An investigation of lower primary teachers' content knowledge of mathematics in Ohangwena region in Namibia

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ABSTRACT

The poor performance in mathematics of learners in schools in Namibia, especially in the grades where learners sit for the national examinations, has been a concern of everybody. Since independence, the Ministry of Education in collaboration with several donor agencies has been aware of the poor performance in mathematics in the country. Several international and local studies have been made in an effort to identify the problems that are hindering learners' performance in mathematics in Namibia.

The findings of some studies that were conducted in the country such as the Southern Africa Consortium Monitoring Education Quality (2004), the Presidential Commission on Education, Culture and Training (1999), and the Mathematics and Science Teachers Extension Program (2002) revealed that the inadequate proficiency of primary teachers in mathematics content could be responsible for learners' poor performance in mathematics.

This study, therefore, is aimed at investigating the mathematical proficiency of lower primary (LP) teachers in Namibia. The study used three instruments to collect data namely, a profile questionnaire – to collect teachers' demographic data, a proficiency test – to test their proficiency level of mathematics using the content of Grade 4 and 5 learners' mathematics syllabi and a semi-structured interview schedule – to get views about their own mathematics content knowledge, attitudes towards mathematics as well as problems that hinder effective teaching and learning of mathematics at LP phase. The study was conducted with 30 lower primary teachers from five primary and combined schools in the Ohangwena circuit of the Ohangwena region.

The study found out that: (1) the mathematical proficiency of LP teachers is below the Grade 7 Mathematics content. Most teachers are not able to solve the content of mathematics at upper primary (UP) phase. (2) LP education is receiving very little support from the Ministry compared to other phases. (3) There are no workshops or training courses organised for LP teachers. They do not receive enough textbooks and materials, their classrooms are overcrowded and teachers cannot pay attention to individual learners. (4) There is a dire need for LP Head of Departments (HODs) who are specialised at LP; most HODs for LP at

schools are not specialised in this area. When it comes to views about future content of mathematics that should be given to LP teachers in Namibia, respondents recommended that future LP teachers should have knowledge of mathematics up to at least Grade 10 but preferably up to Grade 12. They do not want to be restricted to LP mathematics, but would like to have a broader knowledge of mathematics content. This would make them more confident in solving their children's problems in mathematics.

Overall, participants recognised the value of mathematics and the role that it plays in society.

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DEDICATION

This thesis is dedicated to my first born, Grace Ndinelao Haufiku who was born during the first year of my study for this course, my girlfriend Miriam Ndatjoonawa Jacob as well my parents Hendrina Gottlieb and Christian Haufiku for their encouragement and unwavering support during my study. Without their support I could not have achieved this.

DECLARATION OF ORIGINALITY

I, AMON HAUFIKU declare that this assignment is my own work written in my own words. Where I have drawn on the words or ideas of others, these have been acknowledged using complete references according to Departmental Guidelines.

30 November 2008

(Signature and Date)

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ACRONYMS AND ABBREVIATIONS

ACE	Advanced Certificate in Education
BETD	Basic Education Teacher Diploma
BES	Basic Education Support Project
BODMAS	Brackets of Division, Multiplication, Addition and Subtraction
CMDE	Commonwealth Massachusetts Department of Education
DEAL	Diploma in Education for African Languages
ECP	Education Certificate Primary
ETSIP	Education and Training Sector Improvement Programme
GRN	Government of the Republic of Namibia
HPEC	Higher Primary Education Certificate
HOD	Head of Department
JS	Junior Secondary
JTED	Junior Teacher Education Diploma
LCE	Learner Centred Education
LP	Lower Primary
LPTC	Lower Primary Teachers' Certificate
M+1	Matric + One Year
MASTEP	Mathematics and Science Teacher Education Programme
MEC	Ministry of Education and Culture
MEd	Masters of Education
MoE	Ministry of Education
MBESC	Ministry of Basic Education, Sports and Culture
NCTM	National Council of Teachers of Mathematics
NEC	National Education Certificate
NHEC	National Higher Education Certificate
NIED	National Institute for Educational Development
NLSMA	National Longitudinal Study of Mathematical Abilities
NMI	Namibian Mathematics Institute
PCECT	Presidential Commission on Education, Culture and Training
PEC	Primary Education Certificate
PP	Pre-Primary

PTC	Primary Teachers' Certificate
UP	Upper Primary
SACMEQ	Southern African Consortium and Monitoring Education Quality
SS	Senior Secondary
TCE	Teaching Certificate in Education

CHAPTER ONE

INTRODUCTION AND BACKGROUND TO STUDY

1.1 INTRODUCTION

The aim of this study is to explore the mathematics content knowledge of selected lower primary (LP) teachers in Ohangwena region in Namibia.

This chapter provides an introduction to the study and explains its relevance. The chapter begins with the context of study and then gives the rationale for the study. Furthermore, it defines the research goals and methodology employed. Finally, the chapter gives an overview of the study.

1.2 THE CONTEXT OF STUDY

This study is primarily motivated by a concern for learners' poor performance in mathematics at upper primary, junior secondary and senior secondary phases.

After 18 years of independence, Namibia still faces challenges in the provision of quality teaching to achieve desired outputs in schools, especially in the area of mathematics. The average performance of learners in mathematics, especially in the national examinations for Grades 7, 10 & 12, remains unsatisfactory (Namibia. Ministry of Education [MoE], 2008).

Several studies were conducted in the country to investigate the proficiency of teachers and learners in mathematics. These include the Presidential Commission on Education, Culture and Training [PCECT] (Namibia. Ministry of Basic Education Sport and Culture [MBESC], 1999); the Mathematics Inquiry (Namibia. Mathematics and Science Teachers Extension Programme [MASTEP], 2002); the Southern Africa Consortium and Monitoring Education Quality [SACMEQ] (Namibia. MBESC, 2001; 2004); and the Basic Education Support project III [BES III] (Namibia. MoE, 2005; 2006a; 2007).

The Mathematics Inquiry (Namibia. MASTEP, 2002) report stated that the poor performance of learners in mathematics in Namibia is due to the teachers' inadequate content knowledge and skills of mathematics. Hence, it recommends revision of the curriculum for Basic Education Teacher Diploma (BETD) to focus equally on subject content knowledge and pedagogy (Namibia. [MASTEP], 2002).

Further, the Southern and Eastern Africa Consortium Monitoring Education Quality [SACMEQ] studies rated Namibia below other Southern and Eastern African countries in terms of both teachers' and learners' proficiency in mathematics (Namibia. MBESC, 2001; 2004). The SACMEQ studies have focused on the proficiency level of Grade 6 teachers and learners in mathematics in the Sub-Sahara Africa.

With an effort to improve learners' performance in mathematics, certain mathematics programmes were introduced in the country to address the content knowledge and skills of both teachers and learners in mathematics. These include the Mathematics and Science Teachers Extension Programme (Namibia. MASTEP, 2002), the Namibian Mathematics Institute [NMI] (Erwee, 2006) and the Basic Education Support Project III [BES III] (Namibia. MoE, 2005; 2006a; 2007).

Nevertheless, none of these programmes have addressed the content knowledge and skills of lower primary teachers. The MASTEP and NMI programmes were focused at junior secondary teachers, while the BES III project targeted Grades 1–4 learners in 6 out of 13 regions (Namibia. MoE, 2005; 2006a; 2007).

In my view, I think one of the problems of learners' poor achievement in mathematics lies with the poor content knowledge of lower primary teachers and that is why I decided to carry out this study.

Since MASTEP and NMI programmes did not benefit all teachers in the country, the Ministry of Education (MoE) through the Education and Training Sector Improvement Programme (ETSIP) embarked upon a consultancy project in mathematics to improve the content knowledge and skills of all teachers of mathematics from Grade 1 to 12 in the country (Namibia. MoE, 2006d).

1.3 RATIONALE FOR THE STUDY

Before I became an Education Officer for Mathematics in the National Institute for Educational Development (NIED), a directorate of the Ministry of Education, and also before I registered for an MEd course, I was interested as a teacher to do research in the area of lower primary (LP) education. In particular, I wished to establish the proficiency level of lower primary teachers in Namibia.

I was and still am very concerned about this because I concur with Burton (1991) that learners' future knowledge of mathematics as well as their perception about mathematics lies with LP teachers. They are the ones who should encourage learners to study mathematics and additionally they should inform learners about the importance of mathematics in the society.

There are quite a number of things that I have observed at LP phase and which I think might contribute to learners' poor achievement in mathematics in this country. These include:

- Lack of training – When I was a school teacher, I seldom found workshops or training courses organised for LP teachers.

- Teacher-Learner ratio – The imbalance of teacher-learner ratio between primary and secondary schools in Namibia also contributes to learners' poor achievement in mathematics. Currently, there are more learners per teacher at primary phase than at secondary. In my opinion, there supposed to be few learners per teacher at primary, especially at LP phase, because these learners are still at early stage of learning and would require more individual support from teachers to provide them with a "groundwork on which to build future mathematics learning" (Ma, 1999:117).

- Overcrowding of classrooms - Although officially the teacher-learner ratio at primary phase is 1:35, in practice this is not the case. Classes of 50–60 learners can be found, especially in the rural areas, and this makes it difficult for LP teachers to pay attention to individual learners.

- Classroom settings – In some rural schools, learners in the LP phase are taught under trees or corrugated iron.

Therefore, my aim in carrying out this study at LP phase was to:

- explore the knowledge of LP teachers in mathematics content;
- find out problems experienced by LP teachers in interpreting the revised LP mathematics syllabus;
- find out whether or not teachers teaching at LP phase have done mathematics at school;
- find out how often LP teachers attend workshops and/or training courses, especially for mathematics;
- establish attitudes of LP teachers towards mathematics; and finally
- find out about the admission requirements for students enrolling for LP education at colleges of education where mathematics should be among the subjects required.

This research will feed into my work and is very important for policy makers and curriculum developers, especially to the BETD curriculum developers, as it will provide insight into the lower primary teachers' proficiency levels of mathematics. I hope, therefore, that the findings of this research will be considered during the next cycle of the BETD curriculum reform process and also hope that the findings will inform some of the work in drafting a comprehensive strategic plan for the consultancy project in mathematics in Namibia (Namibia. MoE, 2006d).

1.4 THE GOALS OF RESEARCH

The goal of this research was to investigate lower primary teachers' knowledge of mathematics in selected primary schools in Namibia.

1.5 RESEARCH METHODOLOGY

This research was conducted within the interpretive paradigm. According to Cohen, Manion and Morrison (2000:180), an interpretive paradigm gives the researcher an opportunity to understand and interpret the world in terms of its actors. Three research instruments were used to collect data and these include:

- A profile questionnaire given to all 30 participants,
- A proficiency test consisting of 30 multiple choice questions, and
- Semi-structured interviews.

The study used both qualitative and quantitative approaches to analyse and interpret the findings of the data collected.

1.6 OVERVIEW OF THE STUDY

The thesis is organised into five chapters. Chapter 1 provides an overview of the thesis. In this chapter, the background of the study, the rationale, goals of the study and methodology employed are discussed. The chapter concludes with an overview of the whole thesis.

In Chapter 2, I have engaged with literature that deals with teachers' knowledge of the subject matter particularly primary teachers' knowledge of mathematics content.

In Chapter 3, I have outlined the research approach and design. Aspects dealt with in this chapter include the selection of the sample, the design of instruments, the research site, the piloting and refining of instruments. The approach used to analyse and interpret data, limitations and ethical considerations have been described in detail.

In chapter 4, the data collected through instruments mentioned in Chapter 3 were analysed and interpreted. The analysis and interpretations of findings were categorised according to the profile questionnaire, the proficiency test and interview schedules where emerging themes were used to analyse data.

In Chapter 5, a discussion of the findings is presented together with recommendations, implications and avenues for future research.

CHAPTER TWO

LITERATURE REVIEW

2.1. INTRODUCTION

The aim of reviewing the literature is to find out what has been previously researched to avoid duplication of studies (Mouton, 2001). In this chapter I have engaged with literature that deals with teachers' knowledge of the subject matter, particularly primary teachers' knowledge of mathematics content.

First, reports of local and international studies carried out in mathematics education in Namibia are investigated in this chapter. These include reports such as the:

- Presidential Commission on Education, Culture and Training (Namibia. MBESC, 1999);
- Mathematics and Science Teachers Extension Programme (Namibia. MASTEP, 2002);
- Southern Africa Consortium and Monitoring Education Quality (Namibia. MBESC, 2001; 2004);
- Basic Education Support [BES] project (Namibia. MoE, 2005; 2006a; 2007); and
- Education and Training Sector Improvement Programme [ETSIP] (Namibia. MoE, 2006d).

Second, researches carried in the field of teachers' knowledge of subject matter, particularly knowledge of mathematics content, were examined.

2.2. THE CONTEXT OF EDUCATION SYSTEM IN NAMIBIA

Mathematics in Namibia has been perceived as a difficult (Tjikuua, 2000) and masculine subject (Cohen, 1994; Namibia. Ministry of Education and Culture [MEC], 1993). Before independence the teaching and learning of mathematics as in other subjects was entrenched in a paradigm of 'Teacher Centred Education' (TCE) and 'rote learning' – teaching and learning of mathematics was done mainly through memorisation of concepts and procedures (Namibia. MEC, 1993; Namibia. MASTEP, 2002). During that time only few teachers, mostly whites, were qualified to teach mathematics and science subjects in Namibia (Cohen, 1994; Tjikuua, 2000).

After independence, the Government of the Republic of Namibia (GRN) adopted a reform policy in education known as *'Toward Education for All'* (Namibia. MEC, 1993). This policy looked at various issues concerning general education in Namibia. Among the priorities were the reform of school curriculum and the introduction of a new teacher-training programme known as Basic Education Teacher Diploma (BETD). The BETD is earmarked to prepare teachers of Grades 1 to 10 with professional insights, skills and subject knowledge (Ilukena, Alberts, Maasdorp and Lynd, 2000; Namibia. MoE, 2006b; 2006c).

The *'Toward Education for All'* requires learners to be self-reliant – to identify, analyse and solve problems on their own. With regard to teacher education, the policy expects teachers to develop new visions, new understandings and new commitments (Namibia. MEC, 1993). It also requires teachers to be proficient in their subjects and to respond actively to new situations. Above all, the policy expects teachers to commit to a paradigm of 'Learner Centred Education' (LCE) (Namibia. MEC, 1993; Squazzin & van Graan, 1999) whereby teaching and learning take place through understanding and own construction of knowledge.

The world view of mathematics in Namibia as in other countries has changed significantly from being a subject for those gifted in mathematics to a subject for all learners (Namibia. MEC, 1993; Tjikuua, 2000; Namibia. MASTEP, 2002).

'Toward Education for All' makes provision for compulsory mathematics up to Grade 10 (Namibia. MEC, 1993) so that by the end of Grade 10 which is an exit level, all learners should achieve the basic proficiency (knowledge and skills) in mathematics required for the job market.

Despite reform in teacher-training programmes and school curriculum, there are still many challenges facing mathematics education in Namibia. There is a remarkably low achievement of learners in mathematics as measured by the national examinations of Grades 7, 10 & 12

(Namibia. MBESC, 1999; MASTEP, 2002). Furthermore, MASTEP (2002) and PCECT (Namibia. MBESC, 1999) reports revealed that Namibian teachers have a limited knowledge of mathematics content, especially those teaching at lower and upper primary phases. Similarly, the SACMEQ I & II reports (Namibia. MBESC, 2001; 2004) revealed a lack of mathematical proficiency among Grade 6 teachers and learners in Namibia compared to other Southern African countries.

In my experience and according to the MASTEP (2002) report and the BETD Broad Curricular for both Pre-service and In-service programme (Namibia. MoE, 2006c; 2006d), the BETD Pre-service and In-service training programmes focus more on pedagogical knowledge than on the subject matter knowledge. The MASTEP (2002) report has discovered that although lower primary teachers have to teach all subjects including mathematics at lower primary phase, the lower primary curriculum at colleges of education does not count mathematics as an entry or pass requirement. There is no specific mathematics content designated for lower primary teachers at colleges of education in Namibia. This is of great concern because it is important that mathematics teachers should be proficient in mathematics content (Kilpatrick, Swafford & Findell, 2001).

In the next section, I discuss why it is important for lower primary teachers to have knowledge of mathematics content.

2.3. IMPORTANCE OF LOWER PRIMARY TEACHERS' CONTENT KNOWLEDGE OF MATHEMATICS

Lower primary teachers have an important role to play in the teaching and learning process of mathematics in schools. As the first teachers to engage learners with mathematics in schools, they are expected to do a number of things to ensure that learners are fully prepared to manage with existing and future knowledge of mathematics. They must develop the learners' foundation in mathematics through a proper selection and utilisation of content. Driscoll (2007) regards primary teachers as the front line of mathematics because of their huge responsibility of preparing students, parents, workers and future teachers across the world for the secondary grades, colleges, as well as for careers that require increasingly demanding levels of mathematical skill and thinking.

Lower primary teachers need to inform learners why mathematics is so important, why they need to study mathematics and what role mathematics plays in the society. Learners should have a clear understanding of the role of mathematics in society. By so doing, learners will develop an interest and love of mathematics. Burton (1991) cited that learners' interest and future knowledge of mathematics begins with their early exposure to and contact with mathematics as a subject at early grades. In addition, Driscoll (2007) claims that primary teachers must be well equipped with a firm knowledge of mathematics to be able to explain the content of mathematics in many different ways to learners. This would enable them to create learners' strong foundation in mathematics.

My argument in this particular research study is that teachers can only teach their subjects confidently and proficiently if they have enough content knowledge. Cruickshank, Bainer and Metcalf (1995) argue that teachers with an extensive knowledge of subject matter become more confident about using varied ways to communicate their subjects effectively to learners.

However, although this study focused on testing the content knowledge of teachers through the writing of the proficiency test, content knowledge is not the only determining factor in the achievement of learners. There are still many other contributing factors – see section 2.5.

In a study that was carried out by the Commonwealth Massachusetts Department of Education [CMDE] in USA, Driscoll (2007) learned that only 10% or less of the adult population in USA is skilful in mathematics and would be able to assist their children in mathematical activities. As a result, the CMDE came up with a proposal to improve the standard of elementary/primary teachers' knowledge of mathematics content (Driscoll, 2007). This proposal later turned into a policy that guides elementary teacher-training institutions in the CMDE on the standard of mathematics content required to train primary teachers for the 22nd century (ibid). The CMDE policy expects primary teachers to have knowledge of mathematics up to at least grade 8 with the following contents and their weightings:

- ✓ number concepts (45%),
- ✓ functions and algebra (25%),
- ✓ geometry and measurements (20%) and
- ✓ statistics and probability (10%)

(Driscoll, 2007).

This would enable them to understand and explain mathematical activities in multiple and logical ways to students.

In the next section I explore different types of knowledge required for teaching mathematics.

2.4. TEACHERS' KNOWLEDGE OF SUBJECT MATTER

According to Banner and Cannon (1997), a teacher's knowledge is fundamental to all instructions. A teacher should possess adequate knowledge of the subject matter to be able to apply its content in various contexts. Aubrey (1997) claims that knowledgeable teachers can easily link their subject content to the outside world by giving real life examples applicable to the learners' immediate environment. Teachers can only be effective in doing this with good content knowledge in their subjects. In addition, Cruickshank et al. (1995) claim that teaching with understanding enables learners to apply effectively what has been taught in the class. Learners enjoy and develop a love for the subject if the teacher has enough knowledge to teach the subject effectively and enthusiastically.

In the same vein Ma (1999) claims that in order to promote conceptual learning and to enhance learning capacity in mathematics classrooms, mathematics teachers should establish both the conceptual and procedural knowledge of mathematics. This will enable them to develop proficiency in teaching mathematics (Kilpatrick et al., 2001) and to manage changes or reforms in the mathematics curriculum (Ball, Lubienski & Mewborn, 2001; Namibia. MoE, 2006d).

Cooper and McIntyre (1996) echo similar sentiments by claiming that good pedagogical content knowledge enables teachers "to understand what it means to teach a particular topic as well as knowledge of the principles and techniques required to do so" (ibid:12). "Teachers must understand mathematics in ways that allow them to explain and unpack ideas ..." (Kilpatrick et al., 2001:37) to enable them to establish "a secure personal understanding of the structure and principles of what they are teaching" (Haylock, 2006: ix); and "to locate every piece of knowledge and its relation to previous knowledge in the whole mathematical system" (Ma, 1999:115).

2.5. TYPES OF SUBJECT MATTER KNOWLEDGE

Brown and Borko (1992); Cruickshank et al. (1995); Brown (2003); Hill, Schilling and Ball (2004); and Hill, Rowan and Ball (2005) identified three crucial knowledge categories required for teaching a particular subject content, that is, the *subject content knowledge,* the *pedagogical content knowledge and* the *curriculum knowledge.*

Subject content knowledge refers to how much knowledge of the subject matter a teacher has; and how such knowledge is organised in the teacher's mind (Hill et al., 2004; 2005). This simply means that for a teacher to be considered knowledgeable in a particular subject content that knowledge must be well organised to enable him to transfer it to learners.

