional and non-proportional materials should be used for this purpose. Proportional materials refer to materials that show the real value of numbers. Examples of proportional materials are base 10 blocks, unifix cubes, paperclips, beads on a string and the abacus. These materials can be used to represent two or three digit numbers as shown in the examples below:

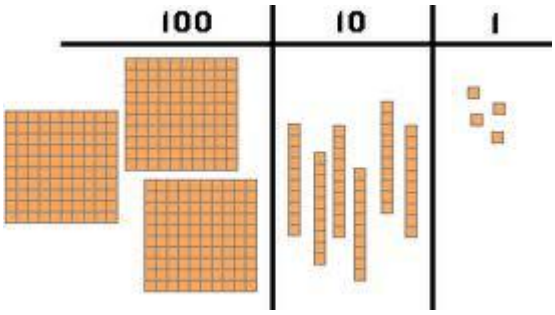


Figure 2: Base 10 blocks

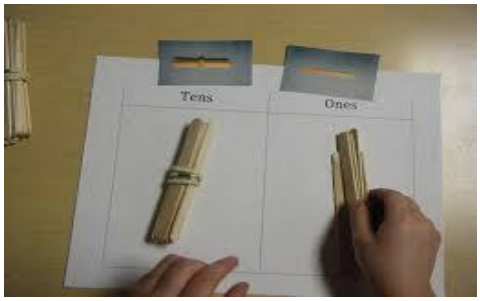


Figure 3: Bundles of 10

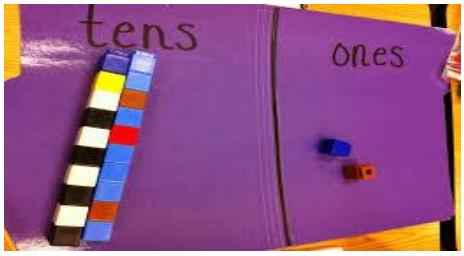


Figure 4: Unifix blocks

Non-proportional materials are materials or models that use objects or number to indicate the value. Examples of non-proportional materials are coins, the spike abacus and number building cards (Kennedy & Tipps, 2000). Teachers have to use proportional and non-proportional materials when teaching about place value, because proportional materials, as shown in figs.2, 3 and 4 help the learner to build a concrete understanding of place value

concepts, while the non – proportional materials, as shown in fig. 5 and 6, help the learner to represent place value in an abstract way.

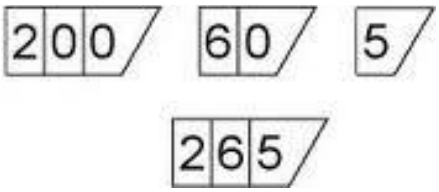


Figure 5: number building cards

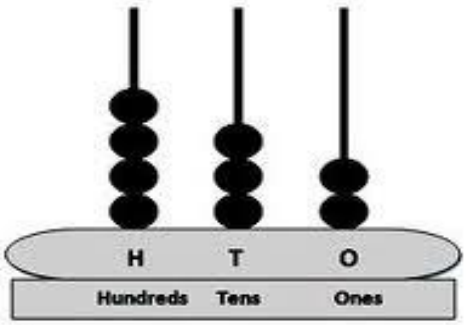


Figure 6: spike abacus

On the spike abacus, the beads as shown in fig. 6 represent the number 432, thus the four beads in the "hundred" column represent 400, the three beads in the "tens" column represent the number 30 and the 2 beads in the "ones/ units" column represent 2.

2.5 Conclusion

The literature review started off with the theoretical framework underpinning the learning theory of learner-centred education as the guiding educational policy in the current Namibian school system. The review focused on constructivism, social constructivism as well as the concept of the zone of proximal development and the notion of scaffolding. Attention was also given to the rationale of using manipulatives in mathematics lessons at the Primary school phase. This was followed by a discussion on the advantages and

disadvantages of using manipulatives in mathematics lessons, what guidelines teachers should follow when they select manipulatives for their mathematics lessons and how the theory of Zoltan Dienes supports the use of manipulatives in mathematics lessons. Furthermore, this section also discussed what number sense is, how it develops in young learners and why good number sense is an essential requirement for progressing in mathematics in higher grades. This section ended with a discussion about place value, how it contributes to the acquisition of a good number sense as well as how it should be taught in the Lower Primary phase.

The next chapter will discuss the research methodology that was used in this study.

CHAPTER 3: METHODOLOGY

3.1 Introduction

The purpose of this study was to investigate how Grade 2 teachers in a few selected schools use manipulatives when they teach number sense and specifically place value in mathematics. The aim of the study was not to make a judgement of the quality of Grade 2 teachers' lessons on number sense and how well they used manipulative material to teach number sense, but rather to form a picture of how Grade 2 teachers understand number sense, place value, which topics they mainly teach to develop number sense, insight about the manipulatives which are used to develop number sense and place value concepts as well as what the outcome of these activities were on the learners' performance in number sense skills, which add value to the study. The researcher wanted to form an in depth understanding of the possible misconceptions teachers might have regarding number sense development, place value and the use of manipulatives to try to determine how these possible misconceptions influence the Grade 2 learners' achievement of a good understanding of number sense.

3.2 Research design

In order to form an in depth understanding of teachers' understanding of and the teaching of number sense and place value using manipulatives, the researcher chose the case study design. A case study is a form of qualitative research that enables the researcher to collect rich information which will help to form an in depth understanding of the case that is being studied (Stake as cited in Mukherji & Albon, 2011). A case can be defined as an investigation of an individual, a family, a group, an institution or a community (Mukherji

& Albon, 2011; Welman, Kruger & Mitchel, 2005). A case is, however, not limited to a single entity. Case studies can take many forms. One can be in the form of a single case, a multiple case or a collective case study. A collective case is a type of case study where more than one case is involved, but where the same phenomenon is studied at different sites. The purpose is to make comparisons between the cases (Gay, Mills & Arasian, 2011; Strydom, Fouche & Delport, 2002). This study used the collective case study design with a mixed method approach in order to get an in depth understanding of the cases involved as well as to make a comparison between the cases. Both qualitative and quantitative data were collected in order to achieve this.

3.3 Population and sampling

A very important question to ask when conducting research is "who will participate?" (McNaughton, Rolfe & Siraj-Blatchford, 2010). Participants chosen for a research study is selected from the population. The population is thus the total or large set from which the individuals or units of the study are chosen and to which the findings of the study might apply (Mukherji & Albon, 2011; Seaberg 1988 in Strydom, et al., 2002). The population for this study was all government schools with Lower Primary grades in the Oshana Region.

The purposive sampling method was used to select the sample. Purposive sampling is a type of non – probability sampling where the researcher chooses the sample for a specific reason. The researcher relies on his/her experience and judgement to choose the sample that best represents the population (Leedy & Ormrod, 2005; Strydom et al., 2002; Welman et al., 2005). The sample for this study consisted of four urban schools in the Oshana Region where English is used as the medium of instruction in the Lower Primary phase.

The reason for this was because the researcher do not speak or understand the mother-tongues, Oshikwanyama or Oshindonga, which are mainly used as a medium of instruction in almost all Lower Primary classrooms in the region. From the four selected schools, two schools were high performing schools and two schools were low performing schools. The schools were classified like this based on the recommendations of the circuit inspector in order to make the comparison between schools as related to teacher practices and learner achievement of number sense. Two Grade 2 teachers per school made up the final sample, thus there was a total of eight Grade 2 teachers for the 8 Grade 2 classrooms. The total number of learners per classroom varied from 30 to 35 learners per classroom.

3.4 Research instruments

The methods used to collect the qualitative and quantitative data were interviews, observations, questionnaires and audio recordings of the interviews conducted with the teachers.

Observations: Observations are useful where the researcher wants to understand and explain everyday behaviours, as well as to determine the effect of something on everyday behaviour. It is also a way of collecting evidence in a way that is the least unpleasant or disturbing to the participants (McNaughton et al., 2010; Mukherji & Albon, 2011). A lesson observation checklist with a five point Likert Scale was used to collect quantitative data based on behaviours that was observed during the lesson. A Likert Scale is a psychometric response scale that is mainly used in questionnaires to obtain the participants' degrees of agreement on a certain statement. It is mostly seen as a five point scale that range from "strongly disagree" on one end to "strongly agree" on the other end. Each level on the scale is given a numeric value e.g. 1 = strongly agree and 5 = strongly

agree (Bertram, n.d.). The Likert Scale was adapted for the purpose of this study to rate to what degree teaching behaviours regarding number sense and the use of manipulatives occurred in each lesson observed. The observation checklist also had a second part on which the researcher made notes on the lesson observed. The notes taken during the lesson observations captured the qualitative data observed. Each teacher was observed in five mathematics lessons throughout the week. The researcher used the same checklist to observe all the lessons at the different schools (see Appendix G).

Questionnaires: A questionnaire is a set of questions on a form which must be completed by a respondent (New dictionary of social work, 1998 as cited in Strydom et al., 2002). Questionnaires are useful to use when information is to be collected about attitudes, beliefs and opinions of individuals (Mukherji & Albon, 2011). The teachers who took part in this study were given the same questionnaire to complete after each lesson was observed. This was called the Post-observation questionnaire for Grade 2 teachers (Appendix H). The purpose with the questionnaire was two-fold. Firstly the researcher wanted to give the teachers the opportunity to reflect deeply on the lessons they taught on a day. The same questions were used, but the content they taught everyday was different. Secondly, the researcher wanted teachers to reflect on the manipulatives they used to teach number sense and what they would do differently next time.

Interviews: Semi-structured interviews were used in this study. The semi-structured interview has certain questions that should be answered, but these questions may vary from one interview to the next, or the questions can be asked in a different order, or even adapted to suit the need of the interviewee (Welman et al., 2005). Interviews were conducted with each teacher on the first day the observation of the lessons commenced

(Appendix F). The researcher planned to have this done before the first lesson was taught, but since two teachers were observed at every school, this was not always possible. The purpose of the interview was to establish rapport with the teacher as well as to find out the beliefs the teacher had about number sense, place value and the use of manipulatives in teaching these skills. The interview questions were based on the questions developed by Maduna (2002). The teacher's responses to the questions were tape recorded for analysis.

Checklist: A checklist can be defined as a list of behaviours or characteristics the researcher is investigating (Leedy & Ormrod, 2005). A checklist was used in this study to test the learners' level of achievement of number sense skills. The researcher developed the checklist using a five point Likert Scale to rate how well each Grade 2 class achieved the selected number sense skills. The scale used was as follow: 1 = poor, 2 = weak, 3 = average, 4 = good and 5 = excellent. The number sense skills that were included on the checklist were partly based on early number sense skills as explained by Van De Walle et al. (2013) such as knowing how many, more, less, the same, part-part-whole concepts as well as on some number concept development aspects as indicated by the Namibian Grade 2 Mathematics syllabus. These included different types of counting, problem solving skills and odd and even numbers. The test was administered in each teacher's class by the researcher on the last day of the observations. The checklist also made provision for additional notes the researcher wanted to make based on what was observed during the test. The test covered selected number sense skills as per the Grade 2 syllabus as indicated in Appendix I. The researcher for example flashed 10 to fifteen flashcards with addition and subtraction sums in the range of 0 – 20 to the learners and tick using the Likert type scale used in the test according to how the class responded and how many correct answers

they were able to give. If only a few learners responded and many wrong answers were given, "poor" was selected. The learners also did written calculations on an answer sheet. The researcher used these written sheets to determine how well the learners knew their number combinations from 1 – 20. Aspects like decomposition of numbers were done. The researcher wrote numbers on the chalkboard e.g. twenty two (22) and the learners had to draw the number for example two groups of ten and two units on a paper. They all then showed what they have drawn. Poor was selected if the majority of the drawings were done incorrectly. The researcher did not want to do a written test with the learners, as she was fearful that the learners and the teacher would feel that they were being judged and that the researcher was looking for faults. The idea of the "test" was to establish whether the learners were exposed to different activities in which a variety of materials were used to see how well the concept of number sense was established. She based these activities on similar ones she used when she was teaching Grade 2 classes herself.

3.5 Pilot study

A Pilot study is a small-scale trial which is done before the full scale study is carried out. Yin (2009, p. 92) suggests that a pilot case study can help to refine the data collection instruments and strategies with respect to both the content of the data and the procedures to be followed in a research study. A pilot study can also identify possible problems or shortcomings which might occur in the main study (Gay et al, 2011). School Z in Ongwediva with two Grade 2 teachers was chosen for the pilot study to evaluate the strengths and weaknesses of the interview questions as a data collection method for the survey. The school was chosen as it had the same characteristics of the four schools

selected for the main study. For instance, English was used as the medium of instruction, although it was the second language for both teachers and learners.

Feedback from the pilot study was used to modify the wording and structure used in the interviews with the teachers before the observation of the first lesson. Questions were also rephrased in order to make it more understandable for the teachers as English was not the mother tongue of the teachers. The scale used on the checklist for classroom observation were also changed from 1 = poor, 2 = weak, 3 = average, 4 = good, 5 = excellent to 1 = not at all, 2 = weak, 3 = average, 4 = good, 5 = excellent. The researcher found that the initial scale did not really capture the degree in which behaviours occurred accurately. The researcher felt that it could be difficult to establish what exactly could be seen as poor practices used by the teacher. Since the classroom observation checklist (Appendix G, part B) focused at specific aspects e.g. lesson plan. The researcher felt it would be better to say 'the teacher did not have a lesson plan' since that might be the case. Furthermore, it would also not be correct to state that the teacher's lesson plan was poorly planned when she in fact did not have a lesson plan available.

The pilot study also convinced the researcher that it was necessary to test the learners' knowledge after the completion of the lesson observation with teachers, in order to answer the last research question. This is how and why the "test" for evaluating learners' achievement of number sense skills was included in the main study (Appendix I).

3.6. Validity and Reliability

Validity in research refers to whether the instruments used to collect data measures the concept in question and if this concept is measured accurately (Strydom et al., 2002). When conducting qualitative research, the researcher can enhance the trustworthiness and understanding of the research findings by using several strategies. A strategy that is frequently used in qualitative research is *triangulation* (Gay et al., 2001; Leedy & Ormrod, 2005). This study used triangulation in the sense that different methods were used to collect the data such as checklists, interviews, observations, audio recordings and field notes. The purpose was to get a detailed picture of how Grade 2 teachers teach number sense, what number sense topics they focused on most often and how they used manipulatives to teach these topics. Both qualitative and quantitative data were collected and compared to see how the two types of data supported the main findings.

Strydom et al. (2002, p. 168) define reliability as the "extent to which independent administration of the same instrument consistently yield similar results under comparable conditions". This study used a pilot study first to test the reliability of the research instruments in order to identify shortcomings which needed to be addressed, within the instruments, to enhance the validity and reliability of the results.

3.7 Data Collection Procedures

Initially, written permission to carry out this study was obtained by the University of Namibia's Post Graduate Studies Committee, to the researcher, to carry out the study as outlined in the approved research proposal. The next step was to get written permission from the Permanent Secretary within the Ministry of Education in order to carry out the

study in the Oshana Education Region. Once permission was granted by the Permanent Secretary, the researcher seeked the permission of the Director of Education of the Oshana Region to carry out the study in the four selected schools which made up the sample. All of these permissions were granted, in written form, by the relevant stakeholders (Appendix A – E). The schools were then visited by the researcher before the study was conducted in order to explain the purpose of the study as well as to inform the schools of the specific dates on which the data would be collected at each school. The interviews with the teachers took place before the observation of the first lesson. In some cases it was not possible due to some time constraints and because the researcher did not want to cause unnecessary disruptions to the time table. Teacher B at each school was then only interviewed after the completion of their lesson observation. The interviews were tape recorded and transcribed afterwards for data analysis.

Data about the actual teaching were collected in two Grade 2 classes at each of the four schools. This was done over a five day period. The data about teaching were collected by using both the checklist with a five point rating scale together with the additional information which was obtained in the form of field notes. The test for evaluating how well Grade 2 learners acquired number sense skills was carried out after all the lesson observations were done. The researcher explained beforehand to the teachers what the test was all about and asked their permission to make use of the last twenty minutes at the end of the lesson observation, to conduct the test with the learners.

3.8 Data analysis

The quantitative data was analyzed using a *t*-test and presented in the form of tables and charts. A *t*-test was conducted on both observed teacher behavior on teaching number sense as well as the Grade 2 learners' performance in the selected number sense skills, comparing the High and Low Performing schools.

The qualitative data were analyzed using coding and content analysis. Cohen, Manion and Morrison (2010, p. 559) describe content analysis as a process by which many words are classified into fewer categories. The researcher first read through the transcribed interviews (Appendix J), field notes and questionnaires to identify similar themes which were coded with the same code. A content analysis was then done using the codes identified. The findings were then described under headings related to the codes given. Finally the findings from both sets of data were compared to see whether there were any correlations between the two types of data.