Cruickshank et al. (1995) argue that the more a teacher knows his/her subject matter, the more confidence he/she will have in teaching that particular subject thus making it more understandable and enjoyable to learners. For instance, a teacher who understands the structure of mathematics is more likely to sequence mathematics lessons in a structural manner that will seem sensible to learners. A teacher with an extensive knowledge of subject matter would stimulate learners' interest of the subject by helping them to see what the subject entails, how its knowledge is being discovered and used, and how it relates to other subjects and the students' own prior knowledge (ibid, 1995:8). So, teachers with extensive knowledge of subject matter tend to be confident about developing their own teaching aids instead of relying on resources such as textbooks.

In addition to subject content knowledge, teachers also need *pedagogical content knowledge* - that is, knowledge of teaching a particular content effectively (Shulman, as cited in Hill et al., 2004; 2005). This type of knowledge does not necessarily depend on the subject matter knowledge.

I concur with Hill et al. (2004) and Hill et al. (2005) that pedagogical content knowledge is independent from subject content knowledge because someone might have extensive knowledge of mathematics content but lack knowledge of teaching; while on the other hand, someone with little content knowledge might teach mathematics effectively. But, it is an advantage to have extensive knowledge of subject matter so that you can be confident about adapting the content to suit learners of different abilities.

According to Hill et al. (2004) and Brown (2003), *pedagogical content knowledge* expects teachers to have extensive knowledge of using various teaching techniques, which depends on factors such as: the type of learners in the class – how capable they are; the class size – how big the class is; and the availability of resources such as textbooks and other teaching resources. If you are teaching a class of 40 learners, for example and there are only 20 textbooks for mathematics, it would be more appropriate to divide learners into pairs so that two learners can share one book.

Pedagogical content knowledge also refers to teachers' knowledge of the community – to establish parents' views about mathematics and to encourage them to assist their children in solving their homework. Parents need to be educated – to be informed about the importance of mathematics and the role it plays in society.

In addition to the two above-mentioned types of knowledge, that is *subject content knowledge* and *pedagogical content knowledge*, the teacher also needs knowledge of the *subject curriculum* (Hill et al., 2004; 2005). *Curriculum knowledge* refers to knowledge of the arrangement of topics within a school year program and over time, as well as the ways to use curriculum resources, such as textbooks, to organise a study program for students (Hill et al. (2005:376). This type of knowledge has to do with teacher's familiarity with the content of the subject in the syllabi as well as in the textbook. The teacher needs to have adequate knowledge of the subject matter to know, for example, how topics are spread and relate to each other in different grades – e.g. the relationship between topics such as *Measures* and *Mensuration* across the various grades.

Apart from the three crucial types of knowledge identified above, Cruickshank et al. (1995) extend the number of types of knowledge required for teaching to seven, to include:

- *general pedagogical knowledge*, that is knowledge of classroom techniques and strategies. This type of knowledge includes teacher's knowledge of classroom organisation – how to arrange chairs according to specific topic to be presented, knowledge of selecting an appropriate teaching method according to learners' ability and potential, the type of lesson to be presented plus many other general considerations required for effective teaching.

- *knowledge of learners and their characteristics* – this includes teacher's knowledge of learners' weak and strong points.
- *knowledge of educational contexts* – i.e. knowledge of school board politics and community; and
- *knowledge of educational ends, purposes and values* are among the additional four types of knowledge. These have to do with a teacher's knowledge of the aims, rationale and goals of education.

I concur with Shulman (as cited in Hill et al., 2004; 2005) that the three main types of knowledge (i.e. *subject content knowledge, pedagogical content knowledge and curriculum knowledge*) are crucial for effective teaching of a particular subject. However my argument is that it does not make sense if the teacher has knowledge of teaching (i.e. *pedagogical knowledge*) and knowledge of curriculum but lacks knowledge of subject content. *Subject content knowledge* in my view is the prime knowledge required by every teacher before *pedagogical* and *curriculum knowledge*. If a teacher lacks knowledge of subject content no matter how good is he at pedagogical and curriculum knowledge he will likely experience problems with the current changes in the subject content and he will not be confident, especially in contextualising the subject content to suit learners' immediate environments.

I agree with Ball (as cited in Brown & Borko, 1992) who argues that subject content knowledge is characterised by procedures that a particular person uses to solve problems in that particular subject. This means, for someone to be regarded as knowledgeable in a particular subject, that particular person is expected to have knowledge of subject content as well as knowledge of teaching methods for that particular subject.

In the next sections I concentrate on specific knowledge required for teaching mathematics and to investigate the impact of teachers' knowledge on learners' achievement.

2.6. TEACHERS' KNOWLEDGE OF MATHEMATICS

Mathematics teachers need a deep understanding and knowledge of the mathematics they are teaching to enable them to facilitate effective learning and development of skills to learners. Teachers with adequate content knowledge of mathematics are confident in making decisions such as how to organise and direct students' work, what questions to ask students at different levels of expertise, and how to support students without taking over the process of thinking for them (Brown & Borko, 1992). It is therefore important for teachers of mathematics to upgrade their knowledge and skills of teaching mathematics to enable them to meet the challenges of today's mathematics. However as teachers of mathematics we must also be prepared to learn from our students and colleagues and to engage in professional development and self-reflection (ibid).

In summary, teachers of mathematics should have adequate and well-organised content knowledge of mathematics to enable to teach it effectively to learners. In addition to subject mastery/content knowledge, teachers should have knowledge of teaching mathematics as well as knowledge of curriculum – to know how the content of mathematics spreads or grows from grade to grade and how topics link together. For example, before teaching the concept of "Division" learners need first to know how to multiply numbers together because division is a reverse of multiplication. To learn a new concept you always have to refer to what you have already assimilated or learnt.

In addition, teachers should have background knowledge of learners to ascertain their strong and weak points, as well as knowledge of the community in which they are living. Community involvement plays a vital role in the teaching/learning process. Teachers need to engage critically with parents to educate them about the importance of mathematics and the role that mathematics plays in the society. It is only when parents have noticed the importance of mathematics that they can encourage their children to study mathematics very hard (Hill et al., 2004).

2.7. TEACHING FOR MATHEMATICAL PROFICIENCY

Kilpatrick, Swafford and Findell (2001) used the concept of "*mathematical proficiency*" to examine and describe the types of mathematical knowledge required for teaching. According to Kilpatrick et al. (2001:369), "proficiency in teaching is related to effectiveness: consistently helping learners to learn worthwhile mathematical content". It enables teachers to work effectively with a wide variety of learners from different environments and across a range of mathematical content. Kilpatrick et al. further claim that teachers need to have a clear vision of the goals of instruction and what proficiency means for a particular mathematical content they are teaching (ibid, 2001:369). In essence, this simply means that teachers need to have knowledge of mathematics content for the grades they are teaching to enable them to teach it proficiently.

Kilpatrick et al. (2001) extend the idea of Cruickshank et al. (1995) to come up with what they termed as the *'five strands'* of proficient teaching in mathematics. They used these five concepts to describe different types of knowledge required for teaching mathematics. According to them, the five strands of proficient teaching in mathematics are: *understanding core knowledge, instructional routines, strategic competence, adaptive reasoning and productive disposition.*

a) Understanding Core Knowledge

According to Kilpatrick, et al. (2001), a teacher must have the conceptual understanding of the core knowledge required in the practice of teaching mathematics. This includes knowledge of integrated mathematics, knowledge of mathematical concepts integrated in other subjects, connections between topics, knowledge of using different teaching strategies for effective teaching and learning (i.e. pedagogical knowledge) and knowledge of how students' mathematical understanding develops - that is knowledge of theories of teaching and learning.

In relation to what Cruickshank et al. (1995) and others have identified, this type of knowledge involves subject content knowledge, pedagogical content knowledge as well as curriculum knowledge. In addition, the teacher needs to be acquainted with knowledge of teaching and learning theories of mathematics such as *behaviourist view of learning, constructivist view of learning and social constructivist and situated learning.*

b) Instructional Routines

This refers to classroom management routines such as how to get a class started each day; procedures for correcting and collecting homework should also be considered. Teachers should develop skills to interact and communicate with learners, for example, knowledge of how to respond to learners who give wrong or misconceived answers during instructional practices. They should know how to deal with students that lack critical prerequisite skills for the day's lesson (Kilpatrick et al., 2001:382). For example, *the behaviourist view of learning* believes that learning follows a logical sequence and that if a learner happens to miss or skip out one concept then it is difficult for him to catch up unless he restarts from the beginning (Copeland, 1984). It is therefore important for teachers to be acquainted with theories of teaching and learning for proper instructional practices.

c) Strategic Competence

Strategic competence has to do with teachers' decisions in planning instruction, implementing those plans and interacting with students. For example, teachers should figure out what to teach, how to teach it, when to teach it and how to adapt the teaching and learning material to suit the target group of learners.

Through conceptual understanding, teachers should decide what content of mathematics learners are supposed to learn; how best they can teach that content and how best learners can learn it; what learners already understand or do not understand, what activities to give to learners, etc (Kilpatrick et al., 2001:382).

d) Adaptive Reasoning

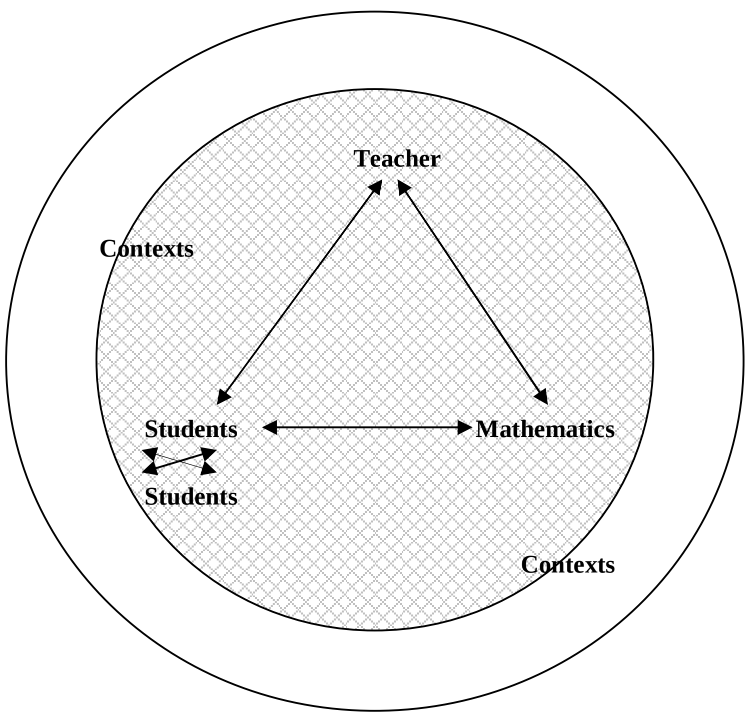
Adaptive reasoning has to do with teachers' realisation of teaching practices by analysing what difficulties students have encountered in learning a particular topic; what students have learned; how students respond to particular representations, questions, and activities, and the like (Kilpatrick, et al., 2001:383).

e) Productive Disposition

Productive disposition requires teachers to realise and make sense of the connection between mathematics, their understanding of children's thinking and their teaching practices. Teachers should also be capable of learning about mathematics, about learners' mathematical thinking as well as their own practice by analysing what goes on in their classes (Kilpatrick et al., 2001:384).

Instead of focusing only on the teacher and what he does as a source of teaching and learning, Kilpatrick et al. (2001) regard the teaching and learning of mathematics as the product of interactions between *the teacher*, *the students* and *the mathematics* (ibid:313). These three components form part of the instructional triangle (Figure 2.1).

Figure: 2.1. ***The Instructional Triangle:*** *Instruction as the interaction among teachers, students and mathematics, in contexts*



SOURCE*: Adapted from Cohen and Ball, 1999, 2000, in press as cited in Kilpatrick et al., 2001:314)*

Figure 2.1 above shows the interaction between the teacher (who plays the central role) and students, teacher and mathematics, students and mathematics as well as interaction between students themselves. But all three main components, that is the teacher, the student, and mathematics, depend upon a social dimension or the context into which the teaching and learning of mathematics takes place. A context can represent many things such as the:

- ✓ school environment – whether the school has adequate resources,
- ✓ community involvement in school activities – whether parents encourage children to study mathematics and also assist them with their homework
- ✓ curriculum – whether the teacher understands the curriculum he is using and if curriculum content is worthwhile or not, etc.

The development of learners' conceptual understanding of mathematical concepts and procedures that would even enable them to learn from each other would require mathematics teachers with adequate knowledge of mathematics content as well as knowledge of teaching the content of mathematics to students.

2.7.1. The Knowledge Base for Teaching Mathematics

According to Kilpatrick et al. (2001), the three crucial knowledge areas required for teaching school mathematics are *knowledge of mathematics*, *knowledge of students* and *knowledge of instructional practices* (ibid:370) (Figure 2.1).

i) Knowledge of Mathematics

Knowledge of mathematics includes knowledge of mathematical facts, concepts, procedures, and the relationship among them; knowledge of the ways that mathematical ideas can be represented; and knowledge of mathematics as a discipline, in particular, how mathematical knowledge is processed, the nature of discourse in mathematics, and the norms and standards of evidence that guide argument and proof (Kilpatrick et al., 2001:370–371).

In the same conceptual line Hill et al. (2005) define mathematical knowledge required for teaching as the knowledge required to carry out the work of teaching mathematics. Examples of mathematical knowledge required for teaching include knowledge of:

- ✓ explaining terms and concepts to students,
- ✓ interpreting students' statements of particular topics,
- ✓ using representations accurately in the classroom, and
- ✓ providing students with examples of mathematical concepts, algorithms, or proofs.

(Hill et al., 2005:373)

ii) Knowledge of Students and How they Learn

This refers to general and specific knowledge of mathematics expected from the teacher. For the former, the teacher is expected to know how various ideas develop in children over time while the latter expect teachers to have knowledge of determining where in a developmental trajectory a child might be. The teacher is also expected to be familiar with common difficulties that students have with certain mathematical concepts and procedures, as well as knowledge about learning and about the sorts of experiences, designs and approaches that influence students' thinking and learning (Kilpatrick et al., 2001:371).

In my view, this type of knowledge requires mathematics teachers to be familiar with theories of learning such as behaviourism, constructivism, social constructivism and situated cognition/learning.

iii) Knowledge of Instructional Practices

This type of knowledge requires teachers to develop a knowledge of curriculum, knowledge of tasks and tools for teaching important mathematical ideas, knowledge of how to design and manage classroom discourse and knowledge of classroom norms that support development of mathematical proficiency (Kilpatrick et al., 2001: 372).

2.8. TEACHERS' KNOWLEDGE OF MATHEMATICS AND ITS IMPACT ON STUDENT LEARNING

A large number of studies have been carried out to investigate the relationship between teachers' knowledge of mathematics and student learning. Although a large number of studies have been carried out in this area, Fennema and Franke (1992); Aubrey (1997); Hill and Ball (2004) and Hill et al. (2005) argued that researchers had given little evidence on the direct relationship between teachers' knowledge of mathematics and student learning.

Among the studies that have attempted to investigate the relationship between teachers' knowledge of mathematics and student learning, as pointed out by Fennema and Franke (1992), is the National Longitudinal Study of Mathematical Abilities (NLSMA) carried out by the School of Mathematics Study Group in 1972. The NLSMA used the number of mathematics courses taken by teachers and correlated them with student learning; however no important relationships were found in this study (Fennema & Franke, 1992). The same study was repeated by Eisenberg in 1977 and still got the same results (ibid). According to Fennema and Franke (1992), these studies, instead of attempting to measure what teachers knew about mathematics or to determine accurately the mathematics content covered in various courses completed, defined teachers' knowledge as the number of university-level mathematics courses successfully completed (ibid:148). And these were just proxy measures for knowledge as "little evidence was presented about how teacher knowledge was integrated or whether a relationship existed between university courses taken and classroom teaching" (ibid:148).

In addition, other studies have used standardised tests to measure teachers' knowledge of mathematics. However, they too have failed to "measure the complexity of teacher knowledge or the relationship between the formal mathematics that teachers knew and what they taught" (ibid:148).

In opposition to the NSLMA studies, a group of educational scholars such as Ball (1990); Shulman (1986); Wilson, Shulman, and Richert (1987) (as cited in Hill & Ball, 2004; Hill et al., 2005) argued that teachers' knowledge of mathematics is not only characterised by factors such as the number of courses taken, degrees obtained, or scores obtained in standardised tests but goes beyond that.

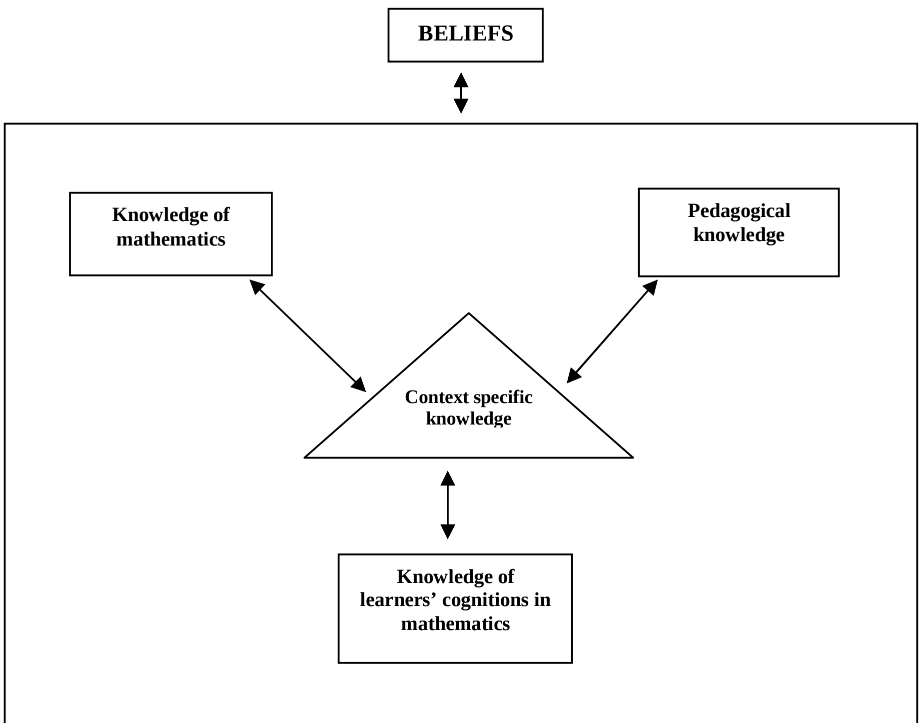
After several attempts by various researchers to investigate the direct link between teachers' knowledge of mathematics and student learning which ended up in failure, Fennema and Franke (1992) proposed a model for future research on teachers' knowledge of mathematics (Figure 2.2). According to them:

> Researching in teacher knowledge means more than investigating the number of mathematics courses teachers have taken or the procedural knowledge of mathematics they possess. Knowledge of mathematics teaching includes knowledge of pedagogy, as well as understanding the underlying process of the mathematical concepts,

knowing the relationship between different aspects of mathematical knowledge, being able to interpret that knowledge for teaching, knowing and understanding students' thinking, and being able to assess student knowledge to assess instructional decisions.

(Fennema & Franke, 1992:161).

Figure 2.2: A Model for Research on Teachers' Knowledge of Mathematics



Source: *Adapted from Fennema & Franke, 1992:162-163*

According to the model of Fennema and Franke (1992), Figure 2.2 above, there are certain issues that need to be taken into account when researching teachers' knowledge of mathematics. These include issues such as *knowledge of mathematics* – how is the conceptual understating of the teacher in mathematics? How does he carry out procedures and also solve problems in mathematics during instruction (Fennema & Franke, 1992:162)?

The other issue that has to be taken into account is also the *pedagogical knowledge* of the teacher which has to do with teacher's knowledge of procedures, e.g. effective strategies for planning, classroom routines, behaviour management techniques, classroom organisational procedures, and motivational techniques (ibid).

The third issue is the *teachers' knowledge of learners' cognition in mathematics* – the teacher should establish how students think and learn and how this occurs within the specific mathematics content (ibid).

Finally, the context or situation into which knowledge of instruction can be transformed to learners depends on the concepts or beliefs held by the teacher about mathematics, what learners have known and what they have to learn (ibid). Therefore, according to Fennema and Franke (1992), teachers' knowledge of mathematics cannot be separated from his beliefs about mathematics - meaning that teachers' beliefs contribute immensely to their knowledge of subject matter and also to their teaching practice.

I concur with Fennema and Franke (1992); Hill and Ball (2004); and Hill et al. (2005) when they argued that a teachers' knowledge of mathematics is not only determined by the number of courses he or she has taken or scores obtained from the standardised test. But there are many factors that contribute to learners' good or poor performance in mathematics as pointed out by Brown and Borko (1992); Cruickshank et al. (1995); Brown (2003); and Hill et al. (2004; 2005) in section 2.5.

However, a teacher who successfully passed many courses in mathematics content would likely be confident about interpreting the mathematics syllabi for the grades he teaches and could easily adapt the instructions and teaching materials to suit learners of different abilities.