3.9 Ethical considerations

Cohen, et al. (2010, p. 51) point out that ethical issues may stem from the kinds of problems being investigated by social scientists and the methods they use to obtain valid and reliable data. In this study I heeded to the following ethical recommendations made by Cohen, et al. (2010, pp. 51-77):

1. The purpose of the research along with its procedures was explained in detail, and informed consent was obtained from all the participants.
2. The participants took part in the study on a voluntary basis and they were informed of

their right to withdraw their involvement at any time during the research process. The issue of confidentiality was highlighted and the participants were informed that their identity would be kept anonymous and that any data could only be exposed with their consent.

3. The researcher obtained written permission to conduct the research from the University of Namibia, the Permanent Secretary of the Ministry of Education, the Director of Education of the Oshana Region, principals and Grade 2 teachers of the selected schools. The Grade 2 teachers were briefed about the purpose of the study by their principals as well as by the researcher herself.

4. The principals were given assurance that the information collected will be treated with confidentiality, that the names of the schools and Grade 2 teachers' identity would be kept anonymous and that any data could only be exposed with their consent. This was explained to both the principals and the Grade 2 teachers when the researcher visited the four selected schools before the actual data collection started.

This study included both Low and High Performing Schools. Schools would be identified as School X, School Y, School M and School N. Schools X and Y represented the two Low Performing Schools, while Schools M and N represented the two High Performing Schools. The teachers were coded Teacher A, B, C and D for the Low Performing Schools and Teacher E, F, G and H for the High Performing Schools. The distinction between Low and High performing schools were however not mentioned to the principals or the teachers as the researcher did not want the participants involved to feel that their particular school could be the low performing school since the aim of the study was not to judge schools in terms of performance. Using these codes in the research report however would make it impossible to trace the information back to a particular school or teacher. The Director of

Education for the Oshana Region requested the researcher to send her the names of the schools which will be included in the study in order for her office to inform the principals of the selected schools about the proposed study. The researcher found that all the principals of the selected schools were aware of the study as they were informed by the Regional Office. The principals and Grade 2 teachers all stated that they had no objections in participating in the study.

CHAPTER 4: PRESENTATION OF RESULTS

4.1 Introduction

This chapter presents the findings of the research study. The aim of the study was to establish the following: (1) how the selected Grade 2 teachers used manipulatives when they taught number sense (2) what perceptions the Grade 2 teachers had of number sense and how it develop in young children and (3) what the relationship was between the findings of the above two questions and the Grade 2 learners' mathematics performance.

Both quantitative and qualitative data were collected in this study. The reason for collecting both sets of data was to get a deep understanding of classroom practices in teaching number sense with the use of manipulatives, as well as to enhance the validity of the data. The assumption made is that the teachers' training and the knowledge they had of number sense and the use of manipulatives had an influence on how they teach and to what extent the learners will understand number sense. The four schools used in the main study were categorized as Low Performing Schools (LPS) and High Performing Schools (HPS). The Low Performing schools were identified as Schools X and School Y while the High Performing schools were identified as Schools M and School N. The teachers included from each school were referred to as Teachers A, B and C for the Low Performing Schools and Teachers E, F, G and H for the High Performing schools. The quantitative data was collected from (1) the lesson observation forms (Appendix G) and from (2) the test on number sense skills which were done by the learners from each class at the end of the lesson observation (Appendix I). A detailed explanation of how the test was conducted with the learners was previously discussed in Chapter 3 with emphasis on its limitations. The quantitative data was analyzed and presented in the form of bar graphs, tables and pie

charts and included the following aspects under the quantitative data analysis: (1) Demographic information about the schools (2) teacher qualification (3) observed lesson presentation skills when teaching number sense skills and (4) overall test scores of Grade 2 learners' performance in number sense skills. Finally, a *t* -test was performed to establish differences between High Performing Schools (HPS) and Low Performing Schools (LPS) which compared teacher performance in teaching number sense skills and the Grade 2 learners' performance at both Low and High Performing schools in pre- selected number sense skills.

The qualitative data was collected during the teachers' pre-observation interviews (Appendix F), field notes taken during lesson observations and the post-observation questionnaires (Appendix H). Through studying and re-reading the qualitative data, themes gradually emerged which were coded numerically. The themes which were used to discuss the qualitative data are as follows: *(1) Background of the schools (2) Teachers' feelings about teaching mathematics in the Lower Primary (3) Number sense topics they found difficult to teach (4) Teachers' understanding of number sense and number sense skills that featured in lessons observed (5) Teachers' understanding of and use of manipulatives (6) Learner activities that featured the use of manipulatives (7) Place value (8) The effect of an inadequate number sense and place value knowledge on the learners' performance in mathematics in higher grades.* The data was then presented according to these themes under Low and High Performing Schools.

4.2 Demographic information

4.2.1 Teachers and schools

The schools were categorized as Low and High Performing schools to establish differences in teaching practices which influence learner performance in mathematics in Grade 2. All schools included in this study were urban schools in Ongwediva and Oshakati towns where English is used as a Medium of Instruction in the Lower Primary. Two Grade 2 teachers were observed in each school, except at School Y, where one of the teachers was absent during the whole week of data collection. All of the selected teachers were female Oshiwambo speakers. The teaching experience of the seven teachers in the Lower Primary phase was as follows: three teachers taught between 5 and 10 years, two teachers taught between 10 and 15 years, while two teachers had a vast teaching experience of between 15 and 20 years.

4.2.2 Teaching experience and qualifications

In the Namibian education system, teachers are required to have at least a three year Basic Education Teachers Diploma (BETD) specializing in Lower Primary Education in order to be considered as qualified for teaching at the Lower Primary phase. The Grade 2 teachers included in this study all had different teaching qualifications which ranged from three year teaching diplomas in various areas of specialization to a three year degree in education. Figure 7 shows how many teachers were qualified for teaching at the Lower Primary phase.

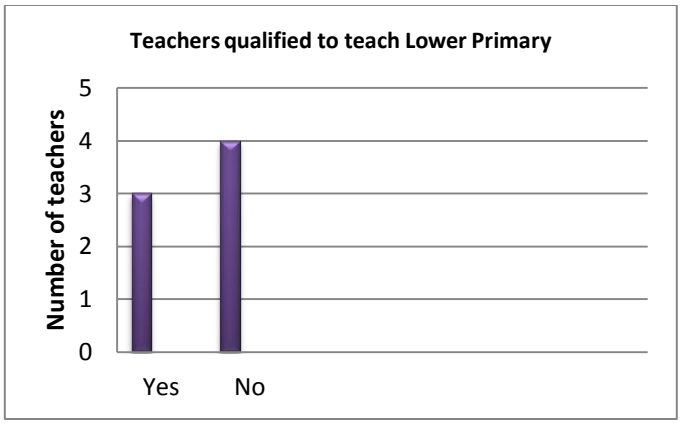


Figure 7: Number of teachers qualified to teach at the Lower Primary Phase.

Figure 7 illustrates that of the seven teachers included in the study, only three were qualified to teach in the Lower Primary phase, while the remaining four teacher were qualified for teaching in the Upper Primary or Secondary phase.

Figure 8 presents the type of qualifications of the teachers who took part in the study.

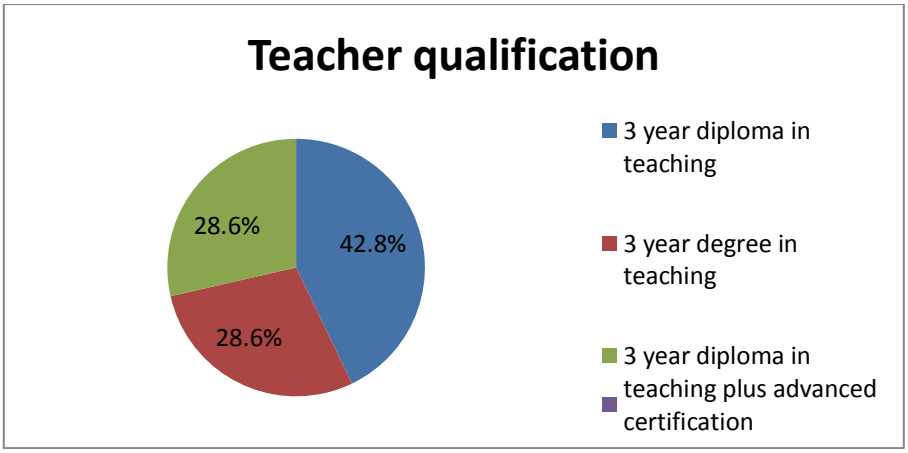


Figure 8: Teacher qualifications

The information presented in Figure 8 shows that three teachers (42.8%) had a three year teaching diploma for teaching in the Lower Primary phase. Two teachers (28.6%) had a three year BA degree, while two teachers (28.6%) had a three year teaching diploma with an advanced certificate in either school management or learner support. Neither one of

these two teachers specialized in Lower Primary. Figure 8 thus show that four of the seven teachers included in the study were not qualified and therefore not trained to teach in the Lower Primary phase.

4.3 Results based on quantitative data

4.3.1. Teachers use of manipulatives and their understanding of number sense

One focus of this study was to establish how teachers understand numbers sense and how well they use manipulatives to teach number sense concepts. The seven Grade 2 teachers included in this study were observed in five lessons to establish (1) how they teach number sense concepts and (2) how effectively they used manipulatives to teach number concepts. In order to understand how the average score for each teacher was obtained, table 2 was compiled illustrating the frequency in which selected lesson presentation skills occurred in each teacher's class. (See Appendix G, part B).

Table 2: Frequency table of lesson presentation skills.

	Teachers' average score for the lesson observations						
Teacher	**A**	**B**	**C**	**E**	**F**	**G**	**H**
Lesson presentation skills:							
1. Lesson preparation	3.2	3.7	0.8	1.4	1.2	2.7	2.2
2. Number sense concepts are linked to syllabus.	3.5	3.7	0.8	1.2	1.2	2.2	2.5
3. Lesson introduction appropriate.	2.5	2.5	1.6	1.4	1.2	2.0	3.0
4.Counting activities are included	3.0	3.0	2.6	1.4	1.4	3.0	3.2
5. A variety of teaching aids used for counting.	2.5	2.5	2.0	1.2	1.0	2.0	2.2
6. Hundred chart used in lesson to identify numbers.	1.5	1.7	1.0	1.0	1.0	1.0	1.0
7. Place value concepts addressed.	1.0	1.0	1.0	1.4	1.2	2.7	1.5
8. Variety of manipulative used to explain place value.	1.0	1.0	1.2	1.0	1.0	1.5	1.7
9.Effective use of manipulatives by teacher – place value	1.0	1.0	0.8	1.2	1.0	1.7	1.8
10. Effective use of manipulatives by learners – place value	1.0	1.0	1.4	1.2	1.0	1.5	1.5
11. Problem solving activities linked to number sense.	1.5	1.2	1.2	1.2	1.0	1.5	1.5
12. Manipulative used by the learners in groups/pairs.	1.7	1.5	1.2	1.0	1.0	2.0	2.0
13. Learners use manipulative to explain answers.	1.2	1.5	1.4	1.4	1.0	1.7	1.0
14. Learners' use of manipulatives to demonstrate their understanding of the number sense concepts.	1.7	2.0	1.2	1.2	1.0	2.0	2.0
15.The lesson conclusion is skillfully done	1.0	1.5	1.2	1.0	1.0	1.5	2.5
Average observation score per teacher	**27.3**	**28.8**	**19.4**	**18.2**	**16.2**	**29**	**29.6**
Maximum average score per lesson	**75**	**75**	**75**	**75**	**75**	**75**	**75**
n = 7							

The frequency of the lesson presentation skills observed in each lesson about number sense were obtained by using an observation sheet which contained a 5 point Likert Scale (See Appendix G, part B). The presentation skills selected are clearly indicated in Table 2. The effective use of each presentation skill was rated according to the following scale: 1 = not at all, 2 = weak, 3 = average, 4 = good and 5 = excellent. The seven teachers included

in the study were observed five times for each of the 15 lesson presentation skills and an average score for each teacher was obtained. When looking at the results of table 2, it showed that on average all teachers performed poorly in the fifteen identified skills. The teachers who performed the best overall were Teacher G and Teacher H. These two teachers scored slightly higher than the others in the following skills: problem solving; the use of manipulative materials by both the teacher and learners; counting activities and place value. What is quite interesting is that Teachers A and B from School X, a Low Performing School, had the highest score with regards to lesson planning. The researcher found that these two teachers really tried their best to plan good lessons according to the Ministry of Education's instructions as indicated in the Integrated Planning Manual for Grade 2. However, all the teachers performed generally poorly in the following categories: the use of the hundred chart in counting activities; using different manipulatives to explain place value concepts and the use of manipulatives by the learners to demonstrate their understanding of number sense concepts. This finding could be explained as follows: the teachers were perhaps not trained well on the effective use of manipulatives when teaching place value; schools have a lack of suitable manipulative for example base ten blocks to teach place value concepts; the learners only used manipulatives like bottle tops to find answers to calculations but not to demonstrate their understanding of number sense skills. However, it must be mentioned that although the majority of the Grade 2 teachers included in the study scored low marks in general on the lesson presentation skills, it was evident that they tried their best when teaching mathematics.

Table 3 below gives a summary of the total observation score the teachers achieved in each lesson observed.

Table 3: Summary of the total observation scores for each teacher

Schools:	**School X**		**School Y**	**School M**		**School N**	
Teachers	**A**	**B**	**C**	**E**	**F**	**G**	**H**
Lesson 1	25	26	14	15	16	19	25
Lesson 2	32	28	28	21	19	20	30
Lesson 3	32	34	19	15	15	24	30
Lesson 4	34	28	15	20	15	49	18
Lesson 5	-	-	18	23	16	-	-
Average score per teacher	**27.3**	**28.8**	**19.4**	**18.2**	**16.2**	**29**	**29.6**
n = 7							

The teachers were identified as A, B, C and D for the Low Performing schools and E, F, G and H for the High Performing schools. Each teacher was awarded an average score for the lessons observed. Each teacher was given a score out of 75 points for every lesson observed (See Appendix G part B). The score given to each teacher represent the average total for all the lessons observed in each teacher's class.

Table 3 indicates that both Teachers A and B (School X, a Low Performing School) were observed in only four lessons. This happened because the school held their inter house athletics day during one of the school days. A similar situation occurred at School N (a Low Performing School). When looking at the table as a whole, it is clear that low scores were achieved, in general, during the first lesson observed. This happened for two possible reasons: the teachers, in most cases, were not yet done with the weekly preparation as used at the Lower Primary phase. Most teachers just taught an unprepared lesson the first time. This information was in fact established during the interviews held with the individual teachers. The second reason could have been the fact that the teachers also were not yet at ease with the researcher and the data collection procedure. Some teachers might have felt that the researcher were there to judge the quality of the teaching. The highest score in the

lesson observation was scored by Teacher H of School N (a High Performing School) while the lowest score was obtained by Teacher C of School Y (also a High Performing School). The table further indicates that none of the teachers included in the study scored above 30 out of a possible 75. There was not a big difference in the average scores of teachers between the Low and High Performing Schools. This was a very interesting finding, because the researcher assumed that the teachers from the High Performing Schools of whom two were trained for Lower Primary would score higher marks.

4.3.2. Test scores of learners' performance in Number Sense skills

This study also tested the number sense skills of the Grade 2 learners in both Low and High Performing schools. The learners' skills in the following number sense aspects were tested: knowing "how many"; recognizing numbers 1 – 10 in different contexts; recognizing two digit numbers in different ways; more, less and the same relationships; part-part-whole concepts, counting skills, problem solving and odd and even numbers. The test used a Likert scale to determine the level of performance in each number sense skill. The scale used were a five point scale with 5 indicating "excellent" and 1 indicating "poor" (See Appendix I). The total score for each class was a possible 40 marks. Table 4 shows the raw score of each class group in the different number sense components tested.

Table 4: Raw scores of number sense skills tested in each class group

Teacher:	**A**	**B**	**C**	**E**	**F**	**G**	**H**
Number Sense Skills tested:							
Knowing "how many"	1	1	2	3	2	2	4
Recognizing numbers 1 – 10 in different contexts.	4	3	4	4	4	2	3
Recognizing numbers 15, 23, 45, 39 using the abacus, base 10 blocks, drawings. Learners were able to see the difference between 15 & 45	3	4	3	2	3	3	3
More, less and the same:	1	2	1	1	2	2	2
Part – part whole:	1	1	2	2	3	2	2
Different types of counting: forwards, backwards, in two's, three's and fives.	3	4	2	2	2	3	3
Problem Solving	1	1	1	3	2	2	2
Recognizing odd & even numbers on a number chart	1	1	1	1	2	2	3
Total score per class out of 40	**15**	**17**	**16**	**18**	**20**	**18**	**22**

The table shows that the lowest total score was achieved in Teacher A's class at School X (a Low Performing School). Her class scored 15 marks out of a possible 40, well below average. The highest score was achieved in Teacher H's class at School N (a High Performing School). Teacher A's learners scored low marks in the following number sense aspects: knowing "how many"; more, less and the same relationships, part-part-whole concepts, problem solving and odd and even numbers. In contrast, Teacher H's learners performed generally better in these areas. It must be emphasized again at this point that the number sense test were done orally in each class. The researcher did not want to test the learners' number sense skills in a formal written form, because she did not want either the teachers or the learners to feel that they were being evaluated or judged. This was in fact a limitation of the study as the scores per class group do not reflect individual learner

abilities clearly. The researcher allocated a score for an individual number sense item based on how the class reacted in general for example if the class were hesitant to give answers to oral problems or gave wrong answers, a low score was awarded. Table 4 furthermore shows that the Grade 2 learners in general performed poorly in the following areas: knowing "how many"; more, less and the same; part-part-whole concepts, problem solving and odd and even numbers. The researcher noticed during the classroom observation that the teachers did not include these aspects in their mathematics lessons. Table 5 below gives a summary of the raw test scores achieved in each class group.

Table 5: A summary of the raw test scores on Number Sense skills

Raw test scores on Number sense skills (out of 40).								
	School X		**School Y**		**School M**		**School N**	
Teacher:	A	B	C	D	E	F	G	H
Test Score	**15**	**17**	**16**	**-**	**18**	**20**	**18**	**22**

The table clearly shows that the number sense skills of the Grade 2 learners at both Low and High Performing schools were below average level if one look at the raw test scores. Except for teacher F's and Teacher H's class groups, the majority of the class groups scored a below average mark out of 40, which was the total. The total for Teachers F and H were either average or slightly above average. The researcher concluded then that the Grade 2 learners taught by the selected teachers included in this study had in general a poor number sense. This could be the result of teachers not really including different number

sense skills in their mathematics like those skills included in the test. Learners had very limited exposure during mathematics lessons to different number sense activities.

4.3.3. Difference in Teacher performance in teaching number sense skills between Low and High Performing schools

A *t*-test was conducted to establish the difference in teacher practices in teaching number sense skills between the High and Low Performing Schools. Table 6 shows the result of the *t*-test.

Table 6: Difference in teacher performance in teaching practices between High and Low Performing Schools

Type of School:	**Mean:**	**Standard Deviation:**	**n**
Low Performing Schools	25.4	6.4872	12
High Performing Schools	21.7	8.3314	18
Mean Difference	3.7		
***p* value**	0.1868		

A total of 12 lesson observations were done at the Low Performing Schools while a total of 18 lesson observations were done at the High Performing Schools. The difference in the total of observations was a result of teachers being absent or schools that only had a four day week instead of the normal five day school week because of the inter house athletics competition that were held at some schools during school hours. After adding together the observation scores of all the Low Performing Schools and comparing it with the observation score for the High Performing Schools, the study found a mean difference of 3.7497. The mean difference was influenced by different teaching practices found at the Low and High Performing Schools. The teachers at the Low Performing School scored

lower marks on average in the observed lesson presentations skills than the teachers at the High Performing schools. A two tailed *t*-test for the difference of the two population means gave a *p* value of 0.1868. Since the *p* value is bigger than 0.05 (which is alpha) the study accepted the null hypothesis which stated that the difference in performance between the two groups was not statistically significant.

A *t*-test was also conducted to establish the difference in the Grade 2 learners' performance in number sense skills between the Low and High Performing Schools. Table 7 shows the results of the *t*-test.

Table 7: Difference in Grade 2 learners' performance in the Number Sense test between Low and High Performing Schools.

Type of School:	**Mean:**	**Standard deviation**	**n**
Low Performing Schools	16.00	1.0	3
High Performing Schools	19.25	2.5	4
Mean difference	3.25		
***p* value**	0.1556		

A total of 3 Grade 2 classes were tested at the Low Performing Schools while a total of 4 Grade 2 classes were tested at the High Performing schools. A mean difference of 3.25 was found between the Low and High Performing Schools. The mean difference is result of the test scores of the learners' test on number sense skills. The grade 2 learners at the Low Performing Schools scored on average slightly lower than the Grade 2 learners at the High Performing schools in the number sense test. A *p* value of 0.1556 was found. Since the *p* value was bigger than 0.05 (which is alpha), the study also accepted the null hypothesis

which stated that the difference in performance in number sense skills between the Low and High Performing Schools was not statistically significant.

4.4 Results based on Qualitative Data

Table 8 below gives a summary of the qualitative data collected in this study. A detailed descriptive presentation of the data will then follow.

Table 8: Summary of the Qualitative data

Aspects of number sense explored:	**Findings:**
1. Teachers' feelings about teaching mathematics.	All the Grade 2 teachers included in this study enjoyed teaching mathematics, although the reasons the majority gave were not related to the fact that they enjoyed the subject themselves.
2. Number sense topics which were found difficult to teach by the Grade 2 teachers.	Many topics mentioned by the teachers as difficult to teach did not really include number sense skills. The only number sense aspect the teachers found challenging to teach was place value. It was also found that the majority of teachers did not really know the number sense skills to develop as per syllabus well.
3. Lesson Preparation	All the Grade 2 teachers had lesson plans available for most of the lessons they taught, but the majority of these lessons did not have clear competencies as per syllabus. Some of the teachers do not really consult the syllabus when they plan their lessons. Very few number sense skills were included in lessons.
	The majority of the teachers did not

4. Teachers' understanding of number sense, how it develops and its importance for doing mathematics.	demonstrate a good understanding of number sense, themselves. The majority of the teachers could not explain in a clear way how number sense developed in the young child, but they were all in agreement that inadequate number sense will hamper learners' performance in mathematics at higher grade levels.
5. Number sense skills that featured in most observed lessons	Doubling and halving, decade numbers, matching numbers with quantities, ordering numbers, different types of counting. The learners performed generally poor in all these number sense areas.
6. Manipulatives	The majority of the teachers described manipulatives as concrete materials. None of the teachers could really explain clearly how they select manipulatives for their lessons. Manipulatives used in most observed lessons were counters like sticks, stones and bottle tops. The majority of the teachers felt that they had used these manipulatives effectively when it helped children to find the answers to calculations. The manipulatives were not enough for all learners. Manipulatives included colourful, plastic bottle tops which were quite old.
7. Learners' activities that featured the use of manipulatives	Working out answers for addition and subtraction sums, doubling and halving numbers, place value concepts (only one class), counting activities. The learners were not skillful in the use of manipulatives. The manipulatives were mostly available, but were not enough for all the learners in the class.

8. Place value	The Grade 2 teachers included in the study did not have a good understanding of place value, why it was important to teach at Grade 2 level and what are effective ways to teach place value. The majority of the teachers found it a difficult concept to teach. The learners did not have a good or in some cases any understanding of place value.

4.4.1 Low Performing Schools

The Low Performing School (LPS) were coded as School X and School Y. The Grade 2 teachers at both LPS were identified at Teachers A, B and C.

Background of the Low Performing Schools: School X is a primary school that offers Pre-Primary to Grade 7. The school was establish before independence and served as a school for student teachers to do teaching practice. The school buildings are a mixture of brick and pre-fabricated buildings. Although the school is kept in a reasonably neat condition, the buildings are in dire need of renovation. The school has a library, but it is not well organized and does not offer much in terms of books and audio-visual materials such as projectors. The Grade 2 classes visited at this school were quite overcrowded with more than the prescribed 35 learners per teacher. Teaching aids were in the form of posters displayed on the walls, but they were old, dirty and not relevant to the mathematic concepts taught. Only one classroom had a number chart displayed which the teacher used occasionally in counting activities and to identify numbers. The school served the population from the nearby informal settlement. The learners were mainly from a low socio-economic background, although some might have come from middle class homes. The learners all appeared neat, well-fed and healthy.

School Y is a relatively new school which was established after independence. The school is situated in the Oshakati-West suburb, which is a mixture of informal settlements and modern buildings. The learners are mainly from a low socio-economic background as well. The school offers Grades 1 – 7 and is a well -established school with new classroom facilities. The school is generally neat and well run, although the Grade 2 classroom the researcher visited was surprisingly unorganized. It was also overcrowded with more than the required 35 learners per teacher. This had the effect that the tables and chairs took up much of the space in the classroom. The teaching aids displayed on the walls were not well made, dirty and were not contributing and appealing to a conducive classroom environment.

a) *Teachers' feelings about teaching mathematics:* The transcribed interviews with each teacher revealed that the Grade 2 teachers at the Low Performing Schools enjoyed teaching mathematics. The reasons they gave were as follows: it is easy to teach at this level because the mathematics contents is simple, it is important for children to know mathematics for everyday purposes and the children enjoyed doing mathematics. Taking a closer look at the answers given made it clear that the Grade 2 teachers at both LPS were not really able to answer the question *why* they enjoyed teaching mathematics clearly. The following response from Teacher C confirms this:

> "Yes, because me and the learners enjoy it a lot"

Teacher C was only able to say that the learners enjoyed mathematics, but she could not state exactly what made them to enjoy the subject. The purpose for asking these questions during the teacher interviews was to establish if the teachers' attitude towards mathematics was positive or negative, as this could influence the way they teach the subject. It would

seem that the teachers at both Low Performing Schools mainly enjoyed teaching mathematics because the math content at Grade 2 level was easy for them to teach.

b) *Number sense topics teachers found difficult to teach:* The Grade 2 teachers at the two Low Performing Schools mentioned during their interviews that they found the following mathematics topics in the syllabus difficult to teach: money, measurement, fractions, division, problem solving and geometry. The reason for including these questions during the interviews was to establish if the teachers at the Low Performing Schools had any problems in teaching any of the number sense skills as indicated in the Grade 2 mathematics syllabus. I was expecting that the teachers would mention quite a few number sense skills that they found challenging to teach. In my previous dealings with Lower Primary teachers as a former Lower Primary Advisory Teacher, I have come to the conclusion that the majority of Lower Primary teachers in the regions where I have worked, had difficulty in interpreting the mathematics syllabi for Lower Primary and that many teachers did not include a variety of number sense skills in their mathematic lessons. To my surprise, I found that of the topics the teachers at Low Performing schools mentioned as challenging to teach, few include number sense skills.

c) *Lesson Preparation:* The Grade 2 teachers were asked during their interviews to explain how and why they prepare for mathematics lessons. The purpose for asking this was to establish to what extent the Grade 2 teachers used the syllabus, syllabus guides and available Planning Manuals when they prepare for their lessons on number sense. Teacher A indicated that she used the following documents when planning her lessons: the Thematic Scheme of work, the teacher's guide for a textbook series used at school and the syllabus for identifying the basic competencies and objectives for the topic taught. Teacher

B said she used a variety of textbooks to plan her lessons. Both Teachers A and B said that they plan their lessons together to ensure that they teach the same topic every day. The research found that refreshing. That way they can talk about things they don't understand and can help each other. Teacher C indicated that she also used the syllabus and prescribed textbooks to ensure she followed the ministerial guidelines. The field notes taken during the actual lesson observations showed that Teachers A and B had lesson plans for the mathematics lessons observed. The lessons were generally well planned with the basic competencies and learning objectives included from the syllabus. However, not all lessons had clear lesson objectives. Although there was evidence that the syllabus was used for preparing lessons, the teachers did not stick to the prescribed number range for developing number sense concepts at Grade 2 level. The teachers mainly worked with the number range prescribed for Grade 1 and did not include a variety of number sense aspects in their lessons. Teacher C did not have lesson plans available for all the mathematics lessons that were observed. The lessons observed in her class failed to cover a variety of number sense aspects. The quantitative data (see Tables 2 & 3) showed that Teacher C scored a low mark in the lesson presentation skills and that her learners scored a below average mark in the number sense test. The lesson plans of Teachers A, B and C did not include a variety of number sense skills such as recognizing numbers, subitising, regrouping, number patterns, ordering and comparing, decade numbers and decompositions of numbers as outlined in the Grade 2 Mathematics syllabus of 2005.

d) Teachers' understanding of number sense, its' importance for doing mathematics, how young learners develop number sense and number sense skills that featured in most lessons observed: Questions 5 – 7 of the pre-observation interview (Appendix F) dealt with the teachers' understanding of number sense. The purpose for

asking these questions was to find out if the Grade 2 teachers included in the study had a good understanding of number sense and the important influence number sense had on later success in doing mathematics. The interviews showed that the Grade 2 teachers at the two Low Performing Schools had very different definitions for number sense. They defined number sense as teaching numbers within a range of many activities like counting, writing numbers in a sequence, learning about addition and subtraction, knowing about the ordinal aspect of numbers, knowing the value of numbers. The teachers at the Low Performing Schools felt that number sense was important because it would help learners to know numbers and to apply it in other mathematical aspects such as measurement, problem solving, calculations, working with place value and doing multiplication and division. It must be said that only Teacher A was very forthcoming and confident in her explanation about number sense and its' importance. Both Teachers B and C were quite hesitant in answering the questions and it showed that they were not sure why it was important to develop number sense in young children. The reason could be that Teacher A was a younger teacher who completed her training only a couple of years ago at a local Teachers' Training College while both Teachers B and C were older teachers who were trained before independence when teachers did not receive the same training. The older teachers included in the study admitted during the interviews that they felt the younger teachers were better trained in some aspects such as teaching methodology than they were. What was interesting though is that none of the teachers at the Low Performing Schools could answer the question about how number sense developed in young children. The answers they gave illustrated that they had a very vague idea on this aspect of child development. For the teachers, number sense developed when children count, use concrete materials and write numbers. One teacher said that number sense developed all the time, it

was a continuous process, but she was not able to elaborate on what she meant by this statement. Teachers B and C were not able to answer the question on number sense development satisfactory. They were not able to say what they felt were the starting points for number sense development. The number sense skills featured in most mathematics lessons observed at the Low Performing Schools were the following:: counting activities in the range of 1 – 70, subtraction, doubling, decade numbers, halving, addition with two digit numbers and identifying two digit numbers on a number chart. The concept of doubling was not correctly explained to the learners. Teacher A explained the concept as "counting the same number twice". Many learners in her class did not fully understand what doubling meant and could not double a given number. She also defined decade numbers as "numbers that ended with a zero. This was also not a very accurate explanation and seemed to confuse the learners. Teacher B let the learners do addition with two digit numbers e.g. 16 + 4, but the learners were unable to do it correctly as they had not yet been taught place value. The learners also did not have an understanding of the concepts of carrying over or borrowing which apply when calculating with two digit numbers. However, Teachers A and B taught mathematics using the correct number range prescribed for Grade 2 for developing number sense. This was a very positive sign. Teacher C included the following number sense aspects in her lessons: counting forward and backward between 1 and 70, teaching about number 12 by telling learners to write "12" in the air and to say "one – two", writing number 1 – 12 in their exercise books and drawing the correct amount of dots next to each number, calculate 2 + 1, 2 + 2, 3 + 2, 4 + 1 and 1 + 1 using bottle tops to find the answers, ordering numbers 1 – 12 from small to big, matching number 1 – 12 with dot cards showing the correct amount of each number, grouping ten bottle tops in groups of 3 and 2. The learners in Teacher C's class did not

seem to have a good sense of numbers between 1 and 10 which should have been established in Grade 1. It was clear that Teacher C did not work within the prescribed number range for Grade 2. Most number activities were done at Grade 1 level. The researcher found this alarming and reached the following conclusion: Teacher C did perhaps not consult the mathematics syllabus for Grade 2 when she planned lessons on number sense.

e) Teachers' understanding and use of manipulative materials: Questions 9 – 11 of the pre- observation questionnaire were asked to establish how well the Grade 2 teachers at the Low Performing Schools understood the term "manipulatives", if they use manipulatives when teaching number sense and whether they thought it was important to use manipulatives in lessons about number sense development. The Grade 2 teachers at both Low Performing schools defined manipulatives as materials children can touch, move around, materials that made the lessons more interesting, helped children to understand better and materials that are important because children learn by seeing and doing. Teacher C did not understand the question well and I had to rephrase it several times but she was still not really able to define manipulatives or state clearly why it can be used during a lesson. The teachers indicated that they made use of manipulatives in their lessons, however, it was only Teacher A who elaborated on how and why she made use of manipulatives. She indicated that she used a variety of manipulatives like bottle tops and stones for counting, grouping activities and calculations. She explained that she was not using manipulatives all the time as she expected learners to do mental calculations from time to time. Both Teachers B and C were not able to explain what manipulatives they used mostly in their lessons and why they used it. Teacher A said that it was important to use counters like bottle tops in two different colours so that children could identify e.g.