Yes, I agree with what is indicated in the model of future research in teacher knowledge of mathematics as proposed by Fennema and Franke (1992), but the fact remains that to conduct a study that would consider all issues as indicated in this model would require a huge study that would make use of a variety of methods such as (i) classroom observation – to observe all the strands of proficient teaching mathematics as pointed out by Kilpatrick et al.(2001); (ii) standardised/ diagnostic test – to ascertain teachers' content knowledge of mathematics; (iii) perhaps an interview might also be necessary to establish what factors promote or limit effective teaching and learning, (iv) a questionnaire might also be employed to collect information relating to teachers concepts/ beliefs about mathematics, and many more.

I feel, however, that a study of this nature would probably require someone to cover a wide range of samples to be able to get comprehensive data in all areas as indicated or proposed in the model. This would also give an opportunity to generalise findings into an overall conclusion because what I have established from the previous studies such as Grossman (1990); Reinhardt and Smith (1985); Ball (1990); Borko, et al. (1992) (as cited in Hill et al., 2005) was that most studies that have been conducted in this field were case studies and the lack of generalisation was a main concern of their research.

As for my study I have only concentrated on one aspect of determining teachers' knowledge of mathematics through an achievement test to establish the proficiency of lower primary teachers in mathematics content in Namibia. And of course, teachers with extensive knowledge of mathematics are expected to outperform others; these are teachers that we expect to properly lay the foundation of learners in mathematics at lower primary phase.

Apart from giving teachers the proficiency test, I have also made use of a questionnaire to establish profiles of individual teachers in order to link these to their level of mathematics knowledge. In addition to the profile questionnaire I have also used the interview to establish teachers' beliefs about mathematics, mathematics teaching and mathematics knowledge.

2.9. CONCLUSION

In this chapter, I have firstly looked at the context of education system in Namibia from the colonial period up to the present, particularly in mathematics education. Secondly, I explored studies about the importance of lower primary teachers' content knowledge of mathematics. Thirdly, I looked at different types of subject matter knowledge required for teaching; and finally, I investigated studies conducted in the field of teachers' knowledge of subject matter to establish if there is a direct link or relationship between teachers' knowledge of mathematics and student learning.

Since most studies that were carried out in this field were case studies, there was surprisingly little evidence gained from them regarding the direct relationship between teachers' knowledge of mathematics and student learning; and there was no room for generalisation of findings from these studies (Hill and Ball, 2004; Hill et al., 2005).

Due to the inability to find concrete evidence on the relationship between teachers' knowledge of subject matter and student learning, Fennema and Franke (1992) came up with an interesting idea to advise future research studies on teachers' knowledge of mathematics. These include teachers' knowledge of mathematics, pedagogical knowledge, knowledge of learners' cognition in mathematics, beliefs as well as context specific knowledge.

Literature has indicated the need for teachers to be proficient in teaching mathematics. Proficiency in teaching is defined as relating to *effectiveness* – consistently helping learners to learn worthwhile mathematical content; and *versatility* – being able to work effectively with a wide variety of learners in different environments and across a range of mathematical content (Kilpatrick et al., 2001).

Finally, my investigation into the literature established that content knowledge, pedagogical knowledge and curriculum knowledge are the three crucial cognitions required for teaching any subject matter proficiently. However, the focus of this study was on teachers' content knowledge of mathematics.

In the next chapter I discuss the research design and methodology employed in this study.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

This chapter documents the research design and methodology followed in the study. It begins with the description of the goals of the research, the choice of paradigm and the research methods employed in the study. It then describes the research instruments used in the study, the sample design and sampling techniques, the data collection and fieldwork practices, the data capturing process and editing, and the procedures used in the data analysis.

Consideration is also given to issues related to validity and reliability as well as ethics, which are crucial features of the research. Finally, the chapter concludes by briefly stating the limitations of the present research.

3.2 RESEARCH GOAL

This study sets out to explore mathematics content knowledge of selected lower primary (LP) teachers in Namibia. This is primarily motivated by a concern of learners' poor performance in mathematics at upper primary, junior secondary and senior secondary phases. The study is conducted in primary and combined schools within the Ohangwena region in the northern part of Namibia.

3.3 THE CHOSEN PARADIGM

The study was conducted within an interpretive paradigm. According to Cohen et al. (2000), an interpretive paradigm gives the researcher an opportunity to understand and interpret the world in terms of its actors. It also enables the researcher "to understand and interpret daily occurrences and social structures as well as the meaning people give to the phenomena" (Kawana, 2007:24). According to Hodgskiss (2007), the goal of the interpretive paradigm is to "reach an understanding of some phenomenon that is not yet well understood" (ibid:38).

This paradigm is suitable as a framework for my study because I am interested in knowing and understanding as well as interpreting LP teachers':

- level of mathematics content knowledge and skills;
- perceptions of individual knowledge of mathematics;
- understanding of the revised LP mathematics syllabi – how they interpret it; and
- attitudes towards mathematics as a subject.

3.4 RESEARCH METHODS

This is a case study located in an interpretive paradigm. According to Panton (as cited in Kawana, 2007), "a case study enables the researcher to gather comprehensive, systematic and in-depth information about each case of interest" (ibid:25). This is exactly what I would like to achieve in my investigation. By making use of a test and semi-structured interviews, I wanted to be able to determine LP teachers' content knowledge of mathematics and get their views about their own mathematics content knowledge.

The study used a combination of qualitative and quantitative approaches to collect data. De Vos, Strydom, Fouche and Delport (2005) call this type of study a "mixed-method" study, because it requires the researcher to use multiple methods of data collection and analysis. The qualitative approach uses the semi-structured interview to collect data while the quantitative approach uses descriptive statistics to quantify and describe the data collected through the proficiency test.

Qualitative and quantitative data analysis approaches are discussed in more detail in section 3.9 that deals with the data analysis procedures.

In the next section, I will describe the research instruments used in the study.

3.5 RESEARCH DESIGN INSTRUMENTS

The study used three instruments i.e. a profile questionnaire, a proficiency test and semi-structured interviews. Actual copies of the instruments are appended (Appendices E, F and H).

These three instruments enabled me to triangulate and validate the findings of the study. In this case, the data collected through the profile questionnaire and interview schedule was used to triangulate the findings with the proficiency test in order to make informed interpretations. Cohen et al. (2000) and De Vos et al. (2005) describe triangulation as the method of using more than one instrument to collect data by using both qualitative and quantitative approaches. According to Cohen et al. (2000), triangular techniques enable the researcher to "map out, or explain more fully, the richness and complexity of human behaviour by studying it from more than one stand point" (ibid:112).

Moreover, Hitchcock and Hughes (1995) describe the concept of "triangulation" as

> helping the researcher to establish the validity of the findings by cross-referencing, for example different perspectives obtained from different sources, or by identifying different ways the phenomena are being perceived
>
> (ibid:323).

Campbell and Fiske (as cited in Cohen et al., 2000) on the other hand, describe triangulation as "a powerful way of demonstrating concurrent validity, particularly in qualitative research" (ibid:112). Similarly, Padgett (as cited in De Vos et al., 2005) describes triangulation in qualitative research as the "convergence of multiple perspectives that can provide greater confidence that what is being targeted is being accurately captured" (ibid:361). In addition, Jick (as cited in (De Vos et al., 2005) claims that triangulation "allows researchers to be more confident of their results" (ibid:362).

3.5.1 The Profile Questionnaire

I developed a questionnaire to collect teachers' demographic information (Appendix E). This enabled me to create a profile of each participant in the study. The profile questionnaire was structured as follows:

- **Personal particulars:** e.g. respondent's code, sex and age category.

- **School particulars:** e.g. school name, grade teaching, cluster, circuit and region.
  I also looked at issues such as the current grade that a particular teacher was teaching, number of years teaching in the current grade, number of years teaching at LP as well as number of years teaching at other phases.
- **Qualifications:** Here I concentrated on issues such as teachers' level of mathematics content knowledge, i.e. – the level a particular teacher achieved in mathematics, the highest grade passed and when it was passed, and a list of teaching and non-teaching qualifications.

3.5.2 The Proficiency Test

I developed a 30 question multiple-choice test to assess LP teachers' proficiency in mathematics (Appendix F). This test was adapted from the BES III instruments for assessing the proficiency level of Grade 4 learners in mathematics content in Namibia (Namibia. MoE, 2005; 2006a; 2007).

As the BES III tests assessed only mathematics content up to Grade 4 level, I included tasks that also assessed Grade 5 level.

Although it is a multiple-choice test, the instrument was developed in such a way that there was empty space left in each question for teachers to show their workings.

Because the aim of this instrument is to assess LP teachers' proficiency level in mathematics content, it was in my interest to construct test items that would test teachers' mathematical proficiency at different cognitive levels. In this case, I used the framework assessment of Bloom's Taxonomy of Cognitive Domain (Bloom et al., as cited in Keeves, 1990; Mason & Bramble, 1997; Chipeta, 1997) to set up test items of different levels of difficulty (Table 3.1).

According to Mason and Bramble (1997), Bloom's taxonomy is classified into a hierarchy of six categories or levels which range from simple to complex; each category is more complex and abstract than the previous category (Table 3.1). The six levels of Bloom's taxonomy of cognitive domains as classified by Keeves (1990), Mason and Bramble (1997) and Chipeta (1997) are: *knowledge, comprehension, application, analysis, synthesis and evaluation* (Table 3.1).

Table 3.1: *Bloom's Cognitive Domain of the Taxonomy of Educational Objectives classified by Keeves (1990), Mason and Bramble (1997) and Chipeta (1997)*

LEVEL	DESCRIPTION
L1 - Knowledge	• This is the lowest (first) level of learning outcomes in the cognitive domain, which has to do with remembering of previous learned material. • It involves the recall of wide range of material, from specific facts to complete theories, but all that is required is the bringing to mind of the appropriate information (Chipeta, 1997:246).
L2 – Comprehension	• According to Chipeta (1997), learning outcomes at this level go one step beyond remembering of material, that is, level 1. It has to do with the ability to grasp the meaning of material being taught. This may be demonstrated by translating material from one form to another e.g. from words to numbers, by interpreting material, explaining or summarising, and by estimating future trends or predicting consequences or effects. • Keeves (1990) subdivides comprehension into three sub-levels, namely: *'translation'* - ability to translate information from one form to another; *'interpretation'* - this requires someone to go beyond recognising the separate parts of a communication and to see interrelations among the parts; and *'extrapolation'* – that requires the receiver of communication to go beyond the "literal communication itself and make inferences about consequences or perceptibility to extend the time dimensions, the sample or the topic" (Keeves, 1990:345).
L3 - Application	• This is the third level of cognitive domain which refers to the ability to use learned materials in new and concrete situations (Chipeta, 1997). According to Chipeta (1997), this level may include application of judgement such as rules, methods, concepts, principles, laws, and theories. The "learning outcomes at this level require higher level of understanding than the one required by comprehension" (ibid:246).
L4 - Analysis	• Analysis has to do with the "ability to break down material into its integral parts, so that its organisational structure may be understood" (Chipeta, 1997:246). • This may include the identification of the parts, analysis of the relationships between parts, and recognition of the organisational principles involved. Learning outcomes here represent a higher intellectual level than comprehension and application because they require an understanding of both the content and then structural form of the material (Chipeta, 1997:246).
L5 – Synthesis	• This level has to with the "ability to put parts together to form a new whole" (Chipeta, 1997). • This may involve the production of a unique communication such as theme or speech, a plan of operations, research proposal, or a set of abstract relations like a scheme for classifying information. Learning outcomes in this area stress creative behaviours, with major emphasis on the formulation of new patterns or structures (Chipeta, 1997:246).
L6 - Evaluation	• This level is "concerned with the ability to judge the value of material such as a statement, novel, poem, research report, for a given purpose" (Chipeta, 1997). • The judgements are to be based on definite criteria. These may be internal criteria, organisational, or external criteria or other specific criteria given to the student. Learning outcomes in this area are highest in the cognitive hierarchy because they contain elements of all of the other categories, plus conscious value judgements based on clearly defined criteria (Chipeta, 1997:246).

In this study, I concentrated only on the first three levels of Bloom's Taxonomy of Assessment Domains i.e. knowledge, comprehension and application (Table 3.2). This is because I wanted to find out if teachers would be able to: (1) recall the content of mathematics previously learned (Chipeta, 1997), (2) translate information from one form to another – i.e. to interpret and extrapolate (Keeves, 1990), and (3) apply rules, methods, concepts, principles, laws, and theories (Chipeta, 1997) when answering test items.

Before constructing items/questions for the proficiency test, I used the 'Table of Test Specification' (Appendix G) to determine the number of items/questions to be set from each syllabus topic and to make sure that all topics in Grade 4 and 5 mathematics syllabi were fully covered by the instrument. Consideration was taken to ensure that each topic was fairly represented in the instrument according to the amount of content covered by the topic in the syllabus.

In summary, the following contents were assessed in the Proficiency test of LP teachers: Number concept, Measurement, Time, Geometry, Data handling and Problem solving (Table 3.2). For detailed information about the specific topic and subtopics assessed in the Proficiency test see Appendix G.

Table 3.2 *Contents Assessed in the Proficiency Test and their Levels of Difficulty*

CONTENT AREA	**BLOOM'S TAXONOMY ASSESSMENT DOMAINS**			**TOTAL**	**%**
	LEVEL 1 (Knowledge)	**LEVEL 2 (Comprehension)**	**LEVEL 3 (Application)**		
	No of questions	**No of questions**	**No of questions**		
Number Concept	5	4	2	**11**	**37%**
Measurement	1	1	1	**3**	**10%**
Time	1	1	2	**4**	**13%**
Money	1	1	0	**2**	**7%**
Geometry	2	1	0	**3**	**10%**
Data Handling	2	1	0	**3**	**10%**
Problem Solving	1	1	2	**4**	**13%**
Total # of questions	**13**	**10**	**7**	**30**	**100%**
Total percentages	**43.3%**	**33.3%**	**23.3%**	**100%**	

Table 3.2 describes the design of the proficiency test using the 'Table of Test Specification' (Appendix G). Teachers were assessed in seven content areas, i.e. number concept, measurement, time, money, geometry, data handling and problem solving. In total there were

30 questions in the proficiency test. More questions were taken from the number concept as represented by 37% in the table. When it comes to the difficulty level of questions, a large number of questions were taken from Level 1 (i.e. knowledge) that contributed 43.3% of the total number of questions in the instrument. The ratio of Level 1 to Level 2 to Level 3 questions is given by 13:10:7. This implies that a total of 13 questions were taken from Level 1, 10 questions from Level 2 and 7 questions from Level 3.

3.5.3 Semi-Structured Interviews

The interview is the predominant mode of data collection in case studies and qualitative research (De Vos et al., 2005; Fraenkel & Wallen, 1996). According to Cohen et al. (2000), "interviews enable participants – be they interviewers or interviewees – to discuss their interpretations of the world in which they live, and to express how they regard situations from their own point of view" (ibid:267).

In most case studies and qualitative research, interviews are used to triangulate the findings obtained from different sources of data (Cohen et al., 2000). According to Hitchcock and Hughes (1995) triangulation helps the researcher to establish the validity of the findings by cross-referencing different perspectives obtained from different sources, or by identifying different ways the phenomena are being perceived. Since my concern for this study is to use multiple methods to cross-reference the findings obtained from different sources and to validate the findings of the research, I decided to construct semi-structured interviews as the third instrument for this study (Appendix H).

In this case, I used a semi-structured interview to triangulate the outcome with the proficiency test. According to Hitchcock and Hughes (1995), the semi-structured interview is the most favoured instrument of educational researchers. This is because "it allows depth to be achieved by providing the opportunity on the part of the interviewer to probe and expand the respondent's responses" (ibid:154). Therefore, it is most appropriate to conduct semi-structured interviews toward the end of a study rather than at the beginning, as they tend to shape responses to the researcher's perceptions of how things are (Fraenkel & Wallen, 1996). On the other hand, Kawana (2007) claims that semi-structured interviews "allow respondents to talk freely about their experiences and feelings without the researcher losing track" (ibid:29).

In the interview dialogue I would be able to explore and understand, for example, why certain questions in the proficiency test were poorly answered.

The interview schedule was divided into two groups of five questions each. The first group consisted of general questions while the second group consisted of test specific questions. The general questions included things such as:

- LP teachers' perception of their own mathematics knowledge;
- their perception of knowledge of mathematics required for future LP teachers;
- any support received from school, circuit, region, etc., that strengthens their teaching of mathematics;
- their views on problems that can hinder effective teaching and learning of mathematics at LP;
- if there are some topics that they do not understand in the LP mathematics syllabus;
- their participation in workshops – how often do they attend workshops;

The test specific questions asked issues around the written test itself to establish teachers' perception of the test and the challenges they faced in answering the test.

The interviews were recorded on tape, with permission of all interviewees, and then transcribed.

3.6 THE SAMPLE

This section describes the sample and the criteria used in the choice of the sample.

3.6.1 Research Site and Sample Design

Before deciding on the research site and sample size of my study, I took into consideration factors such as expense, time and accessibility that in most cases prevent researchers from gaining information from the whole population (Cohen et al., 2000). I purposely selected to conduct my research study in primary and combined schools within the Ohangwena circuit in the Ohangwena region – see the map of Namibia, Appendix I. According to Cohen et al. (2000), purposive sampling enables researchers to build up the sample that is satisfactory to their needs. Moreover, Fraenkel and Wallen (1996) state that in purposive sampling, “researchers do not simply study whoever is available, but use their judgement to select a sample that they believe, based on prior information, will provide the data they need” (ibid:101).

I chose Ohangwena circuit because I know the location of schools and most of them are close to my hometown. I would thus not incur excessive travelling expenses during my fieldwork. The other reason why I chose this site is that I have taught in the Ohangwena circuit for many years and know most of teachers there. Therefore, I was confident that they would not hesitate to participate fully in my research.

3.6.2 Sampling Size and Sampling Techniques

Before deciding on the sample size I consulted my supervisor who advised me to involve 30 lower primary (LP) teachers in my study and interview approximately five of them.

Five (5) schools were then identified and letters requesting authorisation were written to the Director of Education, Inspector of Education as well as Principals of identified schools in the Ohangwena region (Appendix A and C).

The sample size was determined from the number of schools identified. Since 5 schools were identified, then on average 6 teachers were taken from each school. Participants who sat for the interviews were selected according to their performance in the proficiency test. I selected two participants with the best results, one in the middle and two with poor results.

3.7 DATA COLLECTION PROCESS AND FIELDWORK PRACTICE

This section explains procedures followed in the study to collect data. It gives details of the data collection process, including gaining access to the participants, data collection techniques and procedures used.

The fieldwork was completed in one week from 2–6 June 2008. The order in which data was collected was as follows:

- At each school, participants were gathered together at one point and given information regarding, amongst others, the purpose of study and procedures followed in data collection. This was followed by the completion of consent forms (Appendix D) and the profile questionnaires (Appendix E).

- To preserve anonymity and protect the participants' identity, each participant was given a unique number that was used throughout the study (see teachers' codes in Chapter 4, Figure 4.15). This number was used on the cover page of each document/instrument given to them, e.g. the consent form, profile questionnaire and the proficiency test.

After the completion of the consent forms and profile questionnaires, participants were given the proficiency test to write. The test was administered after learners had gone home. Teachers were requested to use their classrooms to write the test. The ideal plan was that all 30 participants had to complete the consent forms, profile questionnaires and proficiency tests before the five participants were selected to be interviewed.

Even though this was the ideal plan, I could not apply it during the actual data collection process. The one week period that I took for the fieldwork was insufficient. I initially interviewed the participants with the highest and lowest scores, and subsequently those with the middle score.

3.8 DATA CAPTURING AND DATA EDITING

This section discusses the procedures used in capturing the data. Here I am going to describe the whole process of data collection starting from piloting, refining of instruments and data collection for the main study.

3.8.1 Stage 1: The Pilot Study

De Vos et al., (2005) claim that:

> In order to undertake scientific research on a specific problem, the researcher should have thorough background knowledge about it. The pilot study is one way in which the prospective researcher can orientate himself to the project he has in mind.
> (ibid:205)

Piloting is an effective way of ensuring relevance, validity and reliability of designed instruments (De Vos et al., 2005; Fraenkel & Wallen, 1996).

The two instruments that were piloted in this study are the proficiency test and semi-structured interviews. The proficiency test was piloted twice while the interview schedule was only piloted once.

i) The Pilot Study 1

The first pilot was based on the proficiency test and it was done with three participants. Two of them are my brothers while the third one is my cousin with a Grade 12 certificate. The aim of piloting the proficiency test to the non-target group was to check for the language used and accuracy of test items to make sure that all participants interpret the test items in the same way (Mouton, 2001). This is one way of testing for validity and reliability of the test items.

After refining the first pilot I gave the test to my colleague who is an Education Officer for Lower Primary at NIED to find out if the test items are appropriate and relevant to lower primary teachers and if the test items were developed at an appropriate level of difficulty.

ii) The Pilot Study 2

After receiving feedback from my colleague, I decided to send the instrument to my friend who was doing a Masters degree in Education in Malaysia to proof read and answer all the questions. After receiving comments from her, I decided to pilot the test for the second time.