groups of two easier. Although Teacher A could not really elaborate much on the importance of manipulatives in mathematics lessons, this remark showed that she understood an important reason for using manipulatives. The teachers were also asked to reflect on the effective use of manipulatives in their lessons and how they could have used them in different ways. These reflections were done every day after each lesson observed by answering the post observation questionnaire (Appendix H). The teachers at both Low Performing Schools felt that they had chosen appropriate manipulatives for their lessons and that they had used them effectively. They gave a variety of reasons explaining why they thought manipulatives were used effectively. Teacher A thought that she used manipulatives effectively when it helped the learners to do the lesson activities e.g. counting, illustrating doubling and halving. She felt that the drawings she used in some lessons helped the learners to understand the concepts doubling and halving so that they could also illustrate the doubling or halving of a given number with drawings. She further said that the use of concrete materials by learners helped her to identify those learners who did not understand the concepts taught. She felt that she could have used more semi – concrete materials like number cards in her lessons. These cards could have been used by learners to put counting numbers in a correct sequence. Teacher B stated that she used manipulative effectively as it helped learners to count, calculate and illustrate their understanding of doubling and halving. Her reflections on the use of manipulatives in her lessons were very much the same as Teacher A. Teacher C was not able to write clear reflections on how effectively she used manipulatives in her lessons. She mainly stated that manipulatives were used effectively as it helped the learners to get the correct answers. However, none of the three Grade 2 teachers at the Low Performing Schools were able to fully explain why they selected certain manipulatives for use in their lessons. It would

seem that materials like stones and bottle tops were selected only because they were easily obtainable, were cheap and could not harm the learners. The teachers could not explain what criteria they used from a teacher's point of view for selecting the materials they used in their lessons.

f) *Learner activities that featured the use of manipulatives:* The field notes taken during the lesson observations revealed that the learners at both Low Performing Schools did the following activities while using manipulatives: counting in twos up to twenty using bottle tops, doing addition and subtraction with the use of bottle tops, using a number chart to identify numbers said by the teacher, using bottle tops to illustrate doubling and halving of one and two digit numbers. The learners in Teacher A's class did not really understood the concept of doubling and halving as most of her lessons tend to be more teacher-centered, with her talking and explaining most of the time. The learners illustrated doubling and halving individually using bottle tops. They did not interact with each other to discuss different ways of doing that. It would seem that the use of manipulatives did not really help them to understand the concept of doubling and halving. They just did what the teacher had shown them. The same practice was observed in Teacher B and Teacher C's classes. The learners in their classes also did not really use manipulatives in such a way to help them discover the concepts for themselves which would lead to a deeper understanding. They mainly used manipulatives to copy what the teacher illustrated on the chalkboard e.g. illustrating doubling. It was also observed that the learners at both Low Performing schools mainly used manipulatives such as bottle tops to find the answers for simple calculations e.g. 2 + 3.

g) *Place value:* Questions 13 and 14 on the pre-observation interview (Appendix F) asked the Grade 2 teachers to define place value, to explain why it was important to

introduce place value in Grade 2 and to explain how they usually teach place value. The teachers at the Low Performing schools defined place value as follows: it has to do with the value of numbers, to learn about tens and units, hundreds and thousands, to categorize numbers and to learn about the place of numbers. Teacher A explained that learners only learn about two digit numbers in Grade 2, but that knowing how to categorize a two digit number in terms of tens and units will help the learners to cope with Grade 3 where learners are taught about three digit numbers. Teacher B was not at all able to explain why it was important to teach place value in Grade 2. Teacher C indicated that if learners are not taught about place value in Grade 1, it can be difficult in Grade 2 to make them understand place value. The teachers at both Low Performing Schools explained how they teach place value: Teacher A used stones to group a two digit number into tens and units, Teacher B used chalks (she was not able to explain how and why) and money. Using money was quite an interesting way, but the teacher was not able to say how she connected money values to place value concepts. Teacher C stated that she taught place value by calling two learners to the front of the classroom saying "this learner is in the place of one and this learner is in the place of zero, so what is the number?" She used this method to introduce number 10. She further explained how she also sometimes draws a number line on the chalkboard so that learners can come one by one and fill in the missing numbers. It was not clear how this method connected to the concept of place value. The Grade 2 teachers at both Low Performing Schools said that they usually teach place value much later in the year as the learners find it difficult to understand it so early in the year. The lesson observations revealed the following practices in teaching place value: Teacher A included decade numbers in one of her lessons, but these numbers were not explained concretely to the learners to form an idea of the concept "ten". She indicated in her lesson

reflection that the learners did not understand the concept "ten" and that she should have used blocks to illustrate what a ten looked like to help them gain a better understanding. Teacher B also included decade numbers in one of her lessons, but she only explained that a decade number is a number that ends with a zero. She then let the children mention a few decade numbers but she also did not explain what is meant by a decade. Both Teachers A and B admitted later that they were both willing to teach place value concepts for the purpose of this study, but that they did not know how to teach it correctly. Teacher C did not include place value concepts in any of the lessons observed in her class.

h) The effect of an inadequate number sense and place value knowledge on the learners' performance in mathematics in higher grades: I also felt it was important to explore what teachers thought the effect of an inadequate knowledge of number and place value could have on Grade 2 learners' performance in mathematics later on. Question 14 on the pre – observation interview dealt with this important aspect. Teacher A felt that if learners did not acquire a good sense of numbers and place value in the Lower Primary phase, their performance in mathematics at the Upper Primary phase will be "chaotic" as she put it. She explained that when learners had a lack in understanding place value and numbers they will not be able to work independently, which is a requirement at the higher grades as class teaching is not done anymore. The child will also find it difficult to work with higher number ranges. Teacher B felt that if a child did not have a good sense of numbers and place value, it will perhaps make the child not to like mathematics because it will be experienced as a subject which does not make sense. This attitude might stay with the child from one grade to the next and his/ her performance in mathematics will be poor. Teacher C was in agreement with Teachers A and B, although she was not really able to elaborate more on the ideas they had already mentioned. She merely stated that learners

will not perform well in mathematics in either the Lower Primary or Upper Primary grades and that their learning concept will be poor. None of the teachers at the Low Performing schools were actually able to state in which areas of mathematics the learners will encounter difficulties in later years as a result of insufficient teaching on number sense and place value.

4.4.2 High Performing Schools

The High Performing Schools (HPS) were identified as School M and School N. The teachers at the High Performing Schools were identified as Teachers E, F, G and H.

Background of the High Performing Schools: A total of four Grade 2 teachers were observed at the two High Performing Schools. School M is situated within Ongwediva town and offers Grades 1 – 7. The teachers at this school were identified as Teachers E and F for School M and Teachers G and H for School N. School M was established shortly after Independence and is a well-established school with new classroom facilities, a library, although this is not so well stocked, as well as a school hall. The school also has computers available to teach children basic computer literacy. The Grade 2 classrooms visited at this school were neatly organized and teaching materials were displayed on the walls, although it was noticed that some materials were quite old and incomplete for example alphabet cards. The learners had access to stationary, exercise books and textbooks. The textbooks were shared in pairs. The learners schooling at School M came from middle to high income households. The parents place a very high value on their children's education and some would donate stimulating materials for example educational games or activity books to the school. School N is situated in the old Oshakati Township which existed before Independence. School N is a former whites-only school which had access to many

resources such as a well-equipped library, a variety of teaching materials to select from by teachers as well as well-developed sport facilities for the learners. The school has a good academic reputation in the community and many parents prefer to send their children to School N. The teaching staff at the school consists of teachers from different cultural backgrounds. The Grade 2 classrooms were spacious and provided a conducive environment for learners, neat teaching aids and colorful posters were displayed on the walls. The classrooms were also equipped with toilet facilities for both boys and girls, although these were old and needed some renovations. The school was able to supply teaching aids such as the abacus, number lines and various posters on numeracy and literacy which were not observed at any of the other schools.

a) *Teachers' feelings about teaching mathematics:* The Grade 2 teachers at both High Performing Schools indicated during the interviews that they also liked teaching mathematics. The reasons they gave were very different from those given by the teachers at the Low Performing Schools. Their reasons were as follows: wanting to make a difference as a teacher, mathematics allows the teacher to use different methods when teaching, mathematics is a skill we use in daily life therefore it is important, teachers enjoyed teaching mathematics because the learners also enjoyed it, the teacher can be creative when teaching the subject because it allows the teacher to explore and experiment with different methods and materials which will help the learners to understand the subject.

b) *Number sense topics the teachers found difficult to teach:* The Grade 2 teachers at the two High Performing schools indicated during their interviews that they found the following topics challenging to teach: money, measurement, place value, subtraction, multiplication and problem solving. Many of these topics did not really include number

sense aspects that should be developed according to the Grade 2 syllabus. The only aspect mentioned that resides under number sense as per syllabus was place value. The responses of the teachers indicated that they did not find number sense a challenge to teach.

c) Lesson Preparation: Grade 2 teachers from both High Performing Schools were asked during the pre – observation interview to explain how they plan their mathematics lessons and what materials they use when planning lessons. As explained earlier, the purpose was to see if the teachers plan lessons according to the Ministry of Education's policies regarding lesson planning in the Lower Primary Phase. Teacher E stated during the interview that she used the following materials: a lesson planning book (it was not clear what she meant with this statement), the syllabus guide for mathematics, textbooks, the mathematics syllabus and sometimes the internet. Teacher F explained that she used the syllabus to identify the correct competencies and that she also consulted the scheme of work and a variety of textbooks to help her to plan lessons. Teachers E and F planned the same lessons to ensure they taught the same topics and content. Teacher G indicated that she used the Integrated Planning Manual for Grade 2, the syllabus and any suitable textbook. She explained that all of these materials helped her to plan appropriate lessons and to know what the learners should be taught in mathematics. Teacher H also indicated that she used the same materials for planning lessons, but that she also uses the internet to find interesting and appropriate activities for the learners to do that will help them to understand the concepts taught in the lesson. The field notes taken during the lesson observations at both High Performing Schools revealed that Teacher E did not have a lesson plan available for the first day's lesson. For lessons 2 – 5, she had lessons plans but these were not clearly planned as the lessons did not have clear lesson and learning objectives. It seemed that the teacher did not consult the mathematics syllabus for planning

her lessons. Teacher F only had a lesson plan available for one of the five lessons that were observed in her class. At School N the situation was very different. Teacher G had lesson plans available for all the mathematics lessons observed in her class. Lesson plans also included the weekly overview which is an outline that showed the mathematics content to be taught in a week. Her lesson plans, however, did not have clear lesson objectives and sometimes the basic competencies were not indicated. Teacher H also had lesson plans available for all the lessons observed. These were neatly typed on the computer but did not always include the basic competencies as indicated in the syllabus and sometimes had no clear lesson objectives. Her lessons, however, were very well prepared in terms of having clear lesson stages and activities to be given to the learners. Both Teachers G and H attached worksheets or activities given to the learners to their lesson plans. Teacher G stated that she planned her lessons together with Teacher H, but Teacher H stated that she usually planned her lessons all by herself and would only consult her colleagues if she did not know how to teach a specific topic. This could be seen during the lesson observations as the teachers taught the same content, but the way they taught it was very different. I felt that Teacher H were in fact a very good teacher if one looked at the methods she used, her classroom set up, interaction with the learners and the teaching aids she made. She clearly had all the qualities of an effective teacher. Teachers E, F. G and H also did not include a variety of number sense skills in their lessons as outlined in the Grade 2 mathematics syllabus, although some included skills such as decomposition of number, which the teachers at the Low Performing Schools did not.

d) Teachers' understanding of number sense, its' importance for doing mathematics, how young children develop number sense and number sense skills that featured in most lessons observed: The Grade 2 teachers at both High Performing schools

defined number sense as follows: the ability to compose and decompose numbers, identifying and reading numbers, knowing "how many" a number represents and the ability to write numbers. Teachers E and F felt that learners needed to acquire a good number sense as it would help them to understand the value of numbers. A good number sense is also important for doing everyday mathematical calculations like working out if money is enough for buying items in a shop. Teachers G and H explained that a well - developed number sense will enable a child to know what a certain number or digit represents and to apply mathematical concepts in everyday life situations such as measuring the distance between home and school and reading time, to name a few. The Grade 2 teachers at the High Performing Schools felt that good number sense will help learners to work with the following aspects of mathematics: decomposition of numbers, the four mathematical operations, putting numbers in a correct sequence, reading number sentences, identifying and writing numbers and working with data. Some of the teachers also felt that all of these aspects should be included in everyday mathematics lessons so that learners could acquire good number sense. The teachers were also asked to explain how they think number sense develops in young children. Teacher E was of the opinion that learners developed a sense of numbers during their Pre- Primary years when they move objects which are counted and through learning to write number symbols for example 3. For Teacher F, learners developed number sense through identifying, reading and adding numbers. She could not explain at what age level learners will start developing these skills. Both Teachers G and H explained that learners develop number sense through play activities, by doing everyday activities like measuring ingredients for cooking a meal, setting the table for lunch for the correct amount of family members, indicating how many eyes, ears and fingers a person has and showing the correct amount for these. For Teacher

H, the home language of a learner also played a role in how they developed a sense of numbers as the child used language to express an idea e.g. I have two feet.

e) Teachers' understanding and use of manipulative materials: Teacher E defined manipulatives as materials that learners can manipulate. These materials could help the learners to form an understanding of the concept that is taught in the lessons. Examples of manipulatives that she mentioned were bottle tops, sand bags, bean bags and "any other material that is teachable", as she put it. She did not explain what she meant with the statement, neither did she elaborate on how the use of sand and bean bags could help learners to understand number sense concepts. Teacher F defined manipulatives as materials or teaching aids the teacher used to help the learners learn in an easier way. For her, manipulatives were concrete materials such as bottle tops, counters like stones, sticks and also a number line. Teacher F, however, did not elaborate on how these materials could help the learners to understand number sense concepts. Teacher G defined manipulatives also as concrete materials like sticks, stones, bottle tops and the abacus. Teacher H stated that manipulative materials used in mathematics lessons should be constantly changed. The teacher should not always use the same type of manipulatives all the time. She identified manipulatives as objects like the abacus, sticks, stones, number cards, food like macaroni. According to her explanation, all of these could be used in counting activities. The teachers at both High Performing Schools seemed to have a very similar idea and understanding of manipulatives. They furthermore indicated during their interviews that they all used manipulatives in their lessons about number sense concepts. The teachers all agreed that it was important to use manipulatives. They gave different reasons. Teacher E explained that the use of manipulatives was important only for some learners, as these learners did not know how to find answers to calculation problems.

Therefore they needed materials that they could use in order to find the answer. She furthermore explained that some learners already know how to find answers to calculation problems as they were "trained". According to her, not all learners needed to make use of manipulatives. She was not able to explain what manipulatives she used mostly in her lessons or how she used them. Teacher F stated that the use of manipulatives will help learners to grasp the concept that is taught more easily. For her, the use of manipulatives helped learners to remember the mathematical concepts taught better as they could see each concept in a concrete form. Teacher G explained that the use of manipulatives will help learners to understand important aspects of number sense such as the actual size of a number. Teacher H also agreed that manipulatives helped learners to understand mathematics better when they use objects that they could touch. The majority teachers were, however, not able either to identify which aspects of number sense could be effectively taught with the use of manipulatives. Most teachers seemed to only view the use of manipulatives as useful in counting activities and finding the answers to addition and subtraction sums. The teachers at both High Performing Schools also reflected on how effectively they used manipulatives in their lessons. Their reflections showed some similarities with those of the teachers at the Low Performing Schools, although it seemed that they were able to write better reflections. Some of the teachers at the High Performing schools were at least able to elaborate a little on why they chose certain manipulatives for their lessons. The teachers at the High Performing Schools felt that they used manipulatives effectively in their lessons when it helped the learners to do mathematics activities like calculations. A similar response was also given by the teachers from the Low Performing Schools. Teacher H said that she used manipulatives effectively when it enables the learners to become more active in the lessons. According to her, manipulatives

helped the learners to engage with the concept being taught, thus making learners take part in the lesson. This was a refreshing observation. Some of the teachers at the High Performing Schools wrote in their reflections that they could have chosen better manipulatives for their lessons to enable the learners to form a better understanding of place value and geometrical shapes, for example, Teacher F said that she could have used concrete materials like sticks grouped into bundles of ten rather than the columns she had drawn on the chalkboard to explain tens and units better. She also said that if she had used three dimensional objects like boxes, learners would have understood the concept of a three dimensional object better. The conclusion made is that although the Grade 2 teachers from both Low and High Performing Schools basically used the same type of manipulatives like bottle tops, stones and sticks because it is easily obtainable, the teachers at the High Performing Schools also included different teaching materials in their lessons like the abacus and number cards. Some teachers from the High Performing schools were able to reflect deeper on the effective use of manipulatives in their lessons. However, none of the teachers at the High Performing Schools were able to explain what criteria they implemented in selecting their manipulatives.

f) *Place Value:* Teachers E and F defined place value as the place where numbers must be arranged like in the number 100, the place in which one put numbers for example tens, units and hundreds. Teachers G and H defined place value as the ability of a learner to write numbers at the right place e.g. tens and units and the ability to know the value of a certain numbers. The teachers at both Low and High Performing schools seem then to have the same understanding of place value. Grade 2 teachers at both High Performing Schools explained that they taught place value as follow: using columns indicating hundreds, tens and units and writing two or three digit numbers at the correct place according to the

column, using concrete objects like sticks to count out ten and adding another stick to illustrate number eleven, using counters and a paper that is divided into two columns: one for tens and one for units. The learners then had to pick out a certain number for example eleven with concrete objects in the column to show how many tens and units the number had. When there were 10 sticks in the column for units, the learners had to move the group of ten to the column marked "tens". This indicated that some of the Grade 2 teachers from the High Performing Schools taught place value in a much more concrete way compared to practices used by teachers from the Low Performing Schools. The teachers from both High Performing Schools explained that it was important to teach about place value in Grade 2 for the following reasons: a learner should already know where to place a number for example as a ten or a unit, to alert learners about the place of numbers so that they find it easier to use in Grade 3 and knowledge of place value helps a learner to write a number correctly. The explanations given for the importance of teaching place value in Grade 2 were very similar to those given by the Grade 2 teachers from the Low Performing Schools. It was also noted that the teachers at the High Performing Schools, similar to those at the Low Performing Schools, were not really aware that place value should be taught because learners work with two digit numbers in Grade 2 and that they have to do calculations with numbers in the range of 11 – 99, therefore knowledge of place value is needed. The teachers also stated, as the Grade 2 teachers from the Low Performing Schools, that they usually teach place value concepts later in the year as this concept is not well developed in Grade1 and learners found it difficult to grasp at the beginning of the year. Some teachers from the High Performing Schools indicated that learners come to Grade 2 lacking mathematical knowledge from Grade 1 and that they have to try to catch up before they could carry on with Grade 2 level work. That was another reason given for

working with place value later on in the year. Field notes taken during the lesson observations showed that the Grade 2 teachers from both High Performing Schools taught place value as follows: Teacher E drew a column on the chalkboard indicating tens and units. She illustrated to the learners how to write a two digit number e.g. twelve using the column. The learners did not seem to understand the lesson as the teacher did not explain the concept of tens and units by using concrete materials like bundles of ten first. She also used learners to illustrate the number thirteen by dividing a group of thirteen learners in two groups: one group of ten learners and another group of three learners, thus illustrating how the number is composed, but still the learners did not grasp the concept of place value. Teacher F at the same school also explained place value in a similar way. She drew a column indicating tens and units on the chalkboard and wrote the number thirteen in the column. She asked the class to read the number and they read it as "one three" instead of "thirteen". She did not discuss with the class how the number thirteen was composed in terms of tens and units and she also did not explain the concepts "tens" and "units" by using concrete materials. She further illustrated vertical calculation e.g. 9 + 1 on the chalkboard and asked the learners what number will be written in the "units" column. She did not explain the concept of carrying over. The learners did not understand the lesson. Teacher G introduced place value by using the number twelve. She drew two circles on the classroom floor with chalk and let ten learners stood in one circle and two learners in the other circle. She explained then by using the two groups of learners, that twelve is made up of number ten and two. She further drew the column indicating "tens" and "units" on the chalkboard and showed the learners how number twelve should be written in the column. She then wrote number fifteen on the chalkboard and explained that number fifteen contained one group of ten and five units. A learner was then called to the chalkboard to

come and write fifteen correctly in the column. The learners were given several two digit numbers to come and illustrate on the chalkboard by writing it in the column. At first, the learners found it difficult, but the teacher kept on explaining and illustrating, so that eventually the majority seemed to understand by the end of the lesson. Teacher H introduced her lesson on place value by giving an explanation of place value first. She explained the concept as places where numbers are to be written and how much a number represented. She then put the learners in groups of four and gave two sheets of paper per group, which the learners had to fold in the middle and write "tens" and "units" on top, indicating two columns. Each group also received the following materials: a die and either toothpicks, bottle tops or small stones. The learners then worked in pairs. One learner had to throw the die twice and the numbers thrown had to be added e.g. if the learner threw a six first and then a five, the total was eleven. Number eleven then had to be illustrated on the column made on the sheet of paper by picking out eleven toothpicks, stones or bottle tops. The learners had to start with the "units" column first and count out until they had ten. The group of ten had to be moved to the column stating "ten", this indicating a group of ten. One object had to remain in the "units" column. The idea behind this was that learners will concretely pick out a two digit number and see how many tens and units it had. They also had to write the numbers correctly according to tens and units in the columns. The learners found this very difficult to do. Only a few seemed to understand the activity. The teacher admitted that the learners found it difficult as it was the first time they worked with place value. She stated that they would need more practice with the same materials in order for them to understand place value.

g) The effect of an inadequate number sense and place value knowledge on the children's performance in mathematics in higher grades: The teachers at both High

Performing Schools agreed that an inadequate number sense and knowledge of place value will definitely hamper the learners' performance in mathematics at higher grade levels. The reasons they gave were as follows: learners will not know how to write numbers in the correct place when doing multiplication, they will not have the basic concepts regarding number and place value and will make the work for the teachers teaching mathematics in the higher grades difficult, learners might experience mathematics as difficult and might believe that they are not smart enough to do mathematics. The reasons they gave were very similar to those given by the Grade 2 teachers from the Lower Performing Schools. The teachers from the High Performing Schools were also not able to state which areas of mathematics learners will find the most difficult as a result of having a poor number sense and a poor concept of place value.

4.5 Conclusion

This chapter presented the data which was collected during the teacher interviews, lesson observations and the teacher reflections on each lesson taught. Two types of data were collected: quantitative and qualitative data. The quantitative data was collected during the lesson observations and the tests conducted in each teacher's class. This was done to get an idea of the teachers' lesson presentation skills and the learners' abilities in selected number sense skills. The quantitative data was presented in the form of tables, pie and bar graphs. The qualitative data was collected during the teachers' interviews, field notes taken during the lesson observations and the teacher reflections. The qualitative data was described using commonly identified themes and was discussed separately for Low and High Performing Schools. Both sets of data were collected simultaneously. The quantitative data showed that the Grade 2 learners at both Low and High Performing Schools performed

poorly in the test on the pre – selected number sense skills (Appendix I). Both quantitative and qualitative data indicated that there was not a big difference in teacher practices and learner performance between the Low and High Performing schools. The lesson plans viewed during the lesson observations revealed that the teachers from both Low and High Performing Schools did not include a variety of number sense skills in their mathematics lessons as required by the syllabus.

CHAPTER 5: DISCUSSION OF RESULTS, RECOMMENDATIONS AND CONCLUSION

5.1 Introduction

Number sense is an important skill for doing and understanding mathematics. It lays the foundation for learning mathematical concepts and skills (Jordan, Kaplan & Ramineni, 2007). Several studies have found that learners' basic knowledge of counting, numbers and doing simple arithmetic can predict their later performance in mathematics (Geary et al., 2013; Aunola et al., 2004). The use of manipulatives in mathematics lessons can help learners, especially at the lower grades, to develop a good sense of numbers provided that the teachers and learners use manipulatives to demonstrate, explore and practice mathematical concepts (Uttal et al., 1997). Therefore, Delaney (2010) suggested that teachers should have two views of manipulatives: (1) manipulatives used for demonstration purposes and (2) manipulatives used for engagement purposes. This suggest that the manipulative materials the teacher will use to demonstrate and explain mathematical concepts and the manipulatives that learners will use to explore and engage with the concept taught will not be the same. Clegg and Courtney-Clarke (2009) found that manipulatives, concrete materials and the use of examples to explain and demonstrate mathematical concepts were not used effectively by Namibian Lower Primary teachers. The same study also found that number sense skills were not developed well in the Lower Primary phase in Namibian schools (Clegg & Courtney-Clarke, 2009).

The focus of this study was to explore how Grade 2 teachers in four schools in the Oshana Region used manipulatives to teach number sense skills. The schools were grouped as

Low and High Performing Schools. The study wanted to find out how teachers used manipulatives when they teach number sense, what perceptions the teachers had of number sense and how it develop and what the relationships was of their use of manipulatives and number sense knowledge on the Grade 2 learners performance in number sense skills. This chapter will therefore discuss the findings of the study according to the main research questions. This will be followed by a summary of the main findings, the recommendations made and finally the conclusion of the study.

5.2 *Research question 1*: How did the selected Grade 2 teachers use manipulatives when they teach number sense?

The quantitative data showed that the Grade 2 teachers included in the study did not use manipulative materials effectively in lessons. The teachers scored low marks in the following lesson presentation skills: using a variety of teaching aids to explain place value concepts and learners' use of manipulatives to explain answers and demonstrate their understanding of number sense concepts taught (See table 2). It was noted during the lesson observations that both the teachers and learners did not make use of appropriate manipulative materials such as proportional and non-proportional materials to explore place value concepts. Kennedy & Tipps (2000) proposed that learners need to investigate numbers in a variety of ways in order to form a good understanding of place value. The use of proportional materials such as Base 10 blocks, which show the real size of a number, as well as the spike abacus, which is a non-proportional material, can help learners to understand place value better. A good concept of place value helps learners to achieve good number sense, to estimate and understand multi-digit operations. When learners do not achieve a good understanding of place value, they will find it difficult to understand

arithmetical algorithms or "rules" (Ross, 2002; Kamii & Joseph, 1988 in Cooper & Tomayko, 2011). A lack of understanding of place value will thus have a negative influence on acquiring a good sense of numbers. The learners' test on number sense skills (Appendix I) showed that the learners in general performed well in the following aspects: recognizing numbers 15, 23, 45, 39 using the abacus, base 10 block, drawings (See table 4). This suggests that the teachers used these materials when they taught number sense skills. However, the classroom observations showed that few teachers used the abacus and none included base 10 blocks when teaching about two digit numbers. The qualitative data collected during classroom observations showed that teachers mainly used stones, bottle tops and sticks in their mathematics lessons. These materials were mainly used by the learners to find answers to calculations and in some cases learners used stones to represent the concepts "doubling". Only one teacher used a hundred chart in counting activities for learners to identify numbers. The lesson observations thus showed that the teachers did not include a wide variety of manipulatives in their lessons on number sense skills.

Furthermore, the qualitative data collected during the interviews showed that the teachers from both Low and High Performing Schools had a similar understanding of manipulative materials. The majority of the teachers defined manipulatives as concrete materials that help learners to understand mathematics better. The data also showed that most teachers from the Low and High Performing schools felt that they used manipulatives materials effectively when these materials helped learners to find correct answers to calculation problems. However, there are certain guidelines for the effective use of manipulatives. Manipulatives are used effectively when (1) it helps teachers to achieve the objective of the lesson (2) it helps learners to think on higher levels which lead to a better understanding

and application of the concept taught (3) when learners are allowed time to play with the manipulative materials in order to discover what they could do with it in a mathematical sense and (4) when the manipulatives selected and used in the lesson are appropriate for the lesson taught (Seefeldt & Wasik, 2006; Smith, 2009). Teachers also need to use guidelines when selecting manipulatives for their lessons (Mustafa- al Absi & Norfal, 2010; Kelly, 2006). It seemed that teachers did not do this. The post observation questionnaire (Appendix H) revealed that the majority of the teachers were not able to state how they have selected the manipulatives they have used for their lessons on number sense concepts.

This study therefore conclude that manipulative materials were not used effectively in lessons to develop number sense skills and place value concepts because teachers did not include a variety of materials to explore place value concepts, they connected the effective use of manipulatives to how well learners used it to do calculations only, they did not allow learners time to discover how they could use the manipulatives in different ways to explore and represent the concept taught and teachers did not use clear guidelines for selecting and using manipulative materials.

5.3 Research Question 2: What perceptions do Grade 2 teachers have of number sense and how it develops in young children?

Number sense can be defined as knowledge of relationships between numbers, an understanding of numbers which develop as a result of counting and representing numbers in different ways, part-part-whole relationships, the ability to make connections between numbers and real quantities, knowing about "more, less and the same" and to have an understanding of the four basic operations (Van De Walle, Karp & Bay-Williams, 2013;

Kennedy & Tipps, 2000; Lee, 2011). Number sense develops as a result of exploring numbers in different contexts using a variety of materials (Gersten & Chard, 1999 in Sousa, 2008; Treacy & Willis, 2003; Ginsberg, 1977 in Baroody & Wilkins, 1999).

It was clear from the transcribed interviews (Appendix J) that the teachers from both Low and High Performing Schools had similar definitions of number sense. However, very few of the teachers' definitions were clearly related to how the reviewed literature for this study defined number sense. The Grade 2 teachers defined number sense as follows: counting, using numbers in a sequence, knowing the value of number, the ability to compose and decompose numbers, identify and reading numbers, knowing "how many" a number represent. None of the teachers were able to connect number sense with the ability to subitise, understanding part-part-whole concepts, more, less and the same concepts and understanding the four basic operations. Although subitising is a component of number that Grade 2 teachers have to address according to the Grade 2 mathematics syllabus of 2005, it was noted during the lesson observations that none of the teachers included subitising activities in their lessons on number sense skills.

The interviews further revealed that none of the teachers had a clear understanding of how number sense develops in young children. Their views of number sense development were not in line with the idea that number sense develop in stages and that counting and subitising are widely accepted as the starting point of number sense development (Van De Walle et al, 2013; Sousa, 2008; Treacy & Willis, 2003). None of the teachers were also able to connect number sense development to the following: rich opportunities for learners to experience with and organize sets of numbers; using pictures, diagrams and numbers to discover the relationships between numbers; working with concrete materials to discuss

and share discoveries about numbers (Lee, 2011; Tsao & Linn, n.d.). Although the quantitative data collected during the lesson observations did not measure well what number sense skills teachers included in their lessons (See Appendix G Part B), the researcher noted during the classroom observations that teachers did not include a wide variety of number sense skills in their lessons as outlined by the Grade 2 syllabus. This finding connected well to the importance of the teacher's pedagogical content knowledge in order to teach mathematics effectively (Lee, 2011; Shulman, 1986). When teachers know what they have to teach and how they need to teach it, they can be effective in the classroom situation. Conant (1963 in Ball & McDiarmid, n.d.) found that the teacher's subject knowledge will influence his/ her efforts to help learners learn the subject matter. This study therefore concludes that the teachers included in this study did not have a clear understanding of number sense and how it develops in young children. As a result, they did not teach number skills effectively and did not include a variety of number sense skills in their mathematics lessons.

5.4 What was the relationship between the findings of research questions 1 and 2 on the Grade 2 learners' performance?

The study so far had shown that the teachers and learners included in the study did not use a variety of manipulatives effectively to demonstrate and explore a variety of number sense concepts in lessons. This was because teachers did not include a variety of manipulatives in their lessons on number sense development and place value concepts. Teachers furthermore connected the effective use of manipulatives to the learners' ability to use manipulatives to find answers to calculations only. The study also found that teachers did not use guidelines for the selection and use of manipulatives in lessons on number sense

development. It was furthermore also found that the Grade 2 teachers included in the study did not have a clear understanding of number sense and how it develop in young learners. The teachers' use of manipulatives, what they saw as effective use of manipulatives and their rather poor understanding of number sense development had a negative impact on the learners' performance in selected number sense skills. The quantitative data collected in the study prove this finding. Table 2 showed that the teachers scored low marks in the following lesson presentation skills: using a variety of teaching aids for counting; the use of the hundred chart to identify numbers; place value concepts, using a variety of manipulatives to explain place value concepts; effective use of manipulatives by the teacher as well as the learners and learners' use of manipulatives to explain answers and demonstrate their understanding of number sense concepts. As a result, the learners scored low marks in the following number sense skills included in the number sense test: knowing how many; more, less and the same concepts; part-part-whole relationships; problem solving and recognizing odd and even numbers (See table 4). It must be emphasized that the way the test was conducted with the learners was one of the limitations of the study. The learners did not write a written test individually, so it was not possible to determine individual learner abilities. The test was done orally and with the use of teaching aids in each class and the learners' reaction to a question determined how they were rated. If they answered fast and correct answers were given, they scored a high mark for that particular skill. If they were hesitant to answer or gave mainly wrong answers, the class scored a low mark.