The second pilot study involved both the proficiency test and the interview schedule; it was done with LP teachers from one school in the near vicinity. These teachers each represented a particular grade at lower primary phase - that is, one teacher for grade 1, 2, 3 & 4. After the test, I purposely selected the grade 1 and 4 teachers for the interview.

The interview schedule was based on the proficiency test. The aim of this interview was to help me to establish an understanding of LP teachers' proficiency level of mathematics knowledge through probing and also by cross-referencing different perspectives obtained from the proficiency test, or by identifying different ways that LP teachers perceive the written test or perceive their knowledge of mathematics (Hitchcock & Hughes, 1995).

During the pilot study, the interview schedule consisted of 22 questions seeking demographic information and test-specific information.

3.8.2 Refining the Instruments after the Pilot Study

i) Refining the Proficiency Test

The following changes were made to the proficiency test after the two pilot studies:

- The instrument name was changed from a *Diagnostic test* to a *Proficiency test;*
- On the cover page, the National Coat of Arms of Namibia was replaced with Rhodes University Crest;
- The duration of the test was changed from 1 hour to 1hour 30 minutes to give them more time for answering;
- Instructions were modified to make it compulsory for teachers to show their workings;
- A consistent colour was shaded to a bar graph in question 11;
- The language was simplified to the level of LP teachers;
- The content was lowered to Grade 4 and 5 learners' mathematics syllabus. Some questions that seemed to be not from the grades 4 and 5 learners' mathematics syllabus were replaced with the appropriate ones. Difficult questions were also removed. For example, a question on the calculation of the *volume* of cuboid was replaced with the one that requires them to calculate the *area* of a rectangle.

- Confusing diagrams that were interpreted differently by different participants were replaced with appropriate ones. For example, during the first pilot study all participants confused a *parallelogram* with a *rhombus*. In this case, the diagram of the parallelogram was replaced with a diagram of a *kite.*

ii) Refining the Interview Schedule

Initially, I had only planned to use two instruments in this study - that is, the proficiency test and semi-structured interviews. The third instrument, which is the profile questionnaire, emerged after the pilot study. This was not piloted.

After the second pilot study I realised that I spent a lot of time interviewing the participants. I decided to minimise the interview schedule by creating a questionnaire that would collect demographic information of all participants in the study. But before doing that I informed my supervisor who then granted me the permission to do so. I then transferred all the demographic related information from the interview schedule to the profile questionnaire. Therefore, the profile questionnaire enabled me to establish a personal profile of each participant in the study.

3.8.3 Lessons Learnt from the Pilot Study

Pilot studies helped me to identify issues that seemed initially to be unclear to respondents or not well articulated. When you develop an instrument it is unlikely that you anticipate all the mistakes such as grammatical errors, flow of information and inconsistencies, etc. But all these can be identified once you give an instrument to somebody else for critical comment before it is piloted (Fraenkel & Wallen, 1996).

Piloting enhances validity and reliability of the developed instruments. It helps the researchers to refine their instruments and become more confident of their validity and reliability. According to Gay (1992), validity refers to the extent to which a test measures what it is supposed to measure. Reliability refers to consistency in achieving the same results when the instrument is applied on different occasions (Cohen, et al., 2000).

3.8.4 Stage 2: The Main Study

During the main study, no further modifications were made to the instruments; everything went according to plan, except for the sampling procedure and administration of interviews.

Although I initially planned to visit 15 schools altogether, I found myself visiting only five of them. This is because at almost every school I visited, all LP teachers wished to participate. This gave an average of six teachers per school (section 4.2.1, Table 4.1). Teachers were very enthusiastic about the research and everybody wanted to partake in the study.

Even though I was supposed to select interview participants according to their performance in the proficiency test, I decided not to do that anymore because I was uncomfortable with the ethical implications. I felt that voluntary participation, anonymity and confidentiality of participants were no longer protected. I felt that random sampling of the five interviewees would be more appropriate. I informed participants that the selection of interview participants would be done randomly after the test. The reason for doing that was to protect their identity as I had promised. No one should notice that teacher A was selected for the interview because he was the highest score or lowest score in the proficiency test. I therefore concur with Fraenkel and Wallen (1996) when they claimed that:

> It is a fundamental responsibility of every researcher to do all in his or her power to ensure that participants in a research study are protected from physical or psychological harm, discomfort, or danger that may arise due to research procedures.
>
> (Fraenkel & Wallen, 1996:39)

3.9 DATA ANALYSIS

This section discusses the rationale behind my selection of data analysis procedures as well as the actual procedures.

According to Fraenkel and Wallen (1996), data analysis in qualitative research deals with the synthesising of information obtained from various sources into a coherent description of what the researcher has observed or otherwise discovered. It involves “organising”, “accounting for”, and “explaining the data” (Hitchcock and Hughes, 1995:139; Cohen et al., 2000:147). In essence, data analysis helps the researcher to make sense of data “in terms of the participants’ definitions of the situation, noting patterns, themes, categories and regularities” (Cohen et al., 2000:147). It therefore helps the research to move away from “a description of *what is* the case to an explanation of *why* that is the case” (Hitchcock and Hughes, 1995:139).

3.9.1 Data Analysis Procedures

The order in which the data was analysed is as follows:

- First, the data was analysed according to the instruments used – starting with the profile questionnaire, the proficiency test and then ending with the interview schedule.

- Second, I analysed the data collected by cross-referencing through different sources to establish an understanding of the phenomena. In this case, the data collected through the profile questionnaire and interview schedule was used to triangulate with the outcome of the proficiency test.

i) Analysis of the Profile Questionnaire

The data collected through the profile questionnaire was analysed using both quantitative and qualitative approaches. The Quantitative data analysis approach made use of descriptive statistics - using measures of central tendency and frequency distribution tables and/or charts to organise and interpret data. The qualitative data analysis format made use of "domain analysis" – that is, identifying units and grouping them into "domains", "groups", "patterns", "themes" and "coherent sets to form domains" (Cohen et al., 2000:149).

The profile questionnaire was analysed according to the following identified themes or domains. These themes are explained in more detail in chapter 4 as well.

- *Distribution of participants by sex, age group, school and cluster;*
- *Distribution of participants by grade and years of teaching*
- *Distribution of participants by qualifications*
- *Distribution of participants by areas of specialisation*

ii) Analysis of the Proficiency Test

The analysis of the proficiency test followed this order. This will also be explained in more detail in chapter 4.

- *Analysis by individual/group*
- *Analysis by age category*
- *Analysis by teaching experience*
- *Analysis by mathematical knowledge*
- *Analysis by qualification*
- *Analysis by specialisation*
- *Analysis by questions*

iii) Analysis of the Interview Schedule

The analysis of interview schedules followed the following themes. This will be explained in more detail in chapter 4.

- *Their own views of mathematical knowledge and competency/proficiency*
- *The way they have been assigned to the current teaching (maths)*
- *Their views of upgrading their own mathematical knowledge*
- *Their perceptions of the test*

3.10 VALIDITY AND RELIABILITY

Fraenkel and Wallen (1996:153) define validity as it refers to the "appropriateness", "meaningfulness" and "usefulness of the specific inferences researchers make based on the data they collect". Cohen et al. (2000) on the other hand, regard validity as the basic and fundamental key to effective research in both the qualitative and quantitative research. According to them, in qualitative research, validity is concerned with issues such as "honesty, depth, richness and scope of the data achieved, the participants approached, the extent of triangulation and the disinterestedness or objectivity of the researcher"; while in quantitative research it is related to issues such as "careful sampling, appropriate instrumentation and appropriate statistical treatments of the data" (ibid, 2000:105).

In this study the validity of my findings was supported by the following factors:

a) The choice of instruments:

I used three instruments to collect, analyse and interpret the findings of the data. This made it possible for me to triangulate the findings of data collected from different sources and make appropriate inferences.

b) The design and content of instruments:

The proficiency test had covered enough content measuring different cognitive levels of understanding. During the construction of the proficiency test, I used the three fundamental factors of Gay (1992) and Mason and Bramble (1997) to determine the validity of the test. These were content validity, construct validity, and predictive validity.

♦ *Content validity*

According to Gay (1992:156), content validity refers to the “degree to which the test measures an intended content area” and “requires both item validity and sampling validity”.
I think the content of the proficiency test was valid enough because it covered all the themes/topics in the Grade 4 and 5 mathematics syllabi for learners and had enough sampling items measuring different cognitive levels of understanding,

♦ *Construct validity*

Construct validity refers to the “degree to which a test measures an intended hypothetical construct” (Gay, 1992: 156). This study did not use a hypothesis, but it was prompted by the findings of the reports of MASTEP (Namibia. MASTEP, 2002) and PCECT (Namibia. MBESC, 1999) that lower primary teachers in Namibia lack the content knowledge of mathematics.

Although this was a multiple-choice test, it allowed teachers to show their workings before choosing the correct answer, but not just to tick out the correct answer.

♦ *Predictive validity*

Predictive validity refers to the “degree to which a test can predict how well an individual will do in a future situation” Gay (1992:159). In this case, the predictive validity of the study will give a clear picture of how the test results will be if taken in a bigger sample. According to Gay (1992), “if a test is to be used for prediction, then it is important to compare the description of the manner in which it was validated with the situation in which it is to be used” (ibid:159). In essence, if teachers are given regular training in the content areas tested during the study, then we could probably expect an improvement in their teaching.

c) The choice of participants:

Although this was a case study, I think the sample was appropriate enough to cater for both internal and external validity. In this case, the outcome of this study could give directions to future research regarding teachers’ knowledge of mathematics, particularly LP teachers in Namibia.

A sample of 30 teachers was appropriate for this study so that I could apply different approaches to data analysis using both qualitative and quantitative approaches.

Although more females were represented in the study than males (Chapter 4, section 4.2.1), this was not through bias of the researcher, but was due to the fact that more female teachers were found teaching at lower primary.

iv) The piloting of instruments:

The designed instruments were piloted: for example the proficiency test was piloted twice to check, amongst others, the language, relevance of the content and accuracy of the test items. The development of the profile questionnaire made it possible to cross-reference, for example, teachers' marks obtained from the test could be compared with their level of mathematics knowledge indicated in the proficiency test.

According to Gay (1992:161), reliability refers to "trustworthiness" – that is the "degree to which a test consistently measures whatever it measures". This means that if the same test could be administered to the same group, then a likely expectation is that the same results would be achieved. Mason and Bramble (1997) and Cohen et al. (2000) on the other hand, defined validity as the extent to which an instrument measures what it supposed to measure.

In this study, the reliability of the proficiency test was underlined by the same scores being obtained from both the pilot study and the actual study; while validity was underlined by content representation and piloting of the test. In addition, interview questions were validated by similar responses being obtained from both the pilot and actual study.

3.11 ETHICAL RESPONSIBILITIES

Ethics has to do with what is right and what is wrong (Fraenkel & Wallen, 1996; Cohen et al. 2000). It is the sole responsibility of the researcher to make sure that participants are fully protected by not revealing information that leads to exposure of their identity. According to Fraenkel and Wallen (1996), the most important ethical consideration of all is that the researcher should protect participants from any harm – (see section 3.8.4 for more details).

To ensure that ethical practices, which are an essential component of case studies, are followed in this research, I did the following:

- I wrote a joint letter to the Director of Education: Ohangwena region and the Inspector of Education: Ohangwena circuit (Appendix A) requesting permission to conduct my research in selected schools within the Ohangwena circuit. In the letter, I indicated my capacity and responsibility in the MoE, the rationale for doing this study, the goals of the research, the target group, the sample size, research site and criteria used in selecting the study sample as well as criteria for selecting interview participants.

  I also indicated the usefulness of the study by stating that the study would make valuable contributions to the ongoing project of Education and Training Sector Improvement Programme (ETSIP) which aims to strengthen the content knowledge and skills of mathematics teachers in the country. I promised to keep the identity of the clusters, schools and teachers anonymous. I also invited them to proofread drafts of the research report to ensure that details were accurately recorded and reported. In addition, I explained the purpose of conducting the research, namely, to fulfil the requirements of the MEd (Mathematics Education) programme I was pursuing at Rhodes University, Grahamstown.

- After having received an approval letter from the Director (Appendix B), I wrote another letter to Principals of the 15 identified schools (Appendix C) informing them about the selection of their schools to partake in the study. A copy of the approval letter from the Director was appended (Appendix B). The context, the rationale and the target group were all mentioned in the letter to give them background information on the study.

- In his approval letter, the Director requested me to provide a copy of my final thesis to be archived in their library for perusal

Participation in this study was voluntary and teachers had to complete the consent forms (Appendix D) before participating in the study.

3.12 LIMITATIONS

This was a case study and one cannot extrapolate its findings to the whole population of Namibia. However, the study can guide future research studies in the field of teachers' mathematics knowledge, particularly LP teachers.

The particular focus of this study was on LP teachers' content knowledge of mathematics. However, there were certain sensitive issues that emerged from the data as it was being collected. These were regarded as confidential limitations for this study because I cannot discuss them.

The other limitation was that I could not visit all the 15 schools as per the initial plan, due to the situation developing beyond my control. At almost every school I visited, all teachers wanted to partake in the study. This left me with no option but to let them partake. This was advantageous to me, especially on travelling expenses, as I only had to visit five schools instead of 15.

3.13 CONCLUSION

This chapter began with the statement of the research goals indicating the particular focus of the study. It then orientated the study in the interpretive paradigm and discussed the methodology used in this study. The chapter also discussed the approach or methods (i.e., qualitative-quantitative) used and research design instruments (i.e., proficiency test, profile questionnaire and interview schedule) employed in the study. Validity, reliability and ethical issues pertaining to the development of instruments were also discussed.

Other issues such as research sample, data collection and fieldwork practices, data capturing and data editing as well as approaches to data analysis were also discussed in this chapter. Insights into some of the limitations were also considered.

The next chapter discusses the collection, analysis and interpretation of the data.

CHAPTER FOUR

DATA ANALYSIS AND INTERPRETATION OF FINDINGS

4.1 INTRODUCTION

This chapter documents the results of the fieldwork. The analysis of data and interpretation of findings in this chapter was done according to the following order, as described in detail in Chapter 3:

- Firstly, I analysed and interpreted the data collected through the profile questionnaire;
- Secondly, I analysed and interpreted the data collected through the proficiency test; and
- Thirdly, I analysed and interpreted the data collected through the interview schedule.

The study was framed by the interpretive paradigm to analyse and interpret the findings of data collected. The analysis of data in this chapter used both qualitative and quantitative formats to analyse and interpret the findings of the data collected through the profile questionnaire, proficiency test and interview schedule. The quantitative data analysis format used frequency distribution tables and/or charts while the qualitative format generated themes to analyse and interpret the findings.

The data collected through both the profile questionnaire and interview schedule were used to triangulate with the findings of the proficiency test.

4.2 ANALYSIS OF PROFILE QUESTIONNAIRE

This section describes the data collected through the profile questionnaire. The demographic data collected through the profile questionnaire were clustered into themes and interpreted. The analysis and interpretation of data collected through the profile questionnaire were done according to the following order:

1. *Distribution of participants by sex, age group, school and cluster;*
2. *Distribution of participants by grade and years of teaching;*
3. *Distribution of participants by qualifications;*
4. *Distribution of participants by areas of specialisation.*

4.2.1 Distribution of Participants by Sex, Age Group, School and Cluster

This section presents participants' data in terms of sex, age category, school as well as the cluster centres to which their schools belong.

The study involved altogether 30 lower primary (LP) teachers, 5 males and 25 females. These teachers were taken from 5 schools among the 15 schools from the Ohangwena circuit that were contacted and showed interest in partaking in the study. Table 4.1 shows the pseudonyms of schools which participated in the study and cluster centres to which they belong. More schools were taken from cluster centre 1 than cluster centre 2. In essence, cluster 1 had more representatives than cluster 2. The average number of teachers participating in the study per school was 6, while the average number of teachers per cluster was 15.

Table 4.1 *Number of Participants Accepted per School*

School Name	**Number of Participants**	**Cluster Centre**
Odidiya PS	7	Cluster 1
Ohameva PS	5	Cluster 2
Okapundja PS	6	Cluster 2
Olupandu CS	6	Cluster 1
Omelekeshe CS	6	Cluster 1
Total	**30**	**2**
Average	**6**	**15**

Participants were categorised into 6 age categories/groups namely, 24–29 years, 30–35 years, 36–41 years, 42–47 years, 48–53 years and 54–60 years (Table 4.2). One third of the total number of participants, which constituted the majority of participants per age group, belonged to the lowest age group, i.e. 24–29 years. There was only one participant from the last age group. The average number of participants per age group was 5.

Table 4.2 *No of Participants per Age-Group*

Age Group	24–29 Years	30–35 Years	36–41 Years	42–47 Years	48–53 Years	54–60 Years	**Total**	**Average**
Number of Participants	10	3	4	8	4	1	**30**	**5**

4.2.2 Distribution of Participants by Grade and Years of Teaching Experience

This section collected teachers' information regarding the grades they were currently teaching as well as the grades or phases that they had taught previously.

i) Number of Teachers per Grade

Teachers who took part in this study were those teaching Grades 1 to 4 only (Table 4.3). As shown in Table 4.3, 8 teachers taught Grade 1, 11 taught Grade 2, 8 taught Grade 3 and 3 taught Grade 4. So, Grade 2 had more representatives than the rest of the grades. The average number of teachers per grade is 8.

Table 4.3 *Number of Teachers per Grade*

Grade Teaching	1	2	3	4	**Total**	**Average**
Number of Teachers	8	11	8	3	**30**	**8**

ii) Number of Years Teaching for the Same Grade

Table 4.4 represents the number of years taught in the same grade. The number of years taught in the same grade ranged from 1 to 18 years. In essence, this indicates that some teachers have been teaching the same grade for many years. For example, 3 teachers had taught the same grade for 18 years; while 10 teachers, which constitute the majority, taught the same grade for 2 years. The average number of years taught in the same grade is 6.

I started to ask myself whether teachers who had taught the same grade for more than 17 years had ever taught other grades at lower primary or had just been confined to those grades.

Table 4.4 *No of Years Teaching at the Same Grade*

											Total	**Average**
No of years teaching the same grade	1	2	3	4	5	7	9	10	13	18	**170**	**6**
No of teachers	2	10	2	3	4	2	1	2	1	3	**30**	

iii) Number of Years Taught at Lower Primary (LP)

Table 4.5 represents the number of years teachers had taught at lower primary phase. From the table, the number of years that teachers taught at LP ranges from 2 to 27 years of teaching. One-sixth (i.e. 5 teachers) of the total number of participants, which form the majority, had taught at LP phase for 2 years while 1 teacher had taught it for 27 years. The average number of years taught at LP is 9.

Table 4.5 *No of Years Taught at Lower Primary*

																Total	**Average**
No of Years Taught at LP	2	3	4	5	7	8	9	10	12	16	17	18	20	24	27	**269**	**9**
Frequency	5	2	3	3	3	3	1	2	1	1	1	2	1	1	1	**30**	

iv) Teachers' Experience of Teaching at Other Phases

Table 4.6 represents LP teachers' information regarding their experience of teaching at other phases. From the table, three (3) teachers had taught at pre-primary, 14 at upper primary and 4 junior secondary phases. None had taught at senior secondary phase.

Table 4.6 *Other Phases Taught by the LP Teachers*

Phase of Study	Pre-Primary	Upper Primary	Junior Secondary	Senior Secondary	**Total**
No of Teachers	3	14	4	0	**21**

Table 4.6 raised many potential questions. Twenty-one teachers in the study indicated having had experience of teaching at other phases and only 9 teachers from the total sample had not taught at other phases before. I was surprised and wondered whether these 21 teachers had undergone training for lower primary education or whether they were just transferred from their previous phases to LP due to reasons only known to them.

However, during an interview with teacher No. 4 (T04) and 5 (T05), I established that these two teachers had been transferred from upper primary to lower primary phase due to certain reasons, even though they have been teaching in UP for some time. Below is the interview conversation with them individually:

I: To start out, when I scrutinised your 'profile questionnaire' I have established that you have taught for more years at upper primary (UP) than at lower primary (LP). And in addition to that, UP is your area of specialisation. But you are now teaching at LP. Why? What drives you from UP to LP phase?

T04: Although I have been teaching at UP for many years, the new teaching structure does not allow me to teach there anymore because of the level of my qualification [NEC] and that is why I end up teaching at lower primary phase. And currently, I'm enrolling with BETD In-Service, but specialising at lower primary.

When I asked T05 the same question, this is what she told me:

I: When I scrutinised your 'profile questionnaire' I have established that you have taught for 27 years and only 2 of them have been teaching at lower primary (LP) phase. The rest of the 25 years you have been teaching at upper primary (UP). What happened? Or why did you shift from UP to LP, where you have been teaching for many years?

T05: Oooo! No! I had health problem.
I: Ok! So, they moved you to lower primary due health problem?
T05: Yes

4.2.3 Distribution of Participants by Qualifications

Under qualifications, I looked at teachers' level of mathematics knowledge, level of academic qualification, years of academic qualifications and professional qualifications.

i) Teachers' Level of Mathematics Knowledge

Teachers were asked to indicate their highest level of mathematical knowledge, that is the highest grade or level they had achieved in mathematics. Table 4.7 shows their responses for level of mathematics knowledge.