A *t*-test was furthermore conducted in two areas: difference in teaching practices between teachers from Low and High Performing schools and difference in learners' performance

in selected number sense skills between the Low and High Performing Schools. Table 3 showed clearly that there was not really a big difference in the teachers' average score obtained in lesson presentation skills observed. It was found that some teachers at the Low Performing Schools scored higher marks in the lesson presentation skills then some teachers at the High Performing Schools. However, the results of the *t*-test indicated that the differences in teaching practices between the Low and High Performing Schools were not statistically significant (See Table 6). The *t*-test conducted on the learner performance in selected number sense skills showed that all the learners from both Low and High Performing Schools scored generally low marks in the number sense test. Although some Grade 2 classes from the High Performing Schools scored average and slightly above average in the learner test on number sense skills, the *t*-test results show that the difference in learner performance was not statistically significant (See Table7).

In conclusion, although there was a difference in teaching practices between the Low and High Performing Schools, it was found that the teachers in general taught number sense the same way and that their learners performed poorly in some number sense concepts tested. This study therefore clearly answered the three research questions that guided the study.

5.5 Summary of the findings of the study

- The majority of the Grade 2 teachers included in this study had a very vague idea of what number sense was. None of the teachers had a clear understanding of how number sense develops in young children.
- All the Grade 2 teachers included in the study used some manipulative materials in their lessons about number sense and place value. The manipulatives used mostly were bottle tops, stones and sticks. Few teachers used the hundred chart or small number cards for counting activities, identifying numbers or for ordering numbers correctly in a certain sequence. The teachers did not make use of both proportional materials (base 10 blocks) and none-proportional materials (spike abacus) to let learners explore and engage with place value concepts.
- Manipulatives like bottle tops were mainly used by the learners to find answers to simple calculation sums e.g. 2 + 4 and to illustrate counting. The learners did not use manipulatives to explain and demonstrate their understanding of the number sense concepts taught.
- Most teachers felt that they used manipulatives effectively in the lessons because the learners could use the materials to find answers to calculation problems.
- None of the teachers included in the study could explain what guidelines they used to select appropriate manipulatives for lessons on number sense. The study have to conclude that the teachers did not use manipulatives effectively because there were no guidelines used for selecting and using these materials in lessons on number sense concepts.
- Although all teachers had lesson plans available for the number sense skills that they taught, some of these lessons did not have clear lesson objectives. Thus, the outcome of

some lessons was not clear. It would seem that teachers just taught some number concepts without having a real purpose for teaching these skills.

- All of the teachers included in the study found place value concepts difficult to teach.
- None of the teachers connected number sense skills taught to problem solving activities so that the learners could apply newly learnt skills in a different situation.
- The study also found that there were no significant differences in teaching practices in teaching number sense skills between the Low and High Performing schools included in the study.
- There was also no significant difference in learner performance in number sense skills between the Low and High Performing schools.

5.6 Recommendations and suggestions for further study

Based on the findings of this study, the following recommendations are made:

For the Ministry of Education: The Ministry of Education, especially the Oshana Regional Education Directorate in consultation with its' Advisory Services need to train the Lower Primary teachers in the region about number sense, how important a good number sense is for learners to perform well in mathematics, how number sense develop in young children and what mathematical activities promote a good sense of numbers. The Lower Primary teachers furthermore need to be advised and assisted in planning effective mathematics lessons with well formulated lesson objectives. The Grade 2 teachers in the region also need to be trained on how to teach place value effectively and what teaching aids should be used to help learners acquire a good understanding of place value concepts. Lower Primary teachers furthermore need guidance on how to select appropriate manipulatives for their

lessons on number sense skills. They also need training on how to use manipulatives effectively in lessons by both the teacher and the learners. The Ministry of Education should perhaps consider testing all the Lower Primary teachers' basic mathematical knowledge so that a training program could be implemented to help Lower Primary teachers to upgrade their basic mathematic knowledge. This in turn could help Lower Primary learners to achieve a good sense of numbers at the end of the Lower Primary phase because teachers will have a better content knowledge.

The University of Namibia (UNAM): UNAM is the institution who is responsible for training the Lower Primary teachers employed in schools. The university should perhaps consider allocating more time for lecturers on the timetable for teaching the numeracy course during the next curriculum review. Student teachers need more practical applications especially when it comes to planning and demonstrating mathematics lessons. This will enable the lecturers to cover mathematical concepts such as number sense development more in depth with the student teachers. This in turn can ensure that a better trained and equipped teacher will be employed. Student teachers should perhaps produce a standard list of manipulative materials needed for teaching mathematics at the end of their period of study so that they are better equipped for teaching number sense skills to the Lower Primary learners. Schools are not able to supply all of these materials needed.

The National Institute for Educational Development (NIED): NIED should also embark on a national training exercise for Lower Primary teachers to explain the importance of developing a good number sense in learners. The institute should consider compiling a teachers' guide for teaching number sense concepts, especially place value. Teachers need specific guidance on this since the syllabus is not clear on how place value should be

taught. This guide could also guide teachers on what teaching materials is best for teaching a specific number sense concept and how the materials can be used effectively in lessons by both the teacher and the learners. NIED should also revise the current way teachers are planning their mathematics lessons. A lesson plan should be developed where the lesson objective is clear and the teachers are following a specific teaching sequence in order to develop mathematical proficiency skills in the learners. This basically means that NIED should train Lower Primary teachers already in service on how to plan good mathematic lessons which focus on number sense development.

Recommendations for further study: Since this study only focused on one educational region and included a small sample from the region, it is recommended that a comparative study is carried out across educational regions in Namibia to find out if the majority of the Grade 2 teachers teaching in Namibian schools really have a poor understanding of number sense and place value and the effective use of manipulatives. Such a study could help the educational stakeholders such as the Ministry of Education and UNAM to implement strategies to overcome the challenges of developing a solid number sense in young learners across the country.

5.7 Conclusion

This study provided a very important insight into the teaching practices in some Lower Primary classrooms with regard to the teaching of number sense skills. The study showed that the teachers are dedicated to teaching the learners well, but that teachers lack knowledge of what number sense really are, how it develop, how to teach place value concepts and using manipulatives effectively in lessons which focus on number sense

development. The teachers included in this study really tried to teach number sense skills to the learners as best as they could with the materials they had available, but the researcher concluded that the teachers, in spite of their number of years teaching experience in the Lower Primary, lacked pedagogical know- how on the effective teaching of number sense skills. This in turn had a negative effect on how the Grade 2 learners eventually performed in important number sense skills such as place value. It is thus important that the teachers teaching at the Lower Primary phase will get assistance and guidance on the following aspects: (1) what number sense is, how it develop, what mathematical activities done in mathematics lessons will help learners to explore, engage and achieve a good number sense (2) how to select and use manipulatives effectively in lessons that focus on number sense development.

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APPENDIX A: RESEARCH PERMISSION LETTER

UNIVERSITY OF NAMIBIA

Private Bag 13301, 340 Mandume Ndemufayo Avenue, Pionerspark, Windhoek, Namibia

The School of Postgraduate Studies
Private Bag13301
Windhoek, Namibia
Tel: 2063523

E-mail: cshaimemanya@unam.na

Date: 14th October 2013

TO WHOM IT MAY CONCERN

RE: RESEARCH PERMISSION LETTER

1. This letter serves to inform that student Elna Potgieter, student number 201113236, is a registered student in the Department of Early Childhood Education and Lower Primary Education at the University of Namibia. Her research proposal was reviewed and successfully met the University of Namibia requirements.

2. The purpose of this letter is to kindly notify you that the student has been granted permission to carry out postgraduate studies research. The School of Post Graduate Studies has approved the research to be carried out by the student for purposes of fulfilling the requirements of the degree being pursued.

3. The proposal adheres to ethical principles.

Thank you so much in advance and many regards.

Yours truly,

Main Supervisor: Dr T. Frindt

Signed:

Dr. C. N.S. Shaimemanya

Signed:

Director: School of Postgraduate Studies

APPENDIX B: PERMISSION REQUEST LETTER MINISTRY

The Permanent Secretary

Ministry of Education

Head Office

Government Office Park

Windhoek

Mr Alfred Iilukena

24 October 2013

Sir,

Re: Permission to carry out a research project in 5 schools in Oshana Education Region

I am an assistant lecturer at UNAM's Hifikepunye Pohamba Campus in Ongwediva in the Department of Early Childhood Development & Lower Primary Education. I am currently enrolled at UNAM for the M Ed degree in Early Childhood Development. I am in my second year of study and had been granted permission by the University's Post Graduate Study Committee to carry out my research project in order to obtain my master's degree. I attach a copy of this permission letter for your perusal.

I am hereby respectfully requesting your permission to carry out the study in five selected schools in Oshana Region. Currently the schools I have selected are as follows:

International Primary School, Charles Anderson Primary school, Erundu Senior Secondary school, Oshakati West Primary School and **Ongwediva Control Primary school.**

The schools selected all use English as medium of instruction in the Lower Primary phase since the focus of my study is to explore how Grade 2 teachers teach numbers sense using manipulatives. I want to use Ongwediva Control Primary school in the pilot study only in order to test my research instruments and to make final adjustments before I will carry out the main study in the other four schools.

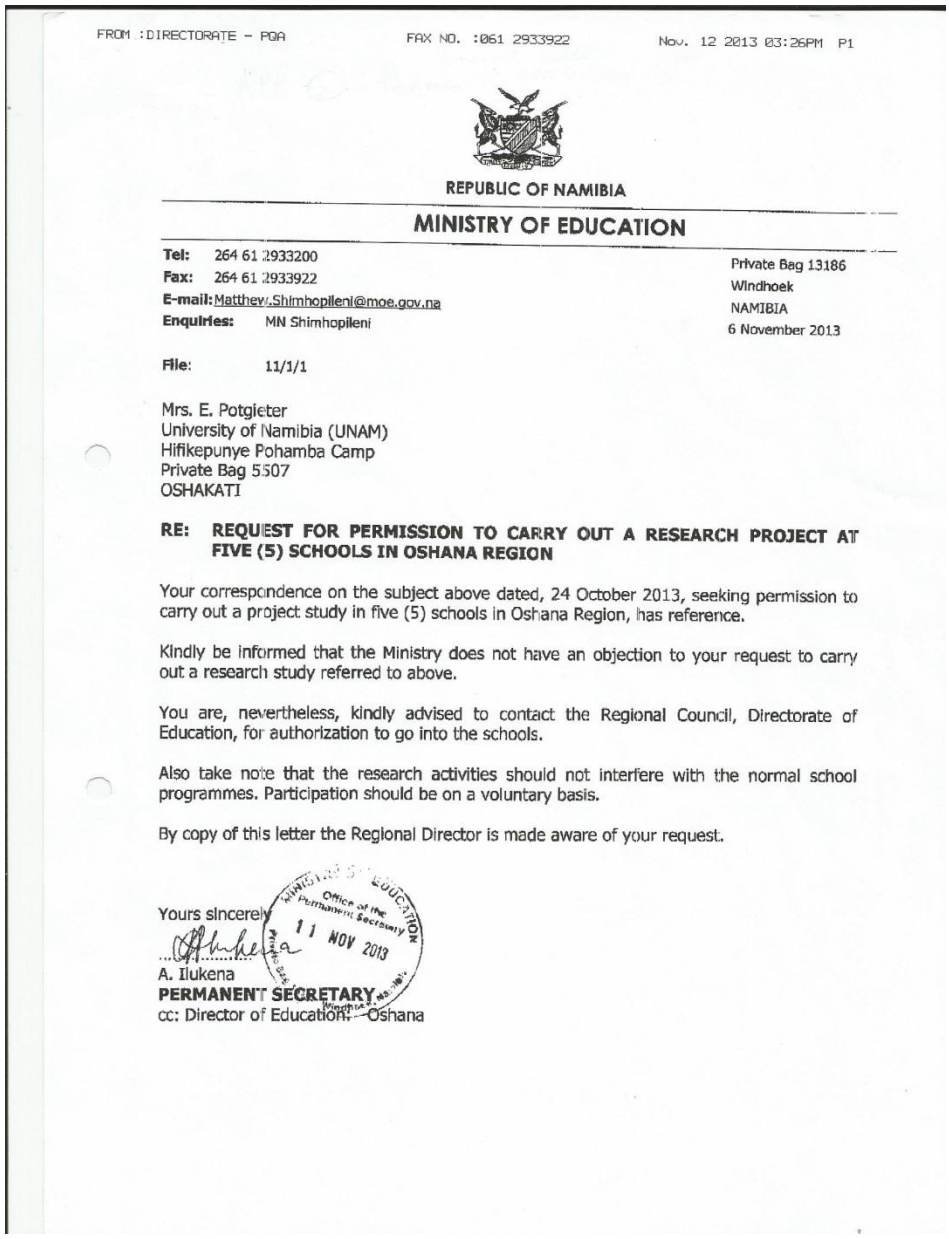
I thank you for your support in this regard. I am awaiting your approval in anticipation.

Yours faithfully,

……

E. Potgieter (Mrs)
Tel: 065 – 2323000 (w)
Email: epotgieter@unam.na

APPENDIX C: APPROVAL LETTER FROM MINISTRY



FROM :DIRECTORATE – PQA FAX NO. :061 2933922 Nov. 12 2013 03:26PM P1

REPUBLIC OF NAMIBIA

MINISTRY OF EDUCATION

Tel: 264 61 2933200
Fax: 264 61 2933922
E-mail: Matthew.Shimhopileni@moe.gov.na
Enquiries: MN Shimhopileni

Private Bag 13186
Windhoek
NAMIBIA
6 November 2013

File: 11/1/1

Mrs. E. Potgieter
University of Namibia (UNAM)
Hifikepunye Pohamba Camp
Private Bag 5507
OSHAKATI

RE: REQUEST FOR PERMISSION TO CARRY OUT A RESEARCH PROJECT AT FIVE (5) SCHOOLS IN OSHANA REGION

Your correspondence on the subject above dated, 24 October 2013, seeking permission to carry out a project study in five (5) schools in Oshana Region, has reference.

Kindly be informed that the Ministry does not have an objection to your request to carry out a research study referred to above.

You are, nevertheless, kindly advised to contact the Regional Council, Directorate of Education, for authorization to go into the schools.

Also take note that the research activities should not interfere with the normal school programmes. Participation should be on a voluntary basis.

By copy of this letter the Regional Director is made aware of your request.

Yours sincerely

Office of the Permanent Secretary 11 NOV 2013

A. Ilukena
PERMANENT SECRETARY
cc: Director of Education: Oshana

APPENDIX D: PERMISSION REQUEST: OSHANA REGIONAL OFFICE

UNIVERSITY OF NAMIBIA

Hifikepunye Pohamba Campus

To: Oshana Regional Council

Directorate of Education

The Director of Education

Mrs. D. Shinyemba

19 November 2013

Madam,

RE: REQUEST FOR PERMISSION TO CARRY OUT A RESEARCH PROJECT AT FIVE SCHOOLS IN THE OSHANA REGION.

I hereby want to acknowledge and thank you for the permission to carry out my research project in your region. The schools I want to use for my research are all town schools and are as follow:

International Primary School, Charles Anderson Primary School, Erundu Secondary School, Oshakati West Primary School and Ongwediva Control Primary School.

I will use Ongwediva Control Primary School in the pilot study only in order to test my research instruments. I will spend only two days at the school. At the other schools I will spend a week per school and the intention is to include 2 Grade 2 teachers per school in the study. My data collection will be qualitative in nature, so it means that I will observe teachers teaching, make videos of the lessons I observed and also to interview the teachers afterwards.

I will adhere to your request and try not to interrupt the teaching process much. The interviews will be conducted in the afternoons with the teachers.

I plan to start with the research when the new school year commences in January 2014. I will however visit each principal beforehand to discuss my research project with them and the teachers concerned in order to stick to the ethical considerations of my research as approved by the University of Namibia.

Thank you so much for your assistance and support in this regard.

Yours sincerely.

…….