Table 4.7 *Teachers' Level of Mathematics Knowledge*

Level of Maths Knowledge	Lower Primary	Upper Primary	Junior Secondary	Senior Secondary	Tertiary	**Total**
Frequency	6	3	8	4	9	**30**

From Table 4.7, it can be seen that 9 teachers indicated that they only did mathematics up to the end of the primary phase, while the rest had done it either up to secondary phase or tertiary level. According to this table, a large number of teachers have done mathematics at tertiary level compared to junior and senior secondary phase respectively. Only 9 teachers out of 30 have indicated done mathematics at primary phase.

ii) Teachers' Level of Academic Qualification

Teachers were also asked to indicate their highest grade passed (Table 4.8). From Table 4.8, one teacher indicated a Grade 5 pass while the rest indicated passes in Grade 10 or 12.

Table 4.8 *Highest Grade Passed*

Grade Level	Grade 5	Grade 10	Grade 12	**Total**
Frequency	1	3	26	**30**

By considering information supplied in Tables 4.7 and 4.8 it might leave us with a reasonably high expectation of teachers' performance in the proficiency test.

iii) Years of Academic Qualification

Teachers were also asked to indicate the actual years in which they had achieved their highest academic qualifications. This information was necessary to find out how long it had been since these teachers were in school. This information would also help me to triangulate with the results of the proficiency test.

Table 4.9 *The Actual Years Teachers Passed Highest Grades*

Year	1974	1980	1983	1986	1987	1988	1993	1995	1996	1997	1999	2000	2001	2002	**Total**
Frequency	2	1	2	1	1	3	3	1	6	1	2	4	2	1	**30**

Table 4.9 represents the distribution of years that teachers passed their highest grades.
From the table, the distribution of years ranges from 1974 to 2002. Some teachers passed their highest grade as early as 1974, the year I was born. My concern is, do these teachers still remember after such a long period the content of mathematics taught to them while in school? In my view, this could only be possible if teachers participated in some in-service training programs, e.g. attending workshops or seminars.

In an interview with T04, T05 and T30, I established that lower primary teachers were indeed neglected; very little attention was given to them compared to the attention given to upper primary, junior and senior secondary teachers. There is a clear lack of materials and textbooks, and no workshops or training courses were organised for them. At some schools there were no specialist LP Heads of Departments; in the schools where there were HODs for LP, they were neither specialised at LP nor teaching there; they were just placed there for the sake of filling the post, it appears.

When I asked T04 when last she attended a workshop or training for LP, she replied: “since I started teaching Grades 3 and 4, I can’t remember having attended any workshop for LP”.

On the question of whether they had an HOD for LP at school, she told me that they did have, but the HOD did not teach at LP and she never assisted them with their problems, especially in Mathematics as she had not specialised either in mathematics or at LP.

This exposed a very big problem in the way that LP education was being treated in Namibia. In my view, more emphasis should be given to LP teachers in terms of both continuous professional and curriculum development. If learners cannot achieve the expected basic competency while at lower primary then it will be difficult for them to link what they have learned at lower primary with senior grades.

Therefore, it is very important to continually upgrade LP teachers with adequate knowledge of mathematics so that they can teach the same knowledge to the young generation. This was confirmed by Driscoll (2007) in Chapter 2. The future knowledge of learners in mathematics depends on LP primary teachers. Therefore, as Driscoll (2007) claimed, lower primary teachers have a huge responsibility to ensure that learners’ future knowledge and of mathematics is properly developed.

iv) Professional Qualifications

In this section, I wanted to establish different types of professionals or teaching qualifications that the teachers had enrolled in. My focus was to trace the number of teachers enrolled through the Basic Education Teacher Diploma (BETD). This is because I knew that before independence, the majority of teachers were either unqualified or under-qualified. But after independence, the majority of them had enrolled through the BETD Pre- and In-service training programmes. I wanted to find out whether there were some LP teachers who were still under-qualified and/or unqualified. I also wanted to establish the different types of courses taken by teachers within different periods.

To obtain the above mentioned information regarding teachers' professional qualifications, I used the following themes to categorise their professions:

- *First teaching qualification* – the first teaching qualification obtained by the teacher;
- *Second teaching qualification* – the second teaching qualification obtained by the teacher;
- *Third teaching qualification* – the third teaching qualification obtained by the teacher; and
- *Fourth teaching qualification* – the fourth teaching qualification obtained by the teacher.

Table 4.10 represents the first, second, third and fourth teaching qualifications obtained by particular teachers. These qualifications are given in an abbreviated form as they are usually known like that. Very few teachers even know what these abbreviations stand for (acronyms and abbreviations are listed on p. xiv).

Table 4.10 *Teaching Qualifications Obtained by Teachers*

1st Qualifications	**Fr**	**2nd Qualifications**	**Fr**	**3rd Qualifications**	**Fr**	**4th Qualifications**	**Fr**
BETD	20	ACE	3	ACE	1	BETD	1
ECP	3	BETD	3	BETD	2		
HPEC	1	ECP	1	DEAL	1		
LPTC	1	JTED	1				
M+1	1	PEC	1				
NEC	2	SEC	1				
NHEC	1						
PTC	1						
Total	**30**		**10**		**4**		**1**

As we can see from Table 4.10, the first qualification was achieved by all 30 teachers, while second, third and fourth qualifications were only achieved by 10, 4 and 1 teacher respectively.

In the 1st qualification column, 20 teachers are BETD holders while 3 and 2 teachers came to obtain their BETD qualifications as second and third qualification respectively. This implies that at first these teachers had some qualification/s and as time went by they decided to upgrade their qualifications through BETD In-service training. In total, 26 out of 30 teachers have achieved a BETD qualification; presumably the majority of them did it through the In-service training (Table 4.10).

Apart from the teaching qualifications, five teachers among the total number of 30 teachers had enrolled through other professional development courses such as secretarial courses, office administration courses, etc. (Table 4.11). In total five teachers had enrolled through other professional courses.

Table 4.11 *Non-Teaching Qualifications*

Non-Teaching Qualifications	**Frequency**
Computer Skills	1
Diploma in Development Studies & Management	1
Secretarial Diploma	1
Certificate in Child-Care and Basic Nutrition	1
Certificate in Office Administration	1
Total	**5**

4.2.4 Areas of Specialisation

Teachers were also asked to indicate the area of specialisation for their qualifications. Table 4.12 gives the list of subjects in which teachers have specialised.

Table 4.12 tells us that there were some teachers who were teaching at lower primary phase but were not specialised there. This was indicated by the subjects and levels where these teachers had majored or specialised. For example, 4 teachers had specialised in upper primary mathematics, 2 in social sciences, 1 in commercial subjects Grades 8–10, 1 in languages, etc.

Table 4.12 *Specialisation of Subjects*

1st Specialisation	**Fr**	**2nd Specialisation**	**Fr**	**3rd Specialisation**	**Fr**
Commerce Grade 8–10	1	Education Management	2	African Languages	1
Eng, Math & Religious	1	Environmental Ed	1	Languages	1
Junior Secondary	1	Junior Secondary	1	Lower Primary	2
Languages Grade 5–7	1	Lower Primary	4		
Lower Primary	14				
Math + Science Grade 5–7	4				
Social Sciences Grade 5–7	2				
Upper primary	2				
Total	**26**		**8**		**4**

In my view, this can also impact or affect learners' achievement, especially in mathematics, because they are taught by teachers who are not really trained to deal with young children. And some of these teachers especially those that did not specialise in mathematics might have negative attitudes towards mathematics and/or experience problems of teaching it. Therefore, in my view, it is important for lower primary learners to be taught by teachers who have undergone LP training or specialised in primary mathematics teaching.

4.3 ANALYSIS OF THE PROFICIENCY TEST

This section interprets the outcome of the proficiency test in two different formats. I used both the quantitative and qualitative approach to analyse and interpret the findings of the proficiency test. These two approaches were used interchangeably.

The combination of qualitative and quantitative data analysis approach enables the researcher to justify the findings of the data collected through a process of triangulation.

The analysis of the proficiency test was done in the following order:

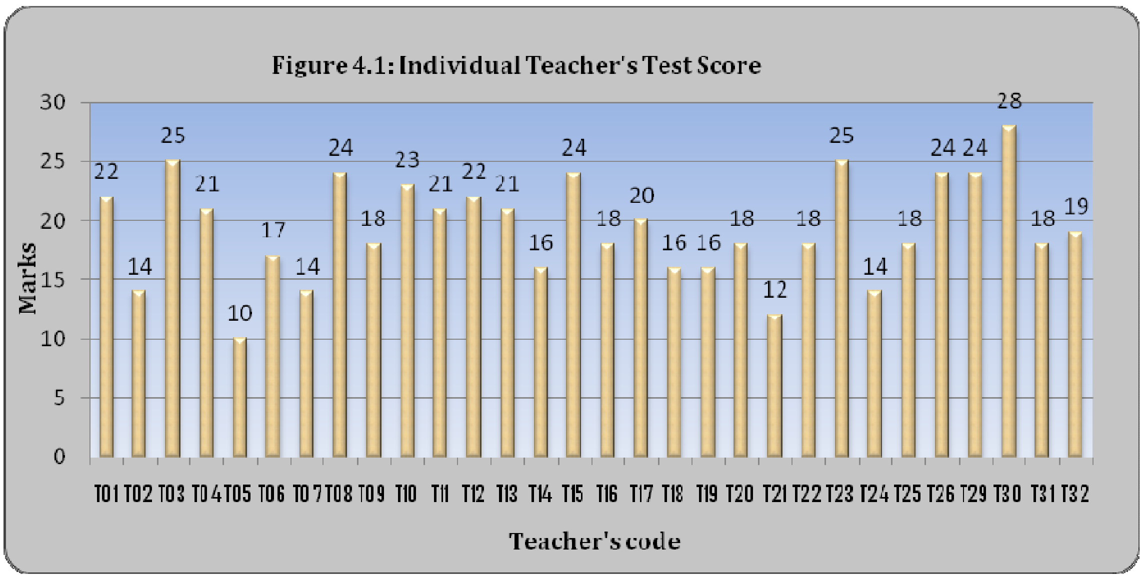
1. ***Analysis of test results by individual participant:*** - *analyse test results by individual participants.*
2. ***Analysis of test results by age category:*** - *analyse test results by age group/category.*
3. ***Analysis of test results by teaching experience:*** - *analyse test results by years of teaching experience to find out whether there is correlation between teachers' number of years of teaching experience and their performance in the test.*
4. ***Analysis of test results by teachers' level of mathematical knowledge:*** - *analyse test results by teachers' level of mathematics knowledge to find out whether there is a correlation between teachers' level of mathematics knowledge and their performance in test.*
5. ***Analysis of test results by qualification:*** - *analyse test results by teaching qualifications held by teachers to find out whether teachers with high qualifications outperform others or vice versa.*

6. ***Analysis of test results by specialisation:*** *- analyse test results by teachers' areas of specialisation to find out whether teachers who specialised in mathematics and science outperform others or vice versa.*

7. ***Analysis of test results by individual questions:*** *- analysis of test results by individual question, considering the number of correct and wrong answers given per question.*

4.3.1 Analysis of Test Results by Individual Participant

In this section, the test results were analysed according to individual teacher's performance. Figure 4.1 represents the graph of individual teachers' scores in the proficiency test.



From the graph it is clearly seen that T05 received the lowest score in the proficiency test with 10 marks out 30, while T30 achieved the overall highest score with 28 marks out 30.

Although the overall performance of teachers appeared good as seen in the graph (Figure 4.1), this did not impress me because the content of this test was taken from the lower grades (i.e. Grade 4 and 5 learners' Mathematics syllabi). Therefore, a better performance than this was anticipated.

4.3.2 Analysis of Test Results by Age Category

Here an analysis was done to measure the performance of teachers in terms of age. Due to sensitivity of personal particulars such as age, I insisted that if they were unwilling, it was not compulsory for participants to give their actual ages when asked to do so. To overcome that I decided to come up with a group/category for age where participants had to indicate the age group into which their ages fall. Teachers' ages were categorised into 6 age categories (Table 4.13).

Table 4.13 *Comparing Teachers' Performance by Age Category*

Age group	24–29yrs	30–35yrs	36–41yrs	42–47yrs	48–53yrs	54–60yrs	**Total/Avg**
Frequency	10	3	4	8	4	1	**30**
Average score	21.7	19.3	17	16.9	18.5	28	**20.2**

From Table 4.13, a third of the teachers belonged to the age group of 24–29 years, which constituted the majority of participants in the study. Although this age group seemed to have more representatives than others in the study, I established that teacher's knowledge of subject matter was not commensurate with his or her age. No matter how young or old the teacher was, if he or she had good conceptual understanding of subject matter, then he could still perform well regardless of age. This was proven by the recipient with the overall highest score of the proficiency test who scored 28 marks out of 30. This top score belonged to the only teacher in the study in the age group of 54–60 years.

4.3.3 Analysis of Test Results by Teaching Experience

Teachers' experience of teaching was categorised into three groups namely: experience of teaching in the current or same grade, experience of teaching at lower primary as well as experience of teaching at other phases (Tables 4.14, 4.15 and 4.16 respectively).

Table 4.14 represents the average score obtained per number of years taught in the current grade.

Table 4.14 *Average Score Obtained per Number of Years Taught in the Current Grade*

Years Taught for Current Grade	1	2	3	4	5	7	9	10	13	18	**Total/Avg**
Frequency	2	10	2	3	4	2	1	2	1	3	**30**
Average score	20	21.1	20	17.3	20.3	16	18	18	16	18	**18.5**

From this table, the highest score linked to the number of years taught in a particular grade was achieved by 10 teachers who had an average score of 21.1 marks out of 30 and who had only 2 years of teaching experience. This was followed by those teachers with 5, 1 and 3 years of teaching respectively. The total average performance for this table was 18.5 marks.

Table 4.15 represents the average score obtained per number of years taught at lower primary.

Table 4.15 *Average Score Obtained per Number of Years Taught at Lower Primary*

Years Taught for LP	2	3	4	5	7	8	9	10	12	16	17	18	20	24	27	**Total /Avg**
Frequency	5	2	3	3	3	3	1	2	1	1	1	2	1	1	1	**30**
Average score	22.8	22.5	17.3	21.3	20	17.3	18	18	28	16	14	16	22	17	10	**18.7**

The highest score for this table was achieved by 1 teacher with an average score of 28 marks out of 30; he had 12 years of teaching experience. This was followed by those with 2 years of teaching experience with an average score of 22.8 marks. The total average score for this table was 18.7 marks.

Table 4.16 indicates the average score obtained per number of years taught at other phases. The highest score for this table was again from the same teacher with 12 years of teaching experience followed by 1 teacher with 3 months (0.25 years) of teaching at other phases. The total average score for the table is 18.5 marks.

Table 4.16 *Average Score Obtained per Number of Years Taught at Other phases*

Years Taught for Other Phases	0.25	1	2	3	4	7	9	10	12	13	**Total/Avg**
Frequency	1	3	2	1	1	2	1	1	1	3	**16**
Average score	24	17.3	15	12	10	17.5	21	21	28	18.7	**18.5**

What I established from the three tables above (i.e., Tables 4.14, 4.15 and 4.16) is that there was a marked difference between teachers' performance in terms of years of teaching experience. On average teachers between 0 and 13 years of teaching experience performed better than those with experience of more than 12 years. In my view, this is because teachers with more years of teaching experience might have forgotten some of the concepts they have learned in school after so many years.

4.3.4 Analysis of Test Results by Teachers' Level of Mathematical Knowledge in Terms of Latest Grade

Here I wanted to find out whether there is a link between teachers' knowledge of mathematics and their performance in the test. Table 4.17 represents teachers' levels of mathematical knowledge in terms of their latest grade. The finding of this table was that there was correspondence between the teachers' highest level of mathematical knowledge and the test results. In essence, this implied that teachers with a higher level of mathematical knowledge would consistently obtain highest scores in the test. In this case 9 teachers did mathematics at tertiary level and they achieved the highest score with an average of 22.7 marks.

Table 4.17 *Average Score per Level of Mathematical Knowledge*

Level of mathematics knowledge	LP	UP	JS	SS	T	**Total/Avg**
Frequency	6	3	8	4	9	**30**
Average score	16.7	20.3	16.4	21	22.7	**19.4**

4.3.5 Analysis of Test Results by Qualifications

Analysis of test results by qualification looked at issues such as highest grade passed as well as the first, second and third qualification achieved.

i) Comparison of Test Results by the Highest Grade Passed

Table 4.18 represents the highest grade passed by teachers. There is a slight difference between the average scores obtained by grade 5 and grade 12 teachers.

Table 4.18 *Comparing Teachers' Performance by Highest Grade Passed*

Highest Grade Passed	Grade 5	Grade 10	Grade 12	**Total/Avg**
Frequency	1	3	26	**30**
Average Score	18	15.3	19.8	**17.7**

ii) Comparison of Test Results by the Qualifications Achieved

Although the majority of teachers obtained BETD as their first, second and third qualification, they performed far below other graduates enrolled through qualifications that are regarded lower than BETD such as HPEC, NHEC, ACE, JTED and DEAL (Tables 4.19 and 4.20).

Table 4.19 *Comparison of Test Results by the Second Qualification Achieved*

2nd Qualification	ACE	BETD	ECPI	JTED	PEC	SEC	**Total/Avg**
Frequency	3	3	1	1	1	1	**10**
Total score	65	42	18	21	20	14	**180**
Average score	21.7	14	18	21	20	14	

Table 4.20 *Comparison of Test Results by the Third Qualification Achieved*

3rd Qualification	ACE	BETD	DEAL	**Total**
Frequency	1	2	1	**4**
Average score	21	16	20	**19**

In my view, although BETD is regarded as the basic teaching qualification for Grades 1–10 teachers in Namibia, it seemed that it prepared teachers with a shallow understanding of mathematics. This was proven by the outcome of the proficiency test in tables 4.19 and 4.20 where the performance of the BETD holders was overshadowed by teachers with other qualifications that are considered lower than BEDT in terms of accreditation by the Namibia Qualification Authority.

4.3.6 Analysis of Test Results by Areas of Specialisation

In Table 4.21, teachers who had specialised in Mathematics and Science or Mathematics and Languages at upper primary phase performed slightly higher than those who had specialised at lower primary phase. In my view, this is because these teachers were exposed to higher level of mathematics content compared to those specialised at lower primary phase.

Table 4.21 *Comparison of Test Results by Areas of Specialisation*

SPECIALISATION	FREQUENCY	AVERAGE SCORE
Commerce 8–10	1	19
Languages 5–7	2	18
Lower Primary	16	18.7
Math & Science 5–7	4	22.8
Math & Language	1	28
Social Studies 5–7	2	19
Upper Primary	2	17
Junior Secondary	2	17.5
Total	**30**	**160**
Total Average Score		**20**

4.3.7 Analysis of Test Results by Individual Questions

In this section, I looked at the performance of teachers in the proficiency test in terms of questions, for example, how many teachers got the correct answer for question 1, etc? By so doing, I made use of the frequency distribution table to analyse and interpret the result of the proficiency test. This helped me to establish whether a certain question was well, moderately or poorly answered.

The data collected through the interview schedules were triangulated with the results of the proficiency test to validate my findings and also to make appropriate inferences.

Due to space constraints of a half thesis, I did not report on all 30 questions in the proficiency test. However, I reported on 10 questions based on the performance of teachers (Table 4.22).

I used the following criteria to select the 10 questions for interpretations: I took 6 questions that were poorly answered, 2 questions that were moderately well answered and 2 questions that were well-answered. The following themes were generated and used to report the findings of the selected questions:

A: Poorly answered questions *- referred to questions scored below 40%. In this case, I took questions 7, 8, 9, 16, 27 and 30 (Table 4.22);*

B: Moderately well answered questions *- referred to questions that were scored between 50% and 60%. Since there were many questions in this category, I decided to take questions 2 and 10; while*

C: Well answered questions *- referred to questions scored 80% and above. Again, since there were many questions in this category, I decided to take questions 1 and 5.*

Table 4.22 represents the number as well as the percentage of teachers who obtained the correct answers to each question. Although the overall performance appeared good, this did not impress me at all because the test items were taken from the content of Grade 4 and 5 Mathematics syllabi for learners. Therefore, teachers were expected to have performed better than they have.

Table 4.22 *Percentage Scored Per Question*

Question No	Correct Answer	No of teachers obtained the correct answers	Percentages
1	D	30	100
2	B	16	53
3	A	23	77
4	A	18	60
5	B	29	97
6	D	16	53
7	D	8	27
8	C	9	30
9	C	3	10
10	B	17	57
11	C	25	83
12	D	25	83
13	C	26	87
14	B	26	87
15	D	16	53
16	A	8	27
17	C	23	77
18	C	27	90
19	C	23	77
20	D	18	60
21	C	12	40
22	D	26	87
23	C	23	77
24	D	25	83
25	C	28	93
26	A	14	47
27	B	8	27
28	B	25	83
29	B	26	87
30	A	7	23
Average number or % of teachers obtained the correct answers		**19**	**64**

The analysis and interpretations of test results remained the same for all 10 selected questions and was done in the following manner:

- ***Question:*** **-** *What was the question all about? State the question exactly as it was stated in the proficiency test.*
- ***Topic / Sub-Topic:*** **-** *From which topic and sub-topic was question taken?*
- ***Grade Level:*** **-** *From which grade is the content of the question taken? Is it taken from Grade 4 or 5 syllabus?*
- ***Letter with the correct answer:*** - *Which letter carries the correct answer*
- ***Leve1 of Difficulty:*** - *Here I used the first three levels of Bloom's Taxonomy mentioned in Chapter 3 Table 3.2 to determine the item of difficulty.*
- ***Expectations:*** - *What was expected from the teachers? How were they supposed to answer the given question? Were they expected to show some workings? How were they supposed to show or demonstrate their understanding?*
- ***Analysis of Solution Strategies:*** **-** *How many teachers attempted and/or did not attempt the question? Which distracters were predominantly chosen? How did they choose the correct answer - was it by chance or through conceptual understanding? Is there evidence of conceptual understanding and/or procedural fluency? Did they demonstrate their understanding of concepts through showing of works?*

A: POORLY ANSWERED QUESTIONS

Questions that were poorly answered in the proficiency test included question 7, 8, 9, 16, 27 and 30 (Table 4.22). Below is the analysis and interpretation of findings of the poorly answered questions:

- **QUESTION 7**

List ***all*** the **prime numbers** between 0 and 20	**Show your workings**
A 1, 2, 3, 5, 7, 9, 11, 13, 15, 17, 19 **B** 1, 3, 5, 7, 9, 11, 13, 15, 17, 19 **C** 3, 5, 7, 9, 11, 13, 15, 17, 19 **D** 2, 3, 5, 7, 11, 17, 19 ✓	

Topic: Number concept

Sub-topic: Types of numbers - Prime numbers

Grade level: Grade 5 syllabus

Letter with the correct answer: D

Level of difficulty: Level 1 – Knowledge

Expectations: No calculation required. Teachers were expected to have conceptual understanding of different types of numbers to enable to select a letter with the correct answer.

Analysis of solution strategies: This question was poorly answered and only 29 out of 30 teachers attempted the question; one teacher did not select anything. Table 4.23 represents the teachers' choices for the correct answer in question 7.

Table 4.23 *Teachers' Choice of Answer to Question 7*

Distracters	**A**	**B**	**D**	***Total***
Frequency	9	12	8	**29**
Percentage	30	40	26.7	**96.7**

In total, 29 teachers attempted the question. 9 of them chose letter A, 12 chose letter B while 8 chose letter D. Although D is the correct answer, 40% of them chose B as the correct answer.

During the analysis of this question I discovered that the majority of teachers lack the conceptual understanding of prime numbers. However, T15 and T26 demonstrated a better conceptual understanding of prime numbers by stating the following statements in the provided working space to supplement their answers, which were of course correct.

T15	T26
"Each of these numbers is divisible by 1 and by itself."	"Numbers divided by 1 and itself only without a remainder e.g. $2 \div 1 = 2$, $2 \div 2 = 1$."

However, I do not know what went wrong with T26 because even though he had shown good conceptual knowledge of prime numbers, he chose a wrong answer, i.e. letter A.

T04 also demonstrated a good conceptual understanding of numbers. During our interview, this is what she explained to me about how she chose the correct answer to question 7:

> T04: Prime numbers are those numbers divisible by 1 and itself only. So when I was checking among the list of given answers [distracters] I found that these are odd numbers, these are even numbers, [pointing to the list of distracters] so then I realised that these are the prime numbers.

- **QUESTION 8**

Calculate: $4 \div \frac{1}{2}$	Show your workings
A 2 **B** $\frac{1}{8}$ **C** 8 ✓ **D** $\frac{1}{2}$	

Topic: Number concept

Sub-topic: Operations with fractions

Grade level: Grade 5 syllabus

Letter with the correct answer: C

Level of difficulty: Level 3 – Application

Expectations: Here teachers were expected to show their workings and to demonstrate their understanding of division of common fractions. They were expected to demonstrate that, for example, $4 \div \frac{1}{2} \Rightarrow 4 \times \frac{2}{1} = 8$. This is because division in the concept of fractions is the reverse of multiplication.

Analysis of solution strategies: Although teachers were required to show their workings, only some did that. 28 out of 30 teachers attempted the question while two teachers did not attempt it at all. Table 4.24 represents the teachers' choice of the letter with the correct answer to question 8.

Table 4.24 *Teachers' Choice of Answer to Question 8*

Distracters	**A**	**B**	**C**	**D**	***Total***
Frequency	14	4	7	3	**28**
Percentage	46.7	13.3	23.3	10	**93.3**

Unlike question 7 where the choice was only between three distracters here the choice was between four distracters. 46.7% of teachers chose A as the letter with the correct answer, while the correct answer was in letter C.

Below are the workings of some selected teachers who did show their workings:

T15

$$\frac{4}{1} \div \frac{1}{2}$$
$$= \frac{4 \div 1}{2}$$
$$= \frac{4}{2}$$
$$= 2$$

T26

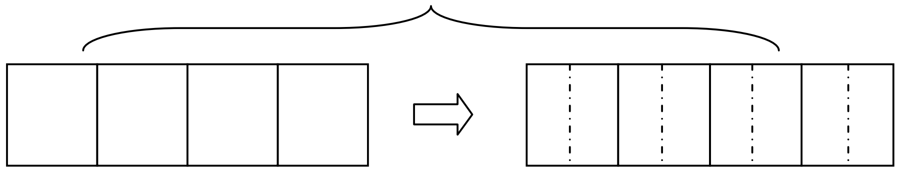
$$4 \div \frac{1}{2}$$
$$= 4 \times \frac{2}{1}$$
$$= \frac{8}{1}$$
$$= 8$$

T30

$$4 \times \frac{2}{1}$$
$$= \frac{8}{1}$$
$$= 8$$

Teacher No. 26 (T26) and 30 (T30) showed good conceptual understanding of division of whole number by fraction, by applying the appropriate rules. Although T19 chose letter B which was incorrect, I think she also had a conceptual understanding of fractions. This is how she demonstrated her understanding of dividing a whole number by a fraction.

T19



She drew a rectangular shape and first divided it into 4 equal parts before dividing each part into two. See her workings above.

- **QUESTION 9**

What is the place value of the digit **4** in 25.7**4**9 **A** Ten **B** Tenths **C** Hundredths ✓ **D** Hundred	**Show your workings**

Topic: Number concept

Sub-topic: Place values

Grade level: Grade 5 syllabus

Letter with the correct answer: C

Level of difficulty: Level 1 – Knowledge

Expectations: The objective of this question was to test teachers' knowledge of place values in decimal fractions. Teachers were expected to demonstrate their understanding through showing of workings, were possible.

Analysis of solution strategies: Although this question seems to be very easy, it was the worst performed question in the proficiency test as only 3 teachers got the correct answer. All 30 participants attempted the question. Letter B has the highest number of scores while letter D had only one score. The correct answer for this question was letter C. Table 4.25 represents teachers' choice of answer to question 9.

Table 4.25 *Teachers' Choice of Answer to Question 9*

Distracters	**A**	**B**	**C**	**D**	***Total***
Frequency	7	19	3	1	**30**
Percentage	23.3	63.3	10	3.3	**100**

Among the 30 teachers, only 10% (3 teachers) got the correct answer to this question. Although this question seemed to have asked a very basic concept that all teachers are expected to know, in my view, it seems that these teachers lack the conceptual understanding of place values in decimal fractions.

Although not everybody showed workings, I discovered from those who did show their workings that they did not distinguish the difference between place value of a whole number and that of decimal fraction. What most of them did was that they started allocating values from right to left, that is placing number 9 at the place value of units, 4 at the place value of tens, 7 at the place value of hundreds, 5 at the place value of thousands and 2 at the place value of ten-thousand as shown below:

TTH TH H T U

25.7**4**9

My interpretation of the commonly given answer B is that because the placements going left from the decimal point are units then tens, it would be an easy mistake to make when going right of the decimal point, to say units then tenths for the number 4, that is to mirror the placements around the decimal point.

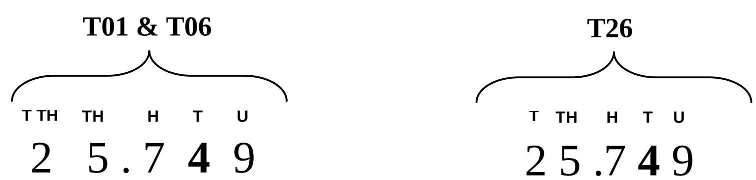
I think they were supposed to do it in this way to be able to get the correct answer, which is letter C.

Tens Units Tenths Hundredths Thousandths

25.7**4**9

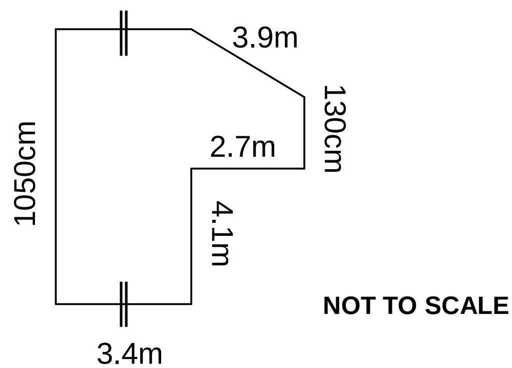
The three teachers who got this question right are T05, T29 and T30. Although these teachers achieved the correct answer to this question, none of them showed any working. Except for T30 who demonstrated a high level of mathematics content knowledge by getting correct answers to 28 questions out of 30, I am not sure if other teachers like T29 chose this answer by chance or through conceptual understanding. But when it comes to T05, I am sure she chose this answer by chance otherwise she could not failed Question 13 (Appendix F) which seemed to be easier than this one. Both Questions 9 and 13 required teachers' knowledge of 'place values'. In fact, T05 achieved the lowest score in the proficiency test (Figure 2.3).

Below are the workings of T01, T06 and T26:



♦ **QUESTION 16**

<table>
<tr><td>The diagram below represents a school garden.
Calculate the perimeter of the garden.
(Give your answer in meters).



A 29.3m ✓
B 1197.5m
C 1194.10m
D 25.9m</td><td>Show your workings</td></tr>
</table>

Topic: Measurement

Sub-topic: Perimeter and area

Grade level: Grade 5 syllabus

Letter with the correct answer: A

Level of difficulty: Level 3 – Application

Expectations: The objective of this question was to test teachers' knowledge of calculating the perimeter of irregular shapes. Teachers were expected to show their workings by first converting measurements to the same units before adding the different lengths together. This question was very challenging as only 8 participants got the correct answer (Table 4.26).

Table 4.26 *Teachers' Choice of Answer to Question 16*

Distracters	**A**	**B**	**C**	**D**	***Total***
Frequency	8	1	4	16	**29**
Percentage	26.7	3.3	13.3	53.3	**96.7**

Analysis of solution strategies: Only 29 participants attempted this question, one participant did not choose anything. Although the correct answer was letter A, 53.3% of teachers opted for letter D, which is wrong. Among the list of teachers who got correct answer to this question were T01, T06, T11, T15, T23, T26, T30 and T32.

- **QUESTION 27**

Work out: $3 + 5 \times 2 - 4 \div 2$	**Show your workings**
A 3 **B** 11 ✓ **C** 6 **D** 4.5 or $4\frac{1}{2}$	

Topic: Number concept

Sub-topic: Four basic operations

Grade level: Grade 4/5 syllabus

Letter with the correct answer: B

Level of difficulty: Level 2 - Comprehension

Expectations: The objective of this question was to test teachers' knowledge of application of 'Order of operations' i.e. BODMAS. Here teachers were expected to show the calculations that led to their answer.

Analysis of solution strategies: Although the performance was still not good, I think this question was not as confusing to the participants compared to others in the test because the chosen letters for the correct answer were only between B and C (Table 4.27).

Table 4.27 *Teachers' Choice of Answer to Question 27*

Distracters	**B**	**C**	***Total***
Frequency	8	21	**29**
Percentage	26.7	70	**96.7**

It is quite interesting to establish from Table 4.27 that 70% of teachers could not get the correct answer to this question. In my view, although these teachers might have learned the concept of BODMAS they appeared to have forgotten. They could not really remember which operation must come first before the other.

During the administration of this test, teachers who had calculators were allowed to use them as long as it was not a scientific calculator. In general, lower primary teachers do not use scientific calculators. However, the aim of this study was not to test whether teachers can solve problems without using calculators, but to find out if teachers can solve the given problems by show their workings where possible.

As can be seen from their workings, the majority of teachers applied similar strategies to get a solution to the given problem (Table 4.28). T09, T20 and T26 are those teachers who got an answer of 6, while T11, 23, 25, 30 are those teachers who got an answer of 11. Below are two solution strategies that were commonly used to solve this question:

Table 4.28 *Solution strategies for T09, T11, T20, T23, T25, T26 and T30 to question 27*

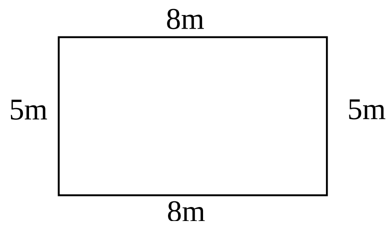
T09, T20 & T26	***T11, T23, T25 & T30***
3 + 5 × 2 - 4 ÷ 2 = 8 × 2 - 4 ÷ 2 = 16 - 4 ÷ 2 = 12 ÷ 2 = **6**	3 + 5 × 2 - 4 ÷ 2 = 3 + (5 × 2) – (4 ÷ 2) = 3 + 10 – 2 = 13 - 2 = **11**

So to analyse the two solutions, one can see that the group of teachers that got the answer of 6 did not apply the BODMAS rule at all. They just solved the operations in the order that they were written – i.e., from left to right.

- **QUESTION 30**

A classroom has a length of 8 metres and a width of 5 metres. Calculate the **area** of the classroom.	**Show your workings**

NOT TO SCALE



A $40m^2$ ✓

B $26m^2$

C $89m^2$

D $80m^2$

Topic: Measures

Sub-topic: Mensuration

Grade level: Grade 5 syllabus

Letter with the correct answer: A

Level of difficulty: Level 2 - Comprehension

Expectations: This question was testing teachers' knowledge of application of measures. That is knowledge of calculating area of a two-dimensional shape such as a rectangle.

Analysis of solution strategies: The choice of letter with the correct answer was between A, B and D. Only 29 out of 30 participants attempted this question, one participant did not choose anything. Although the correct answer was letter A, 66.7% of teachers opted for letter B (Table 4.29).

Table 4.29 *Teachers' Choice of Answer to Question 30*

Distracters	**A**	**B**	**D**	***Total***
Frequency	7	20	2	**29**
Percentage	23.3	66.7	6.7	**96.7**

I think some teachers became confused because instead of applying the method for calculating the area of a rectangle, they used the method for calculating the perimeter. Below are the solution strategies for T11, T15, T23, T26 and T30 (Table 4.30).

Table 4.30 *Solution strategies for T11, T15, T23, T26 and T30 to question 30*

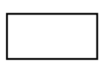
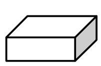
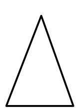
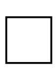
T11	T15	T23	T26	T30
$A = s \times s$ $= 8 \times 5$ $= \underline{40}$	$A = l^2 \times w^2$ $= 16^m + 10^m$ $= \underline{26m^2}$	$A = (8 \times 2) + (5 \times 2)$ $A = 16 + 10$ $= \underline{26m^2}$	$A = 2 \times 5 + 2 \times 8$ $A = 16 + 10$ $= \underline{26m^2}$	$A = L \times B$ $= 8m \times 5m$ $= \underline{40m^2}$

T15, T23 and T26 got the same answer of $26m^2$ while T11 and T30 got the same answer of 40 m^2. T11 and T30 applied the same strategy; T23 and T26 also applied similar strategies, but they used a formula for calculating the perimeter. The correct answer to this question was in letter A. Therefore, only T11 and T30 applied the correct procedures and demonstrated their conceptual understanding of calculating an area of rectangle.

B: MODERATELY WELL ANSWERED QUESTIONS

The two questions chosen among the moderately well answered questions in the proficiency test are questions 2 and 10.

- **QUESTION 2**

Which of the following diagrams is a three-dimensional figure?	**Show your workings**
A 	
B  ✓	
C 	
D 	

Topic: Geometry

Sub-topic: Shapes

Grade level: Grade 4 syllabus

Letter with the correct answer: B

Level of difficulty: Level 1 – Knowledge

Expectations: The objective of this question was to test teachers' knowledge of three-dimensional shapes. No calculation was required in this question.

Analysis of solution strategies: Although this question looked very easy, to some teachers it was not easy at all. Some teachers like T01 and T12 demonstrated their conceptual understanding of a *three-dimensional shape* by writing the following statements in the working space:

T01
"Three-dimensional is an object which can stand by its own and when it is standing you can see it at more than one side."

T12
"A, C, D are 2-dimensional"

In this question, the choice of letter with the correct answer was between B and C, of which 46.7% of teachers chose letter C, which was wrong.

Table 4.31 *Teachers' Choice of Answer to Question 2*

Distracters	**B**	**C**	***Total***
Frequency	16	14	**30**
Percentage	53.3	46.7	**100**

In my view, I think teachers who chose letter C as the correct answer, lack the conceptual understanding of *three-dimensional shapes.* Perhaps they thought that the concept *three-dimensional* implies *three sided figure.*

Although T30 had the overall highest score of the proficiency test as evidenced in section 4.3.2 Table 4.13, he was also among those teachers who opted for letter C. When I asked him why he failed this question while he solved other questions correctly that seemed to be much more difficult than this one, this is what he told me.

T30: Ooooo! I think I have just confused! But it was even long time without doing real mathematics, you know!

♦ **QUESTION 10**

Work out the average of 6, 8, 13, 16, 17	**Show your workings**
A 10 **B** 12 ✓ **C** 15 **D** 60	

Topic: Data handling

Sub-topic: Averages

Grade level: Grade 5 syllabus

Level of difficulty: Level 1 – Knowledge

Expectations: The objective of this question was to find out whether the teachers had a conceptual understanding of averages. Here teachers were expected show their workings by adding together all the given numbers and dividing the sum by 5.

Analysis of solution strategies: Although calculation of averages would seem to be a routine practice for every teacher because they apply it several times when assessing learners' performance, this was not easy for some teachers at all. This can be clearly seen from their choice of letter with the correct answer in Table 4.32. From the table, we can establish that only 28 out of 30 teachers attempted this question while two teachers did not attempt it.

Table 4.32 *Teachers' Choice of Answer to Question 10*

Distracters	**A**	**B**	**C**	**D**	***Total***
Frequency	1	17	2	8	**28**
Percentage	3.3	56.7	6.7	26.7	**93.3**

Only 56.7% of the total number of teachers who attempted this question got the correct answer, while 43.3% failed it.

In my view, I think the reason why 8 teachers chose letter D is that, they merely added all the numbers together (and got an answer of 60) without dividing by 5 – see the solution strategy for T25 below:

T25

$$\overbrace{= 6 + 8 + 13 + 16 + 17}^{T25}$$

= <u>60</u>

What I learnt is that these teachers did not understand the concept of averages, even though they apply it almost daily during assessment of learners, be it in a test, in an exam or homework. So one wonders how some of these teachers administered their learners' progress when they failed to demonstrate their conceptual understanding of averages.

C: WELL ANSWERED QUESTIONS

The two questions taken from the well-answered group of questions in the proficiency test are questions 1 and 24.

- **QUESTION 1**

Give the next two numbers of the pattern: **1; 3; 5; 7; …; …**	**Show your workings**
A 9 and 10	
B 11 and 12	
C 10 and 11	
D 9 and 11 ✓	

Topic: Number concept
Sub-topic: Number pattern
Grade level: Grade 4 syllabus
Letter with the correct answer: D
Level of difficulty: Level 1 – Knowledge

Expectations: The objective of this question was to test the teachers' knowledge of number patterns. This question requires teachers to identify the type of numbers in the given sequence or pattern in order to get the next two numbers of the sequence.

Analysis of solution strategies: This question was very easy for all the participants. They all got the correct answer. For example, T03 and T15 realised that the given pattern/sequence increases by 2.

T03

"Add 2 each time"

T15

"They are odd numbers or you add 2 to all numbers in the sequence"

- **QUESTION 24**

Which of the following fractions is the **largest**? $\frac{1}{2}; \frac{1}{4}; \frac{1}{5}; \frac{2}{5}$ **A** $\frac{2}{5}$ **B** $\frac{1}{4}$ **C** $\frac{1}{5}$ **D** $\frac{1}{2}$ ✓	**Show your workings**

Topic: Number concept

Sub-topic: Fractions

Grade level: Grade 5 syllabus

Letter with the correct answer: D

Level of difficulty: Level 3 – Application

Expectations: The objective of this question was to test teachers' knowledge of ordering of fractions. This question expected teachers to arrange fractions in order of magnitude. Teachers were expected to demonstrate any strategy that will allow them to distinguish the magnitude of fractions.