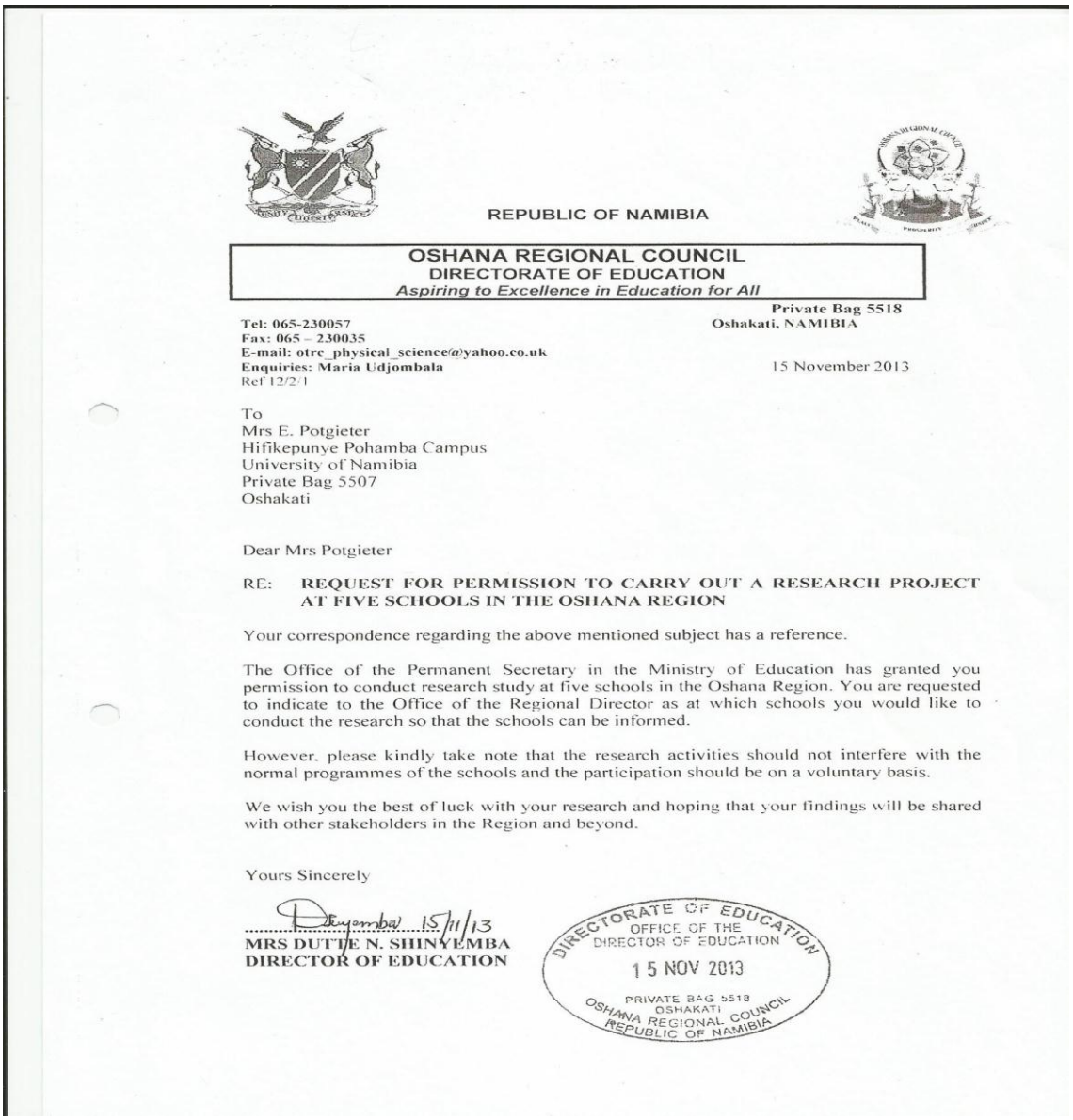
E. Potgieter

Assistant Lecturer

Faculty of Education/ Dept. of ECD & LPE

Hifikepunye Pohamba Campus

APPENDIX E: APPROVAL LETTER: DIRECTOR OF EDUCATION



REPUBLIC OF NAMIBIA

OSHANA REGIONAL COUNCIL
DIRECTORATE OF EDUCATION
Aspiring to Excellence in Education for All

Private Bag 5518
Oshakati, NAMIBIA

Tel: 065-230057
Fax: 065 – 230035
E-mail: otrc_physical_science@yahoo.co.uk
Enquiries: Maria Udjombala
Ref 12/2/1

15 November 2013

To
Mrs E. Potgieter
Hifikepunye Pohamba Campus
University of Namibia
Private Bag 5507
Oshakati

Dear Mrs Potgieter

RE: **REQUEST FOR PERMISSION TO CARRY OUT A RESEARCH PROJECT AT FIVE SCHOOLS IN THE OSHANA REGION**

Your correspondence regarding the above mentioned subject has a reference.

The Office of the Permanent Secretary in the Ministry of Education has granted you permission to conduct research study at five schools in the Oshana Region. You are requested to indicate to the Office of the Regional Director as at which schools you would like to conduct the research so that the schools can be informed.

However, please kindly take note that the research activities should not interfere with the normal programmes of the schools and the participation should be on a voluntary basis.

We wish you the best of luck with your research and hoping that your findings will be shared with other stakeholders in the Region and beyond.

Yours Sincerely

Shiyemba 15/11/13
MRS DUTTIE N. SHINYEMBA
DIRECTOR OF EDUCATION

DIRECTORATE OF EDUCATION
OFFICE OF THE
DIRECTOR OF EDUCATION
15 NOV 2013
PRIVATE BAG 5518
OSHAKATI
OSHANA REGIONAL COUNCIL
REPUBLIC OF NAMIBIA

APPENDIX F: PRE OBSERVATION INTERVIEW

Pre – observation interview questions with Grade 2 teachers.

The purpose of this interview is to establish rapport with the Grade 2 teachers who are taking part in this study and to find out how they feel in general about teaching Lower Primary mathematics, how they view number sense development and how they use manipulatives in their mathematics lessons on number sense.

1. Do you like teaching mathematics? Why or why not?
2. What do you find challenging about teaching mathematics in Grade 2? Give reasons.
3. How do you prepare for your Mathematics lessons?
4. When do you prepare for your mathematics lessons?
5. What is number sense?
6. Why is it important for doing mathematics?
7. How do you think number sense develop in young children?
8. What aspects in the Grade 2 mathematics syllabus deals with the development of number sense skills? Why do you say so?
9. What do you think is meant by "manipulative materials" in teaching mathematics?
10. Do you make use of manipulative materials when you teach Grade 2 learners about number sense? Why?
11. Why do you think it is important/ not important to use manipulatives in lessons about number sense?
12. Do you think the use of manipulative material in mathematics lessons on number sense will enhance the learners' learning or not? Why?
13. What is place value and why is it an important aspect of numbers sense to develop in Grade 2?
14. How will an inadequate development of number sense and place value in the Lower Primary influence the learner's performance in mathematics in later school years?

Adapted from Maduna, 2002

APPENDIX G: CLASSROOM OSERVATION FORM

OBSERVATION FORM FOR GRADE 2 MATHEMATICS LESSONS ON NUMBER SENSE DEVELOPMENT USING MANIPULATIVE MATERIALS.

Part A: General information (to be completed once only)

1. School: (tick in appropriate box)

Low performing 1	**Low performing 2**	**High performing 1**	**High performing 2**
School 1	School 2	School 3	School 4

2. Teacher: 1 ☐ 2 ☐

3. Gender of teacher: Male ☐ Female ☐

4. The teacher is qualified to teach the Lower Primary Phase: 1 ☐ Yes 2 ☐ No

5. Teacher qualification: (1) 3 year teaching diploma ☐ (2) 3 year degree with teaching diploma ☐ (3) Any other qualification ☐

6. Teaching experience in the Lower Primary phase: (1) 1 – 5 years ☐ (2) 5 – 10 years ☐

☐ (3) 10 – 15 years ☐ (4) more than 15

7. Manipulative materials used in the lessons include: a variety of materials such as counters, base 10 blocks, number charts etc. 1. ☐ Yes 2. ☐ No

8. A variety of activities to develop number sense as per syllabus were included in the lessons observed 1. ☐ Yes 2. ☐ No

9. Place value concepts were included and developed in all lessons observed:

1. Yes 2. No ☐ ☐

PART B: Lesson presentation skills observed in each lesson about number sense development.

Scale used: 1 = poor 2 = weak 3 = average 4 = good 5 = excellent

Lesson Presentation Skills:	**1**	**2**	**3**	**4**	**5**
1. The lesson plan is well prepared with clear objectives, teaching stages, learner activities and a suitable conclusion.					
2. The number sense concepts chosen for the lesson are clearly indicated and related to the Grade 2 math syllabus.					
3. The lesson introduction is clearly linked to the number sense concepts chosen for the lesson.					
4. Counting activities form part of number sense development in the lesson.					
5. The teacher uses the hundred chart, counters and the abacus to illustrate counting in a variety of ways such as forwards, backwards, counting in twos, threes, fours, fives and tens.					
6. The hundred chart is used by both teacher and learners to identify numbers, discuss place value of two digit numbers and to discuss the relationship between numbers e.g. more, less, the same.					
7. Place value concepts are addressed in this lesson.					
8. Manipulative materials such as base 10 blocks, strips of tens, unit blocks and the spike abacus is used in the lesson to illustrate place value.					
9. The teacher explains and demonstrates very well to learners how the above manipulatives represents tens and units.					
10. Learners use the manipulatives mentioned in (8) when explaining answers related to place value.					
11. Number sense concepts chosen for the lesson are skillfully linked to problem solving activities.					
12. Manipulative materials are used by the learners in groups/ pairs to solve problems related to the number sense topics taught.					
13. Learners make use of manipulative materials in explaining answers to others or the teacher.					
14. The way learners use manipulative materials demonstrate their understanding of the number sense concepts taught in the lesson					
15. The lesson conclusion is skillfully done to ensure learners understood the number sense concepts taught.					

Additional comments on the lesson observed:

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APPENDIX H: POST OBSERVATION QUESTIONNAIRE

Post Observation questionnaire for Grade 2 teachers

School:…….
Teacher:…….

Lesson focus:…….. Date:…….

1. Which number sense skills were you hoping the learners would acquire in today's lesson?.....
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2. Do you think the lesson was successful in addressing the number sense skills you taught?
Why?.....
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3. What manipulative materials did you use to teach the selected number sense skills? How did you select these manipulatives?.....
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4. Do you think you chose appropriate manipulatives for your lesson? Why do you say so?.....
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5. Were the manipulatives effectively used during the lesson by both the teacher and the learners in order to understand the topic that was taught? Why?.....
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6. What could you have done differently in the lesson with regards to the number sense skills you have taught and the manipulatives that you have

used?.....
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7. How can you include place value concepts in everyday mathematics lessons?

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8. What problems will the learners have in future with mathematics if they did not acquire a good understanding of place value in Grade 2?

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Adapted from Maduna, 2002

APPENDIX I: TEST FOR TESTING GRADE 2 LEARNERS NUMBER SENSE SKILLS

This test was conducted for approximately 20 minutes during the second last lesson observed in each teacher's class.

Scale used:

1 = poor **2 = weak** **3 = average** **4 = good** **5 = excellent**

1. Knowing "how many".	**1**	**2**	**3**	**4**	**5**
Able to give answers to subtraction and addition sums on flashcards.					
2. Recognizing numbers 1 – 10 in different contexts. Learners were able to recognize numbers 1 – 10 on patterned dot cards. They were able to recognize same numbers in different patterns.					
Learners were able to recognize numbers 15, 23, 45, 39 in different ways: abacus, base 10 blocks, drawings. Were able to tell the difference between 15 & 45.					
3. More, less and the same: Learners were able to answer the following: 2 more than 9, 3 less than 18, 4 more than 7, give any two numbers that will be the same as 10 together.					
4. Part – part whole: Learners were able to answer the following: one part is 7, another part is 3, what is the whole? The whole is 9, one part is 6, what is the other part? Formulate a word sum using part and whole.					
5. Counting: Count backwards from 54 – 32 without using a number chart. Count on from 16 in twos to 60. Count on in 3 from 9 – 30 Count in fives backwards from 50 - 5					
6. Problem solving: Solve the following number sentences: _ - 3 – 2 = 1 5 + 3 – 7 = _					
7. Odd & even numbers: Learner are able to show a row of odd and even numbers on the number chart and are able to explain what makes a number odd or even.					

APPENDIX J: TRANSCRIBED TEACHERS INTERVIEW

Transcription of interviews with teachers

High Performing School 1

Teacher 1

The numbers refers to the questions as they were asked according to the structured interview.

The responses were transcribed verbatim.

1. I like teaching mathematics, because I want to make a difference as a teacher, to use different methods when I teach.

2. The thing I find very challenging is teaching money, the value of money, also amount of money and teaching subtraction and multiplication. Money is difficult to teach because for example if you give a child N$ 1 plus 10c plus 5c, they will just see a lot of money, but do not understand the value, so it takes some training for them to understand that 10 x 10c have the same value as N$ 1. Subtraction and multiplication is difficult because when it comes to minusing, learners do not understand why we have to take away and multiplication means to duplicate twice, especially with multiplication, they have to understand place value first.

3. I use the lesson planning book, syllabus guide, textbook, especially Day by Day, Pollination, check in any book, internet, the syllabus.

4. We prepare on Thursday afternoons, me and my colleague. We do the same lessons.

5. Number sense is actually, according to my own understanding, how you decompose numbers and they are trying to be sensible to you, for instance having three dots, it represent

the number 3. For the child to be able to see and visualize three objects and are able to see the number.

6. Number sense gives the understanding to children that not only are you able to see a number, but you are able to see the value of the number.

7. It helps them, in Pre – Primary, where they are able to touch the objects that they are counting, they are able to experience numbers e.g. writing number 3, they will feel how it is written … the movement of writing number 3.

8. Number Concept Development is such as decomposition of numbers, subtraction, multiplication, division and additions. These are the number concept skills. I see them introduced in the lesson, one way or another.

9. Manipulative materials are materials that children can manipulate such as to use them to come to an understanding such as bottle caps, sand bags, bean bags and any materials that is teachable.

10. It is important because some children are not trained to use them, but some are trained so for some learners manipulatives are useful and for some not because they know how to go about to get the answer. Some children, their brain still have to develop to see how to come to an answer. They need manipulative materials. (*The teacher's answer basically covered questions 10 – 12, therefore the next question to follow is question 13.*)

13. Place value is the place where numbers must be arranged such as 100. I must know where the units, tens and hundreds are. Children must understand where to place the numbers correctly otherwise they get a wrong answer. It is important to teach place value in Grade 2 because children are able to locate and able to understand where the number is to be positioned. I usually teach place value by using columns. I take 3 or 4 digit numbers and I try to put them at the place they should be according to the column.

14. It’s going to be catastrophic because they will not know where to place numbers in e.g. multiplication where to put numbers in the right place. It really affect their whole development of mathematics and so it is going to affect them in the future.

Teacher 2

1. Yes, mathematics is something we use in our daily life. I like teaching mathematics cause I develop kids in everything they can do in daily life e.g. counting, numbers… that is why I like mathematics.

2. The topic that I find difficult is mostly problem solving, cause children find it difficult when you read problems to them, they cannot really figure out what operation to use. I also find it difficult to explain, sometimes I give them clues and it is really challenging. Up to the third term there are still some who do not understand problem solving.

3. (The teacher at first did not understand the question). I use the scheme of work, curriculum for topics and what to teach under each topic, learners' books and textbooks like Day – by – Day and The Friendly Earth series. I use these mostly to focus on the basic competencies because I have to teach according to the curriculum.

4. Thursdays

5. With my colleague. We do a weekly plan, from there we do a daily lesson plan, each on her own. We teach the same topics in a week.

6. Number Sense I think is when children develop number skills like identifying numbers, reading numbers – by that way they develop number sense where they can even put two numbers together to get another number.

7. It is very important cause as I explained earlier, it is something that we do in our daily lives, when you go to the shop to buy something, you use numbers, things in the house – maybe you give children sweets, they have to count. Number sense is very important in doing mathematics, cause it allow children to develop number sense and number concept development that they have to work with numbers in their daily lives.

8 You know children develop number sense when they are looking at the concrete materials, let me say in the Grade 1 and 2 some of them cannot really say this is number what – what. By looking at pictures or concrete materials they can see then they develop number sense. By seeing, visualizing, using concrete materials. Under Number Concept Development there are different topics e.g. sequencing of numbers, doubling, halving, computation which include addition, subtraction, multiplication and division. All of these use numbers which lead to number concept development. I think they all develop number sense cause everything use numbers e.g. reading numbers and number sentences.

9 Manipulative materials I think, is materials that you use or teaching aids to teach or o help children to learn easier e.g. pencils, bottle tops, any counters, stones, sticks, a number line.

10 Yes, just to help kids to grasp more easily because if you don't use it sometimes it is not really that easy for them to get the point, but if they see something, they can remember easily. (*Questions 11 and 12 were also partly answered with this response*).

13. Place value I think is where you put numbers in each place, for example units, tens, hundreds. It is the place of numbers for example when you add numbers together to see now I got units, tens and hundreds. Then you can arrange them in their place value. Why do we teach place value in Grade 2 for the first time? Just to develop – there is a beginning where we have to start, just to alert the kids when they go to Grade 3 so it will be easier for them. Then they will not struggle. I use a column indicating Tens and Units on the chalkboard for them to see units are one digit numbers and tens are two digit numbers.

14. It will be badly, I have also experienced it. A child come from Grade 1 and did not understand adding numbers together. I have to work more harder, cause the child does not

have the background of that. Now I have to push more harder. But if the child understands in the Lower Primary, it will be easier to proceed in a normal way, but if they did not get that sense of number it will affect them badly. They will not do good. They have to be given extra lessons to grasp it.

Low Performing School 1

Teacher 1

1. Yes, so much! I don't know. It is just this thing that I like from High school. I always liked math, now coming back here, math is just so simple, you know, for little kids. I just enjoy it.

2. Teaching fractions is very challenging. Maybe I find it challenging and difficult to explain to the little ones. If I can teach it in Grade 4, it is fine. But for Grade 1 or 2, for me, somewhere there is a problem. Division is challenging as well. You know, at times I use little pictures, sometimes I use counters, but then they know more when you use pictures. They get it easily when using pictures. When you use bottle tops or small stones, you see all/ most of them getting zero, there I dunno where I go wrong. Problem solving is not a problem unless we have to solve a bit complicating problems like you get in some books. You see, books differ. You might find an activity suitable to what you are teaching in a book, but then you might find the word sum difficult to explain. Sometimes you just feel like throwing away the textbook.

3. I use my thematic scheme of work, it gives me an idea of what to teach for a week. Once I have a clue of what to teach, I get my mathematics teacher's guide (Day by Day). I look at the activities stipulated there, when I have teacher and learner activities in place, I open my curriculum and find the objectives and competencies that are matching my activities and I copy them onto my lesson plan. The teacher's guide tells you what materials to use in most cases.

4. We normally plan together and we normally do it after school. But then, always on Friday we have a problem to plan for Monday. Especially this time that we are doing

athletics, we hardly sit down and plan. We just come to school, see what to do, then later after work, we put it on paper. We plan once a week, first we do a weekly overview, from the overview, we do the daily plan.

5. Number sense has to do with teaching numbers within the range of many activities. So we do this ordinary counting which is rhythmical counting, count in groups of 2 – 3. I stick to the range given in the curriculum e.g. count up to 60. Because if I have a number chart full of numbers, some of the learners find it confusing. I prefer writing the numbers on the chalkboard using the range I am supposed to deal with, because they manipulate it easily. At times I can omit some numbers and ask learners to fill it in. Besides counting, it also includes addition and subtraction and computation. You know, learners are still developing that sense of take away.

6. Number sense is very important, because if they learn or know numbers then it will not be difficult for them to do any other thing e.g. measuring. Learners have a problem in reading and writing numbers. If you give them this line in a book to measure, when the kids come with a ruler, they can read that the line is 6cm long, but the child might write 9 insead of 6. Somewhere there the articulation of numbers in wrong. So for me, I find number sense, or number concept to say, very important in all aspects of mathematics, even if you have to deal with problems, as long as they can manipulate the numbers, as long as they know them very well, not just in a sequence, they will be able to use them.

7. I think they, you know, in small children, it develops all the time. But I think it is much faster when you use manipulative objects. Not just numbers, just numbers are too boring, even for myself. I like it when I use different manipulatives, so then they don't get bored e.g. sticks, small stones, bottle tops, real objects like apples to show them sharing when talking about fractions.

8. Counting, addition, fractions

9. Manipulative materials are things that kids can touch, things they are able to move e.g. bottle tops, small stones, things they can feel, touch move.

10. Ja, but not always. You know, at times I would like them to use their heads e.g. the counting we did, when we do it for the first time, we use manipulatives so they can see, next time I would like them to tell me the numbers in twos up to twenty in their heads. I can have things like flashcards and then I can put some numbers there on the chalkboard. I omit some numbers and ask them to put these numbers in or I can have a whole range of numbers in groups of two and then we put them there one by one. Now we are no longer using the bottle tops, we are using the numbers themselves. I want to drill this number in. Manipulatives can be concrete like bottle tops, semi – concrete like flashcards. I use both, but not at the same time. I use these because I find it interesting. It is just fun for kids, when they are of different colours, learners are able to identify them easily e.g. counting in two. They can feel it… it is attractive.

11. Answered already in 10

12. Answered already in 10.

13. Place value, this also confuses me. I think it is the place of a number, such as e.g. in twenty three, 2 is the tens and 3 is the units. It has to do with the value of numbers. Something in that direction. It is important to know these values, because it will prepare them for Grade 3, it will not be difficult…These guys, they don't know the hundreds yet, all they do is just tens and units. Perhaps teaching it in English will be quite difficult, maybe for the first time we can translate it into the Mother – tongue to get an inside picture and we can start with the tens "omilongo" and values "oikupe". We can use stones and group them… the tens aside and the units, then we put them together to get the whole number which is fourteen for example.

14. Very bad, it is actually going to be chaos. With Grade 5, they will not be used to this class teaching. They are learning to fit in with their new teachers now with this number sense, at times you, these teachers in the Upper Primary are not aware of the strategies we use in the Lower Primary. Kids will be left there to work independently. Now if this kids do not know to count or know numbers, they will find it difficult to work on their own or to work with higher number ranges. Number Sense is very important.

Teacher 2

1. Yes, I do. Because almost in life everything its based on mathematics. Whether it's old ladies, old people, whatever they do in their daily life, here and there is based on mathematics. Sending a child, bring me like 7 pieces of sticks, I am going to send you to the shop, I am giving you N$ 50 and then what you are going to buy is 10 dollar, so I am expecting you to bring back like N$ 40. So our everything in life is almost based in mathematic. It is very important for someone to know mathematic.

2. Ah, it is the dimensional shapes. It is very difficult for the learners just to figure out what do we mean by two dimensional, you try to explain it and then not really a hundred percent get to understand that topic.

3. I normally have to have a teacher's guide, then I look for the textbook of the grade, then I also have to look for other mathematical related books because I also have different books available. Some of the books are not in use anymore, but at least I have to consult them because the information you get there is still helpful. You need to know what you are supposed to do, because sometimes, if you did not consult the prescribed books, teacher's guides, you might plan what you have to teach somehow wrong. But then if you are guided, it is okay.

4. I actually plan in advance e.g. today is Tuesday, if I have to teach it tomorrow, I must prepare it today so that I can see what type of teaching aids I can us. Those years we use to do our planning weekly, but as from last year, our facilitators, they suggested it could be better if we do a daily preparation. Like those years, I used to teach Grade 1, so now we normally sit together and plan how we can tackle the topic. My colleague and I plan together so we teach the same topic everyday, but when it comes to the exercise, as long as we know this is the

topic, maybe my colleague can say 2+2 and I can say 1+3, thus different activities, but teaching the same topic every day.

5. Number sense, there I am talking under correction… I think … ah… it is the way the person is supposed to understand the numbers. A person is supposed to know which numbers comes before a certain number. I think that is what I can say about number sense.

6. For place value purposes and … it is important to have number sense in order to calculate.

7. I think they learn by counting and when they use concrete objects. Ja, they get to know it. They learn about amount by counting (*the teacher was not sure how to answer this question*).

8. Hmm… if I understand the question, it will be Number Concept Development, it can be computation, counting, through subtraction, division, multiplication. These things will help them to develop number sense because they get to know that when you are talking about two plus two, it becomes more, you add.

9. Okay, I think when you are just teaching them orally, they will not understand, but when you bring up these things like stones and then they are touching it themselves, then they are able to experiencing this is 2 + 2. Then they will understand because it is like it is becoming a bit more interesting.

10. Ja, I do, but when it is coming to … okay… like place value, the syllabus is not that clear, but yes, we do.

11. *The teacher was not able to answer this question.*

12. *The teacher was not able to answer this question*

13. Place value is just to teach the learner, it is about the units, tens, hundreds, thousands, Just to let the learner know that if we have to categorize the numbers, we only took one

number… it will be units only. When they are two, it becomes tens and so on. It is important to teach place value in Grade 2, because in Grade 1, they learn a bit of basics and now when they come to Grade 2, they must learn to work with more numbers because… (*The rest of the answer was not clear or understandable*.) Okay, sometimes I can use like chalks and sometimes money. Sometimes they understand, okay… you have one dollar and 10 dollar, followed by 20, you come to a hundred…ja, we only stop at hundred. (The teacher clearly did not have a good idea how to approach place value and why it was an important aspect to teach).

14. I think it will also lead for some learners not to like mathematics, because it will become a bit difficult for them when they go up without understanding the basics. So, if they understand, mathematics will become more interesting.

High Performing school 2

Teacher 1

1. Yes…hmm… mathematics is a very important subject. I like very much the math for the small kids, cause most of them they also like the mathematics according to my experience in this Lower Primary… most of the time when coming to the class, if there is no mathematics that day, they are going to ask you: "Teacher, we did not do mathematics!" And then, I think they also like it.

2. The topics which is challenging is this place value. It is challenging because it is too difficult for the learners to understand it. Ja, you even do a lot for them to understand. They find it difficult cause if you say maybe write 10, she can start with zero and then the one after… or you can find that she write 20, you said 21, she is supposed to write 20 and then 1.

3. Ah, when I plan my mathematics lessons, I use my integrated manual, my syllabus or curriculum and some books just for resources, either old mathematics books, just to get an example from. For me to use these materials, that is my guide, that is what guide me to what I am going to teach. And the syllabuses is always where I am going to get my learning objective and my basic competency. This is why I use these two documents, the Integrated Planning Manuel and syllabus every day when I plan my lessons.

4. I do it in advance, if I am going to teach tomorrow, I prepare today. Like nowadays we use this weekly lesson plan, then like this week I planned already for the whole week. Daily, I just plan activities. I do a weekly overview first, plan my daily lessons. For this year, we did not yet start to plan together. We planned individually; the reason is simply that we did not come together yet to plan together. Usually we plan together. But we are thinking of planning together in order to teach the same topic and the same lesson on the same day.

5. Number sense is really what a child have to understand which number is this one. Maybe I say write number 2. For the child to know that number two is asking to give you 2 things… you are going to give me that two things. Saying what is really two. Number sense means then "how many."

6. Ja, number sense is needed for a child to know even because this you do it in everyday life, no matter you are walking, no matter you are cooking… every day you are using number sense. You can ask maybe from home to school how many houses do you pass to reach the school.

7. Ja, it develop also through play, through doing things at home such as when they are laying the table e.g. how often do you lay the table in a day, how many people are in the family and those things.

8. (*The teacher did not really understand this question well*). Number Concept Development and computation. Counting helps to develop number concept. If the child cannot even count, it is also impossible for her to know the numbers, either orally or recognizing this number is what – what.

9. Manipulating means to use concrete things such as sticks, stones, bottle tops, abacus.

10. Ja, especially in number concept. For them to know exactly when I am talking about number 5, this is 5 sticks or show them 5 counters in the abacus.

11. The teacher could not answer this question.

12. The teacher could not answer this question.

13. Place value is for a child to write the numbers at the right place, such as ones and tens. It is important to teach to teach place value in Grade 2 for the child even to know how to write a number and then, hmm… cause in Grade 2 we use to have our answers go up to either 20 – 30 and say 10 + 20 = 30. Then we are going to write these numbers at the right place. Ja,

place value, first I start with concrete objects. I put them in groups, I take 10 sticks and I count from 1 – 10 and then I say this is "one" and when we put it together, we call it eleven. And then, when it comes to writing, we are just going to write "one" and that zero you are not going to write it, now you write the 1 for units.

14. They will not even do well in mathematics for their whole life because the child need to have this background of mathematic. We understand the numbers at the early stage to grow up with that sense, otherwise there the things get to higher (*The teacher referred to the higher grades*), here we start really with the simple things. At Grade 4, they are really higher.

Teacher 2

1. Ja, I do. It gives one the chance to explore, to experiment, hmm… with all kinds of things. You are not limited to what to use or how to teach a certain activity. You can be creative in any way you want. You can use what you like as long as the learners understand the basic concept you want then to achieve. You can use songs, games, computer, objects, real objects.

2. Challenging is maybe keeping people on task. (*The teacher misunderstood the question first and had to be guided a little*). Money, because sometimes you explain but then sometimes learners don't grasp how to count money, especially when it comes to change and most of the time we don't really have real money to use in the classroom. Measurements sometimes also when it comes to meters, mass, also instruments to use, sometimes we don't have these.

3. Sometimes the syllabus, sometimes different resource books, sometimes if you have prescribed books you use that or you might find a resource book in which the activities are more appropriate than in the prescribed book and sometimes I also get my activities from the internet. I make a research on the internet to find appropriate activities for my class to do. I use these to guide me to come up with, not a perfect, but appropriate, easy going lesson or a lesson that will be easily understood by learners.

4. We do it weekly, but let's say if I teach mathematics today, but I did not obtain my basic competencies, I have to redo it. I have to re plan on that. Because it is weekly, we only do it at the end of the week. That gives me the chance to make changes on my lesson plan or approaches to help learners to master the skill. Sometimes when I don't understand a certain topic, I consult with my colleagues or sometimes my Head of Department to guide me on how

to go about this. And if I still cannot do it, I sometimes ask a colleague to come and assist me, but most of the time I plan it myself.

5. Number sense is for learners to be able to identify, to write or know different numbers. If you could mention a number, the child should perhaps get a picture of how a number look like or should be able to know how many a number is.

6. Number sense (*laugh*) is really important because of the different concepts we are teaching. If you know a number, you will be able to do measurements. All other concepts are related to numbers. You need to know numbers before you will be able to do other things e.g. time, measurements. All other skills in mathematics are related to numbers.

7. That is the environment… also it contributes. Sometimes it comes naturally before a child knows a number, né, a certain number name, a child can tell in his native language this is "two". It comes naturally, like you have body parts e.g. two fingers, as people talk e.g. pick up those two what – what… you will always have numbers in our day to day conversations with our kids.

8. Counting, identifying numbers, maybe number names, data handling. Because if you start with a specific topic, or maybe have to start with a song to get the children's attention and those songs are mostly based on numbers (*The teacher did not seem to understand this question.)*

9. Manipulative materials have o be changes, you cannot just be confined to one type of material. Abacus, sticks, stones, small number cards, food… to count with.

10. Yes, just to enhance learners' learning or maybe to make them to understand better. It is always good if they use things that they can touch or things they use on a daily basis.

11.

12.

13. Place value is like number are progressing… uhm… and as learners have to make computations e.g. adding and subtracting, learners have to know exactly with what numbers they are dealing with. The need to know what is the value of that certain number, why they put that number at that place and how much it is. You put number 11. There is one a number in front and a number at the back. The number in front is how many pieces of 10 or groups of ten. Another one is standing at the back, these are ones. We teach it in Grade 2 at the end of the year because when people are coming from the other side, it is a new topic they have to learn (*The teacher referred to Pre – Primary and Grade 1*). It takes time for them to understand this concept. Their number concept is not developed that much in Grade 1. I do it at the end of the year. I use sticks or small counters. I give and piece of paper and divide it into two columns, one for ten and another for ones. Then every time you as a child to count from 1 – 10 on the ones side. If they reach ten, they have to move ten counters to the ten side to represent a group of ten. I do this with several numbers.

14. It will influence negatively as learners tend to believe if they can't do a certain thing they are bad at it e.g. "I am not clever or smart enough to do math". If they believe they are not good at math, they don't know it, they will not try it. They need to be given that freedom to try math with their own manner.

Low Performing School 2

(*At this school only one teacher was observed, because the other Grade 2 teacher were absent for the whole week that the data were collected*).

Teacher 1

1. Yes, because me and the learners are enjoying math a lot. (*The answer given was not clear or audible*).

2. Geometry. Don't have clear information about how to teach it. I don't know how to teach it because the syllabus is not clear.

3. The scheme of work, the syllabus and also these books that we have. We use it because we want to go along with the ministry's guidelines.

4. We prepare it the day before. We do it with colleagues, all the Grade 2 teachers… we sit together and we plan together and we do it weekly, we do it also daily… a weekly overview and a daily lesson plan.

5. Number sense… (*The teacher did not really know*). Number concept is to know the number. The learners must know how to write the number, the learners must also know that this number is number 2 when she/ he write the number one way.

6. I think number concept is important because a person can't count without knowing numbers. He or she cannot count, put things together or cannot divide or multiply without number concept.

7. They develop numbers by seeing it and by writing it and by also … hmm… touching the concrete things.

8. To put this… the…example dots (*The teacher did not understand the question*). It is number concept development itself, computation… because we work with numbers and operation signs.

9. (*The teacher did not understand the word "manipulative". The researcher had to rephrase the question completely*). They are important because these small children, they learn by seeing and touching.

10. Yes. They like learning by seeing and touching and feeling things.

11.

12.

13. Place value, I think is the place of the numbers, for example, when we have number ten, we have two numbers, né, one is in the place of tens and zero in the place of units. When learners are not taught about place value in Grade 1 it can be a problem in Grade 2. Hmm… I give them examples, for example, I take two learners, like I talk about number ten. I put them in front of the class and say this learner is in the place of one and this one is in the place of zero. This one we call it a "ten" and this one we call it a "unit". I can also use a number line on the chalkboard and leave some numbers out. I call some learners to come and put those numbers in their places.

14. They cannot perform very well, because they… all the learning concept is poor. They find it very difficult to do mathematics at other grades.