Analysis of solution strategies: The choice of letter with the correct answer was between letter A, B, C and D (Table 4.33). The correct answer was in letter D. Although this is a level 3 question, the majority of teachers demonstrated their conceptual understanding of fractions.

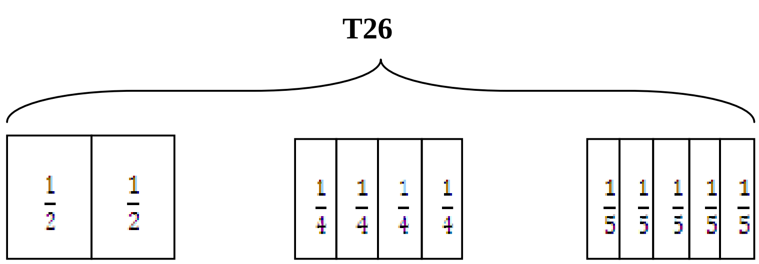
Table 4.33 *Teachers' Choice of Answer to Question 24*

Distracters	**A**	**B**	**C**	**D**	***Total***
Frequency	2	2	1	25	**30**
Percentage	6.7	6.7	3.3	83.3	**100**

We can see from Table 4.33 that 83.3% of teachers achieved the correct answer to this question.

I was very impressed by the way some teachers demonstrated their knowledge of fractions. A variety of strategies were demonstrated and most of them led to the correct answer. Below are the selected solution strategies for T23, T26 and T30.

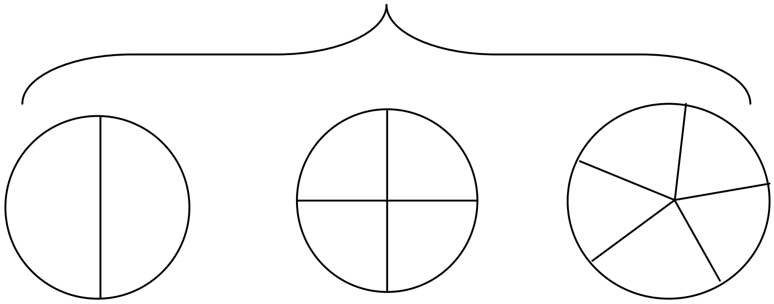
T26 used the following diagrams to illustrate the **largest fraction**.



He used the same box and divided it first into two halves ($\frac{1}{2}$), then four quarters ($\frac{1}{4}$), then five fifths ($\frac{1}{5}$), etc of equal size. He then realised that half ($\frac{1}{2}$) pieces of box are bigger than the others. Hence, chose letter D as the correct answer.

T23 used the same strategy as T26, but she used circles instead of rectangular boxes.

T23



While T30 on the other hand, converted the given fractions into percentages to get the largest fraction, which should off course be represented by the largest percentage.

T30

$\frac{1}{2} \times 100 = 50\%$ $\quad$ $\frac{1}{4} \times 100 = 25\%$ $\quad$ $\frac{1}{5} \times 100 = 20\%$ $\quad$ $\frac{2}{5} \times 100 = 40\%$

4.4 ANALYSIS OF DATA COLLECTED THROUGH INTERVIEWS

As I went through the interview transcripts, I generated the following themes based on teachers' general views about mathematics:

- *Their views of their own mathematical knowledge and competency/proficiency*
- *The way they have been assigned to the grades*
- *Their views on upgrading their own mathematical knowledge*
- *Their perceptions of the test*

Although the main focus of this study was on teachers' knowledge of mathematics content, I think it is worthwhile to highlight some issues that were commonly raised by lower primary teachers as contributing factors to learners' poor performance in mathematics. These were:

- *Poor background knowledge of learners*
- *Lack of textbooks and other resources at schools*
- *Overcrowded classrooms*
- *Teachers' attitudes towards mathematics*
- *Lack of specialised HODs at LP*
- *Medium of instruction at LP*

In my view, these areas are worth commenting on; hence, I recommend them for future research. I think future researchers need to investigate other factors (in addition to teachers' content knowledge of mathematics), that also contribute to learners' achievement in mathematics.

4.4.1 Teachers' Own Views of Mathematical Knowledge and/or Competency

During the interviews with the LP teachers I established that they are not comfortable with their current state of mathematical knowledge. I was told that some LP teachers are not even able to solve the content of mathematics at the level of Grade 7. This makes them feel more inferior as they are not able to assist even their own children with problems in mathematics, especially those at the upper primary phase.

This is evidenced during a conversation with T04.

> T04: As teachers we also have our children who go to school and some of them are at UP phase. Let say a child has given homework in mathematics and come to me as parent to assist. How would the child feel if I cannot be able to assist, although I'm a teacher? It is very embarrassing to the child to accept that a LP teacher cannot be able to solve UP mathematics. But, how will the child takes you as a teacher?

When I asked them whether it is necessary for a lower primary (LP) teacher to have knowledge of mathematics, this is what T05 had to say:

> T05: Yes, very important!
> I: Why is it important?
> T05: Because math is something very important. It was even one of my favourite subjects when I was at primary level. But after standard 6 my parents told me to pursue Biblical Studies instead of mathematics, so I accepted because as children we must adhere to parent's rules.
> I: So you are emphasising that mathematics is very important?

T05: Of course, yes!
I: How important is mathematics?
T05: Nowadays the knowledge of mathematics is required everywhere for example, let me say in most vacancies that are being advertised require candidates to have knowledge of mathematics. And it is very difficult nowadays for a person to get a job if does not have knowledge of mathematics.

When I asked them about their views of lower primary teachers' future knowledge of mathematics in Namibia – up to which level did they think LP teachers should have knowledge of mathematics, some felt that lower primary teachers should have a knowledge of mathematics up to grade 7 while others felt that they should have knowledge of mathematics up to grade 12.

T04: For LP, a teacher should have at least passed mathematics up to grade 7 level and will continue doing mathematics when go to college of education.

T05: I think LP teachers should all have passed mathematics at least up to grade 12. ... This is because mathematics cannot be forgotten. I think if all LP teachers have knowledge of mathematics content up to grade 12 then this will get rid of the current problem of some teachers who disadvantage learners due to their lack of mathematics content knowledge.

T30: Yeah, I think he/she needs to have passed mathematics up to grade 12. This would enable him/her to have enough knowledge of mathematics. Or at least grade 10 as the minimum passing grade.

T04 further emphasised that teachers should have knowledge of mathematics beyond the grades they are teaching. This would boost their confidence in teaching the subject and also enable them to reason meaningfully.

T04: I think it is good for LP teachers to have knowledge of mathematics up to grade 7. This will help him/her not only to have knowledge of mathematics at LP phase but to have knowledge of mathematics at the entire primary phase. Let me say maybe one teacher at UP phase is sick then if all teachers are having the same knowledge of primary mathematics regardless the grades they are teaching then it would be very easy for the school principal to arrange someone from LP to attend to UP learners whose teacher is getting sick.
Now, if your knowledge of mathematics content is only confined to LP curriculum then you cannot be able to assist in this regard. Therefore, it could be more appropriate if all primary teachers regardless of their areas of specialisations could be trained on the same content and at the same level of mathematical proficiency/competency.

Although T05 could not do mathematics up to grade 12 due to advices of her parents to take Biblical Studies instead of mathematics, she still views mathematics as an important subject in life.

> T05: Mathematics is something very important. It was even one of my favourite subjects when I was at primary level.

She therefore recommends every lower primary teacher to have knowledge of mathematics.

> T05: Nowadays the knowledge of mathematics is required everywhere for example, let me say in most vacancies that are being advertised require candidates to have knowledge of mathematics. And it is very difficult nowadays for a person to get a job if does not have knowledge of mathematics.

From these interviews, I have established that even teachers themselves are not confident with their own content knowledge of mathematics and that is why some of them have suggested that LP teachers should have knowledge of mathematics up to grade 12. In my view, I think there is a great need for the same study to be carried in a bigger sample to give a clear picture of the current state of LP teachers' content knowledge of mathematics in Namibia.

Although, the Ministry of Education (MoE) through the Education and Training Sector Improvement Programme (ETSIP) is embarking upon a consultancy project to strengthen the content knowledge and skills of all mathematics teachers in Namibia (Namibia. MoE, 2006d; 2008). I don't think the outcome of this consultancy will really give a depth and clear picture of the current state of LP primary teachers' knowledge of mathematics content in the country. This is because the consultancy project is only given 35 working days to complete the task and it has to concentrate on mathematics teachers from grade 1 to 12 (Namibia. MoE, 2008). In my view, I think the given period is not enough for this exercise to enable obtain a valid and reliable picture of the current state of LP teachers' content knowledge of mathematics in all the 13 regions in Namibia as only some regions will be visited. The outcome of this consultancy project is expected to draw up a "comprehensive strategic plan" that would inform or rather advise the MoE on the current state of teachers' knowledge of mathematics content at all levels as well as the standard of mathematics content knowledge that would be required by mathematics teachers at all levels (Namibia. MoE, 2008:5).

4.4.2 The Way Teachers have been Assigned to the Class Teaching Grades at LP

What I also observed from both the interview transcripts and the profile questionnaire is that the majority of teachers who are currently teaching at LP phase previously were teaching either at upper primary or junior secondary phase. Some were assigned to teach at lower primary due to health problems while others were transferred due to their level of qualification. For example, when I asked T04 and T05 why they had moved from upper primary, where they had been teaching for several years, to the lower primary phase, this is what they had said:

> T04: Although I have been teaching at UP for many years, the new teaching structure does not allow me to teach there anymore because of my qualification [NEC] and that is why I end up teaching at lower primary phase. Currently, I'm enrolling with BETD In-Service, but specialising at lower primary.

> T05: Oooo! No! I had health problem
> I: Ok! So, they moved you to lower primary due health problem?
> T05: Yes
> I: Ok.

What I also noticed happening at lower primary phase is that LP teachers were assigned classrooms randomly by their school principals without considering their knowledge of mathematics and each teacher was confined to a specific grade only. So the principals did not attempt to assess which teacher was better in terms of mathematics knowledge so that he or she could teach for instance the Grade 4 class; a Grade 4 teacher could be found to be weaker in mathematics cognition than the Grade 2 teacher.

To overcome this problem, some schools introduced a rotational system whereby teachers had to move along with their children from one grade to other. Although this system seems to be good and supported by majority, T04 is against it.

In her view, the system had both advantages and disadvantages to learners. The advantage was that if the teacher was very good at mathematics then learners would benefit. However, if the teacher's attitude towards mathematics was negative and/or he had poor knowledge of mathematics content then learners would suffer. This would affect their future knowledge of mathematics as they would also start to develop negative attitudes towards mathematics.

I: Okay, but what caused teachers to be moved from one grade to another?

T04: Apparently, it has to do with the system of moving with your learners from current grade to the next grade?

I: Oooo! Which means like in your case teaching in grade 3 this year, next year you will proceed with your learners to grade 4 and another teacher will be located to grade 3?

T04: Yes, but it makes some learners to remain behind. For example if a particular teacher is weak in mathematics then this will affect all learners as they will also be poor in mathematics.

I: How many times can I move with my learners? Can I move with them from grade 1 up to grade 4?

T04: No, you can only move with them once.

4.4.3 Teachers' Perceptions of the Test

i) Their General Perception about the Test

Although it had been long time for some LP teachers without being engaged with this type of mathematics, all teachers that were interviewed found the test valuable and worthwhile. T04 commented that the test "was okay" because the questions were designed at the appropriate level.

As for T05, the test awakened her mind and showed her a lot of things that need to be taught to learners, things that she had not previously thought of or known. In an interview with T05, T09 and T30 this is how they commented on the test:

T05: The test was good; I even wanted to ask if you can give me an extra question paper so that I can keep practising on my own, because to me really this test is very constructive and encouraging.

I: So, in which way does the test encourage you?

T05: By just seeing some questions from this test it waken up my mind to see what things that can also be taught to learners. Things that I did not thought of. And that is why I said I wish if you can give me an extra question paper so that I can practise.

I: Ok, how does the test help you?

T05: When I saw the questions I am thankful. When I am going to teach my children I will base my teaching on some of the things that I have seen in the test.

T09: Aamh, well, it was not really difficult, is only that aamh, some of the things in the question we don't deal with them anymore....

T30: I can say it was okay, but on the other hand it was tough too. He he he he he [we are all laughing] It demands concentration.

I: Okay, so it was very tough

T30: Yes, it [proficiency test] needs someone to check nicely before ticking out the correct answer, because if you just rush-out, whatever method you apply you find the answer there [laughing again]. So it needs someone to think critically. So, it was a bit tough.

I: Do you think it was a constructive test? Do you think you have learned something from it?

T30: Yes, it is a constructive test and it really wakens up someone's mind to put much emphasis in his/her job.

ii) Their Perception about the Content of the Test

During the interviews I asked teachers whether there were some questions in the proficiency test that seemed to be difficult for them or a bit challenging and ones where they were not quite sure whether they had obtained the correct answers or not. The following were some of the questions that were regarded as challenging and/or difficult by the interviewed group of teachers: questions 7, 14, 15, 16, 22, 25 and 29.

Although these were the only questions identified as difficult and/or challenging by the interviewees, I evidenced that the teachers also performed poorly in some questions that were not listed such as question 8, 9, 21, 26, 27 and 30. For example, there were only three teachers among the 30 participants who got the correct answer to question 9. For more details see section 4.3.9.

4.4.4 Teachers' Views on Upgrading their Mathematics Knowledge

Apart from the training given during implementation of the revised LP curriculum, LP teachers never received any inset training; and no follow-up was made to find out whether teachers were correctly interpreting the syllabus or whether they were experiencing difficulties.

I established that most of the schools did not have Heads of Departments (HODs) for lower primary phase, and where there were HODs, they were not specialised at LP phase and were not teaching there either. In most cases LP teachers received assistance from other teachers at UP and JS. During the interview with T04, this is what she had to say:

I: Okay, let's say you have a problem of teaching certain topic, can you ask help from the HoD?

T04: Do you mean to ask assistance from her [she meant the HOD]; like in mathematics for example?

I: Yes!

T04: Ah, No! She doesn't know. Unless if you ask other teachers who teach mathematics at senior phases such as upper primary and junior secondary.

I: Oooo! Then there is a problem, or what do you think?

T04: Definitely!

LP teachers indicated the need to receive training, especially in mathematics content, to upgrade their content knowledge and skills in mathematics. Some teachers, particularly those with more years of teaching experience, claimed that they had forgotten some content of mathematics because they had not used it for a long time.

When I asked them how often they attended training courses/ workshops for LP mathematics or when last they had attended a training/ workshop for LP mathematics, this is what they had to say:

T04: Since I started teaching grade 3 & 4 I can't remember having attended any workshop for LP.

T05: Wuwuwu!…I last attended in 2005 but for grade 1.

T30: Not really. Sometimes we receive training or attend workshop after two years. And usually only one teacher requested to attend per school and come to train others [cascade training model].

4.4.5 Factors that Contribute to Learners' Poor Achievement in Mathematics

Apart from teacher knowledge of mathematics content, LP teachers felt that there are factors that contribute to learners' poor performance at LP phase especially in mathematics. These include:

- ***Overcrowding of classrooms:*** – Teachers found it difficult to pay individual attention to a class of 50 to 60 learners.
- ***Poor background knowledge of learners:*** - According to the government's rule on promotion requirement, a learner who failed twice in a phase must be automatically promoted to the next grade (Namibia. MEC, 1993). As a result of this automatic

promotion employed in our education system, the majority of learners had problems achieving basic literacy and numeracy skills; and a result, their performance in mathematics is very poor because they did not achieve all the basic competencies from previous grade(s).

According to T04 and T05, LP learners generally experienced difficulty in topics like measurements.

- ***Medium of instruction:*** – Some teachers felt that it was more appropriate if learners started being taught in English right away from grade 1. Learners were not well prepared in grade 1; emphasis was placed more in counting in mother tongue.

- ***Lack of textbooks and other teaching and learning resources*** made it difficult for teachers to teach mathematics in a constructive manner.

- ***Lack of HODs for LP:*** – Most schools did not have HODs for LP and where there were HODs, they were not specialised at LP phase and were not teaching there either.

In an interview with T30 this is what he commented about the above-mentioned points:

T30: I think emphasis must be given to grade 1. Teachers must work hard and force learners to know the letters of alphabet and also to know numbers. Because what I have observed is that their emphasis is more in Oshiwambo counting from 1 to 100 and they never train them how to do it in English. For example, if you ask a grade 2 learner to write down the number 27 on the chalkboard. Ah, [surprised] if you see what he/she has written there you will be surprised. If he/she does not write 72 while you have asked 27, he/she will write the number 2 like this [showing me by writing the number 2 which looks like letter ‘S’] while the number 7 will be written like this [number 7 is written like letter ‘F’].

When I was just at the class right now, mh! [surprised] doing some multiplications! I have just asked one learner to write down for me the number 36 on the chalkboard. He/she then writes it [number 36] nicely. Then I asked him to multiply it by 9 [36 × 9]. Mh! [suprised] You know how that nine was written? He/she started it like this [showing me how the child started writing the number 9] and then looks like letter ‘b’. So you can see that the child did not master numeracy and literacy skills from grade 1.

So, my emphasis is again on learners to master letters of alphabet as well as numeracy. They should know how to read and write numbers both in the mother tongue as well as in English.

I: Okay, ah! How many learners do you have in your class?

T30: Oh, our classes are full

I: Don't you think that this could also be one of the contributing factors to learners' poor performance?

T30: Definitely! Because even if you want to give individual attention you cannot, because the class is full. So you can try to attend to the individual learners but by the time you reach the 15^{th} learner in the classes, then the period is over.

I: Yes, is true, the time has to come over before attending to all.

T30: … and if tomorrow you say no you want to continue with those remained yesterday you will find yourself in a situation beyond your control because while attempting to help those remained yesterday. Those one you helped yesterday will today need your assistance again in a different activity. So you will just end up in limbo.

I: Is true!

T30: Like in my class I have 55 learners

I: Oh! Then they are many; and it will be difficult to pay attention to individual learners

T30: Not at all!

I: How about materials? Do you also regard them as part of contributing factors to effective teaching and learning at lower primary?

T30: Of course, materials are one of the major contributing factors

4.5 CONCLUSION AND SUMMARY OF THE FINDINGS

This chapter dealt with the analysis and interpretation of the study findings. This study was aimed at determining lower primary teachers' proficiency in mathematics content. The three instruments used to collect data were the proficiency test, the profile questionnaire and the interview schedule.

From the analysis of the data I established that:

- The majority of teachers at lower primary phase were females aged between 24 and 29 years old.
- Some teachers had been teaching the same grade at lower primary for many years. The maximum was 18 years without changing to another grade. Other teachers spent more than 26 years teaching at lower primary.
- I established that due to their poor knowledge of mathematics, some teachers developed negative attitudes towards mathematics.
- I also learnt that mathematics was not a requirement for entrance into a BETD lower primary programme. And no content of mathematics was given to LP college trainees at all.
- Although the majority of teachers in the study were BETD holders, there was no marked difference between the BETD holders and non BETD holders.

In terms of support given to lower primary teachers, teachers commented that:

- They received very little support from the government. Their books were insufficient, they had overcrowded classrooms, they didn't have proper classrooms and chairs, and no workshops were organised for them when compared to their colleagues who were teaching at upper primary and junior secondary phases.
- Some teachers had been in the service for more than 26 years and yet they did not receive upgrading training courses, especially on the revised curriculum. Therefore, they felt that they were not part of the system.
- There were no HODs for LP teachers at most schools. And in those schools that did have them, the HODs were not specialised at LP. At all schools that I visited I found not one HOD who had specialised at LP. They had been taken from other phases.

- There was a serious need of textbooks and materials for learners at schools. Schools were receiving very little stock of lower primary textbooks and materials. Five to four learners were sharing one textbook. And teachers were struggling to create their own teaching aids.

When it came to teachers' knowledge of mathematics:

- Although the overall performance appears to be good, the finer analysis of the proficiency test reveals that the participants struggled with many of the items
- There were very few teachers that were confident with the content of mathematics. The majority of them had the content of mathematics below grade 7. But they were willing to upgrade their knowledge of mathematics and hence, they were appealing to the government to organise workshops for them so that they could be on par with the latest knowledge of mathematics.
- Classrooms were overcrowded and teachers could not pay individual attention to learners.
- Not all teachers that were teaching at LP are specialised there; some of them had specialised at upper primary and junior secondary.

However, some teachers demonstrated a good conceptual understanding of mathematical concepts.

Overall, all teachers valued the study as valid and worthwhile. And above all, they all saw the importance of mathematics and the role that it plays in the society.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter is perhaps the most important chapter in my thesis because it presents the end product of my research. In this chapter, I document the summary and discussion of the main findings of the study. Particular attention is given to the connection between the literature review and the study findings, the gaps left in the study, significance of the study, limitations, recommendations for further research and own reflection.

5.2 SUMMARY AND DISCUSSION OF MAIN FINDINGS

This is a case study conducted within the interpretive paradigm using both the qualitative and quantitative approaches. The study was aimed at exploring the mathematical content knowledge of lower primary teachers in selected primary and combined schools in the Ohangwena region.

A sample of 30 lower primary teachers was taken from 5 primary and combined schools in the Ohangwena circuit. These 5 schools were purposely selected from the 15 identified schools in the study. The study used a proficiency test, a profile questionnaire and interview schedule to collect data. The proficiency test was the main instrument used in the research to determine the LP teachers' competence in mathematics; the profile questionnaire and interview schedule were used to triangulate with the findings of the proficiency test.

The following were the main findings of the study:

- Although the overall performance of teachers in the proficiency test appeared good, this did not mean that they had a good conceptual knowledge of mathematics, especially when it is considered that the test was based on content from Grade 4 and 5 learners' mathematics syllabi. The standard is very low compared to international norms of mathematical proficiency for primary teachers (Driscoll, 2007).

Another reason why I found the performance of the teachers discouraging is that most questions that were asked in the proficiency test were knowledge questions, the lowest level of Bloom's Taxonomy of cognitive domain (Tables 3.1, 3.2 and Appendix G).

Despite the low content of mathematics assessed in the proficiency test, teachers performed very poorly in some questions; these were the questions that I expected the teachers to answer well because they assessed their understanding of basic concepts of mathematics. Among the questions that were poorly answered were questions 7, 8, 9, 16, 27 and 30 where teachers scored below 40%. These were my target questions for determining their proficiency level in mathematics.

The content of these six poorly answered questions was taken from the topics *Number concept, Measures and Mensuration*. This implied that these teachers lacked the conceptual understanding of mathematics in these three areas of mathematics content. According to Driscoll (2007), as referred to in Chapter 2: page 9 of this study, primary teachers' mathematics knowledge should include at least 45% *"Number concept"* content and 20% in *"Geometry and Measurements"*. In essence, this means that almost 50% of the primary teachers' mathematics content should be taken from the *"Number concept"*.

- Below is a brief report on each of the poorly answered questions:

  - ✓ **Question 7 –** this question was taken from the topic 'Number concept' subtopic 'Prime numbers'. Although I expected all teachers to know what a prime number was, only a few of them knew. In this case 8 (27%) teachers, including those who probably guessed, obtained the correct answer, while 22 (73%) of them failed. This implied a weak conceptual understanding of Prime numbers among the teachers.

  - ✓ **Question 8** – this question was taken from the topic 'Numbers concept'; it required teachers to divide 4 by a half (i.e. $4 \div \frac{1}{2} \Rightarrow 4 \times \frac{2}{1} = 8$). In this case only 7 (23%) teachers passed this question, while the rest 23 (77%) failed it. As it can be seen from the figures, this showed that teachers' conceptual understanding of 'division by fraction' is very weak.

  - ✓ **Question 9** – this was the worst ever performed question in the proficiency test as only 3 (10%) teachers managed to get the correct answer, while the rest 27 (80%)

failed. This question, another from the 'Number concept' category, asked about 'Place value' in a decimal fraction format. In essence, the poor performance illustrated that teachers' conceptual understanding of 'Place value' in decimal format is extremely weak.

- ✓ **Question 16** – this was a level 3 question taken from the topic 'Measures". The question required teachers to calculate the perimeter of an irregular shape, where the teachers had to convert the measurements to same units first before finding the perimeter. Only 8 (26.7%) teachers passed this question while the rest 22 (73.3%) failed it. Again a very weak conceptual understanding of measures was demonstrated in this question.

- ✓ **Question 27** – this question was another taken from the 'Number concept' topic to test teachers' knowledge of the application of the BODMAS rule. Again, a dismal understanding of the order of operations was demonstrated here as only 8 (26.7%) teachers managed to get the correct answer while the rest 22 (73.3%) failed it.

- ✓ **Question 30** – this question was taken from the topic 'Mensuration'. Here teachers were asked to calculate the area of a rectangular shape with dimensions 8m by 5m. However, only 7 (23.3%) teachers managed to get the correct answer to this question while the rest 23 (76.7%) failed it. This once more demonstrated a very weak conceptual knowledge of teachers' application of measures.

- From the findings of this study it was apparent that although some teachers claimed to have done mathematics up to the tertiary level, the average proficiency level of LP teachers in this study in mathematics is marked below the content of Grade 7 mathematics. This was substantiated by information gained from the interviews with some teachers, who claimed that their knowledge of mathematics did not enable them to assist a Grade 7 learners' with problems in mathematics; and they always feel inferior whenever approached by learners with problems in mathematics, including their own children.

- The other finding was that the way in which the LP teachers had been allocated to class teaching was not done procedurally or based on proficiency. You could find someone teaching Grade 4 who had negative attitudes towards mathematics.
- A major finding was that, although the LP curriculum had undergone several transformations, LP teachers had never been given opportunities to upgrade their content knowledge. Unlike their colleagues teaching at UP, JS and SS phases, LP teachers had not received workshops.

5.3 THE LINK BETWEEN LITERATURE AND THE STUDY FINDINGS

My particular interest in this study was to explore the impact of teacher's knowledge of the subject matter on learners' achievement. However, literature that I found in this particular study was a bit silent in this respect. Literature that I found in this particular area did not elaborate how teacher's content knowledge of mathematics influences learners' performance. There was no particular study carried out to investigate the specific link between teachers' knowledge of subject matter and learners' achievement. Moreover, most studies that were carried out in this field of teachers' knowledge of subject matter were mainly focused on teacher's confidence and effectiveness of teaching the content.

Another important aspect that I noticed in this study, also confirmed by a number of researches such as Fennema and Franke (1992); Hill and Ball (2004); and Hill et al. (2005), is that teachers' knowledge of subject matter is measured against the three crucial types of competency, namely *subject content knowledge*, *pedagogical knowledge* and *curriculum knowledge*. So, for a teacher to be regarded as knowledgeable in a particular subject, he or she should collectively possess qualities of all these three crucial types of knowledge.

5.4 SIGNIFICANCE OF THE STUDY

Although it is a case study and one would not normally generalise its findings, I think this study is very important, making critical information about the condition of LP education in Ohangwena circuit available to education managers and planners. It may thus give direction to further research studies which consider other areas that are worth researching in LP education.

On the other hand, I think the sample of 30 teachers in this circuit is substantial enough to provide good insight. Hence the findings of this study have given a reasonable picture of the standard of LP teachers in the Ohangwena circuit in terms of their content knowledge of mathematics.

5.5 GAPS LEFT IN THE STUDY

The study could not accommodate other issues that emerged from the data especially those that emerged from the interviews. I think it would be worthwhile for further study to research issues that were mentioned in this study, for example, to explore factors that contribute to learners' poor performance in mathematics, as well as those that contribute to effective teaching and learning at LP phase.

5.6 LIMITATIONS OF STUDY

This study had some limitations - see Chapter 3 section 3.12. Although in Chapter 2 I indicated that teachers' knowledge of subject matter is measured against the three types of subject matter knowledge, this study could not focus on all the three types of subject matter knowledge due to the following limitations:

- This was a case study and focussed only on one aspect of subject matter knowledge.
- In my view, a study that would cater for all three types of knowledge would demand the following:
    - ✓ More personnel to conduct the research, especially in data collection,
    - ✓ More funding, and
    - ✓ A bigger sample in order to generalise the findings

- A relatively small sample was used and thus compromised any notion to generalise across Namibia as a whole.

5.7 RECOMMENDATIONS FOR FURTHER RESEARCH

My recommendations to further study are as follows:

Due to the gap left by this and previous research, there is a need to carry out a study that will specifically concentrate or focus on the link between teacher's knowledge of subject matter and learners' achievement. When I chose to do research in this area, I was optimistic that I would find more literature with information on the influence of teachers' knowledge of subject matter on learners' achievement, but information on this relationship was lacking.

It would be worthwhile, therefore, to carry out a study that will only concentrate on the correlation between teachers' knowledge of subject matter and learners' achievement.

Further, similar research should be done on a larger Namibian scale.

5.8 OWN REFLECTION

In this section I highlighted some experiences learned from the study.

The followings are some important points learnt from the study:

- **Selection of research topic: -** when I chosen this topic I was very optimistic to obtain as much information as possible from previous studies, but only to find out while in the process of writing the literature review chapter that all studies that were conducted in this field (teachers' knowledge of subject matter) did not investigate the impact of teacher's knowledge of subject matter (and of mathematics) on learners' achievement.

- **Writing the research proposal: -** I concur with Mouton (2001) and De Vos, et al. (2005) that before writing the research proposal the followings points must be taken into consideration:

  - ✓ Have a clear understanding of what you want to achieve from the study,
  - ✓ find out whether the problem is researchable and has not been researched before to avoid the duplication of studies,

- ✓ find out if there is enough evidence from previous studies to validate your findings

- When planning for a research study and during the writing of research proposal it is important that the following issues are taken into consideration: validity and reliability of research instruments, research type, research site and sample, the paradigm as well as approaches under which the study to be conducted, and ethics.

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APPENDICES

APPENDIX A

AUTHORISATION LETTER TO THE DIRECTOR OF EDUCATION

03 March 2008

The Regional Director: Ohangwena
Private Bag 2028
Ondangwa

Dear Sir

I am a registered part-time student with the Department of Education Rhodes University Grahamstown South Africa for Master's degree course in Mathematics Education since March 2007. This is now my second and final year and as a rule Master students have to carry out research studies in areas of their interest in their final year before their degrees being confirmed.

As a student and Education Officer responsible for Mathematics Grades 5-12, I'm interested to investigate the content knowledge and skills of lower primary teachers in mathematics in Namibia. Based on that note, I have chosen Ohangwena circuit in your region as the research site of my study. This is because I am familiar with many teachers in the circuit and I hope that they will not be hesitant to share their experiences with me.

I am confident that the findings of my study will make valuable contributions to the current ongoing project of Education and Training Sector Improvement Programme (ETSIP) aimed to strengthen the content knowledge and skills of mathematics teachers in the country.

I will be grateful to receive authorisation from you to conduct my research study in your region. My research is a Case Study approach and is based on diagnostic testing of 30 teachers selected randomly. All 30 teachers are expected to sit for a diagnostic test and it will be contacted after teaching hours. Based on the performance from the test, five teachers will be selected for an interview. The aim of this research is not to test for teachers' knowledge level of mathematics but to discover the areas of training required by lower primary teachers in mathematics in the country.

The circuit, region and teachers in particular will be assured of anonymity in the final research report and will be invited to proofread drafts of the report to ensure that details are accurately recorded and reported.

Should you have any concern or questions about this request, please don't hesitate to contact me on the above listed contact details.

Kindly, receive the attached consent form for completion and return back to me as proof of agreement.

Thanking you for your usual cooperation

Kind regards

____

Amon Haufiku
Education Officer: Mathematics

CC: T.K. Johannes
Inspector of Education: Ohangwena

CONSENT FORM

This is to certify that I/we the undersigned have given Mr. Amon Haufiku, student number: 607H1494 a permission to carry out his research study in the Ohangwena circuit in Ohangwena region.

Mr Haufiku is doing his final year MEd Mathematics Education through Rhodes University South Africa and would like to carry out a Case Study research to investigate the Mathematics content knowledge of 30 lower primary teachers in the circuit.

I understand that the data for analysis will be collected from diagnostic testing and interviews with the lower primary teachers in mathematics content; and information from these will be used in the final report. I am assured that my region, and in particular my teachers will be anonymity in that report.

....

J. Udjombala Date

Regional Director: Ohangwena

....

T. K. Johannes Date

Circuit Inspector: Ohangwena

APPENDIX B

ACCEPTANCE LETTER FROM THE DIRECTOR OF EDUCATION

12-MAR-2008 10:39 From: To:062502613 P.1/2

UNITY LIBERTY JUSTICE

REPUBLIC OF NAMIBIA

MINISTRY OF EDUCATION: OHANGWENA REGION

Private Bag 2028, Ondangwa, Tel. 264 65 281 903, Fax. 264 65 240190

Enq: Josia S Udjombala
E-mail: tatemadala@yahoo.com
Ref: SP

Mr Amon Haufiku
Rhodes University Student (Part-time)
Fax. 062 – 509073

March 12, 2008

RE: AUTHORIZATION TO CONDUCT RESEARCH IN OHANGWENA REGION

I write to refer to your letter of March 3 instant with regard to the above subject matter.

Permission is hereby granted for you to do research in our region and conduct interviews as contemplated in your letter. The following conditions should, however, apply:

- participation by individual teachers is voluntary
- school academic programmes are no way to be disrupted
- once completed, a copy of your research findings should be deposited with our library, or teachers resource centre.

I wish you success in your studies.

Yours sincerely

12/3/08

MINISTRY OF EDUCATION
THE REGIONAL DIRECTOR
12 MAR 2008
DIRECTORATE OHANGWENA
PRIVATE BAG 2028, ONDANGWA
REPUBLIC OF NAMIBIA

JOSIA S UDJOMBALA
DIRECTOR: MoE
OHANGWENA REGION

CONSENT FORM

This is to certify that I/we the undersigned have given to Mr. Amon Haufiku, student number: 607H1494 a permission to carry out his research study in the Ohangwena circuit in Ohangwena region.

Mr Haufiku is doing his final year MEd Mathematics Education through Rhodes University and would like to carry out a Case Study research to investigate the Mathematics content knowledge of 30 lower primary teachers in the circuit.

I understand that the data for analysis will be collected from diagnostic testing and interviews with the lower primary teachers in mathematics content; and information from these will be used in the final report. I have been assured that my region, and in particular, my teachers will have anonymity in that report.

J. Udjombala
Regional Director: Ohangwena

MINISTRY OF EDUCATION
THE REGIONAL DIRECTOR
12 MAR 2008
DIRECTORATE OHANGWENA
PRIVATE BAG 2028, ONDANGWA
REPUBLIC OF NAMIBIA

12/3/08
Date

T.K. Johannes
Circuit Inspector: Ohangwena

Date

APPENDIX C

AUTHORISATION LETTER TO PRINCIPALS

19 May 2008

The Principal
....
....
....

Dear Sir/Madam

Re: Research in Lower Primary Mathematics Education

Since Namibia gained its independence in 1990, learners' achievements especially in mathematics and science subjects remain unsatisfactory in most schools as measured by the national examinations results. In line with V230 and the Second National Development Plan (NDP2) the Government of the Republic of Namibia (GRN) through the Ministry of Education (MoE) has adopted a national strategic plan known as Education and Training Sector Improvement Programme (ETSIP) in 2006. ETSIP is a 15 year comprehensive strategic plan aims at addressing different areas in the education sector. Under general education, one of the objectives of ETSIP project is to strengthen the knowledge and skills of mathematics teachers at all levels in the country.

Currently I'm enrolling with MEd in Mathematics Education via Rhodes University, South Africa; and As an Education Officer responsible for Mathematics Grades 5-12 at the Directorate National Institute for Educational Development (NIED) and also as the Deputy Chair of the National Mathematics Task Force, I have decided to carry out a research study relating to my duties and responsibilities in the ministry. As part of the ETSIP project, the National Mathematics Task Force is expected to conduct research studies in mathematics education from Pre-primary to tertiary education in the country. It is within this context that I have chosen to conduct my research study at lower primary mathematics education. The study will be conducted in the Ohangwena region.

I therefore would like to inform you that your school has been selected as sample for this study. As indicated earlier this study will engage only with teachers of lower primary phase (i.e. Grades 1-4). I have already granted permission from the Regional Director of Education:

Ohangwena, Mr. Udjombala and I hope Circuit Inspectors have already informed. This research will be conducted during the month of June 2008. Please inform the relevant participants (i.e. lower primary teachers) accordingly. More information regarding research instruments and administration will be communicated at the site.

Attached please find a copy of the acceptance or permission letter from the Ohangwena Regional Director of Education, Mr. Udjombala.

Counting in your usual cooperation

Yours in education

…………………………………….
Amon Haufiku
Education Officer: Mathematics

CC: T.K. Johannes
Inspector of Education
Ohangwena Circuit

APPENDIX D

CONSENT FORM

I the undersigned have understood the aims and rationale of this research and will volunteer myself to contribute to the study. I have assured that my particulars will be handled confidential and I have the right to withdraw any time I wish.

………………................	…........................…	………………….
Respondent Code	Signature	Date

APPENDIX E

RHODES UNIVERSITY

Where leaders learn

Teachers' Profile Questionnaire

Respondent's Code: __________

Sex: ☐ Male ☐ Female

Grade Teaching: **1** ☐ **2** ☐ **3** ☐ **4** ☐ (State whether A, B, C or D)

School: ____

Cluster: ____

Circuit: ____

Region: Ohangwena

INSTRUCTIONS: TICK (✓) OR CROSS OUT (X) THE APPROPRIATE BOX

1. PERSONAL PARTICULARS

1.1. Age Category:

☐ 18-23 yrs

☐ 24-29 yrs

☐ 30-35 yrs

☐ 36-41 yrs

☐ 42-47 yrs

☐ 48-53 yrs

☐ 54-60 yrs

2. SCHOOL PARTICULARS

2.1. School: ____

2.2. Cluster: ____

2.3. Circuit: ____

2.4. Current grade teaching G1☐ G2☐ G3☐ G4☐ ***(State whether A, B, C or D)***

2.5. Number of years teaching in the current grade: ☐ years

2.6. Number of years teaching at lower primary phase: ☐ years

2.7. Have you been teaching at other phases before? ☐Yes ☐No

If **Yes**,

a) At which phase(s) have you been teaching? ***(tick as many boxes as possible)***

☐ Pre-primary ☐Upper primary ☐ Junior secondary ☐ Senior secondary

b) What subjects have you been teaching there?

……………………………………………………………………………………………

……………………………………………………………………………………………

c) For how long have you been teaching there? → ☐ years

3. QUALIFICATIONS

3.1. Up to which level have you done mathematics as a subject? *(tick the appropriate box)*

Lower primary	Upper primary	Junior secondary	Senior secondary	Tertiary level

3.2. State the highest grade passed *(tick the appropriate box)*

Grade 5	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10	Grade 11	Grade 12

3.3. When did you pass the grade mentioned under 3.2.above? *State the year*________________

3.4. What are your teaching qualifications?
State ***all*** your ***teaching qualifications***, their areas of specialisation, institutions through which obtained and years obtained.

No.	**Qualification**	**Area of Specialisation**	**Institution**	**Year Obtained**
1.				
2.				
3.				
4.				
5.				

3.5. State *all* **non-teaching qualifications,** their areas of specialisation, institutions through which obtained and years obtained. (This can either be a certificate, diploma, degree, honours or masters degree).

No.	**Qualification**	**Area of Specialisation**	**Institution**	**Year Obtained**
1.				
2.				
3.				
4.				
5.				

Thank you for completing this questionnaire

APPENDIX F

RHODES UNIVERSITY

Where leaders learn

MATHEMATICS PROFICIENCY TEST

Lower Primary Teachers

Respondent's Code: __________

Sex: ☐ Male ☐ Female

Grade Teaching: **1** ☐ **2** ☐ **3** ☐ **4** ☐ (State whether A, B, C or D)

School: ____

Cluster: ____

Circuit: ____

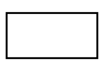
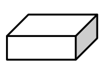
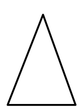
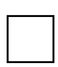
Region: Ohangwena

Purpose

The aim of this test is not to assess the individual teachers' competence in mathematics, but to assist in determining the areas of training required in mathematics teaching at Lower Primary Phase in Namibia. Please be assure that any information pertaining to identification of your name, school, cluster, circuit and region will be held confidentially. Your participation in this study is therefore highly valued.

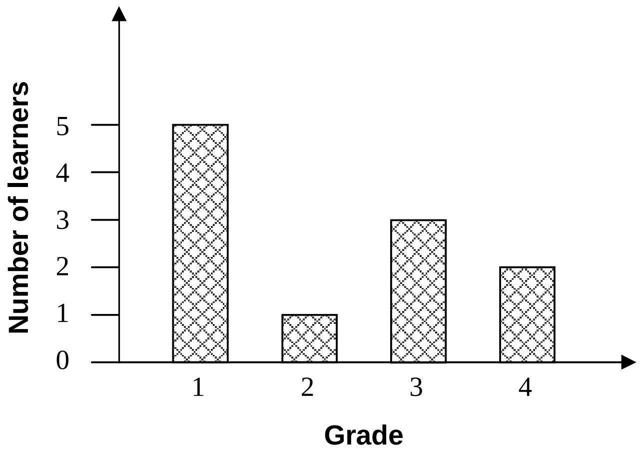
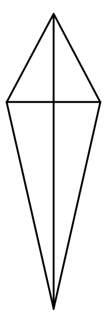
Instructions to Participants

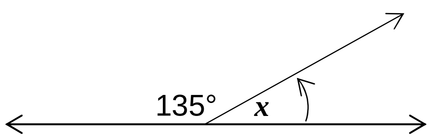
1. This question paper consists of 30 questions.
2. Answer all questions.
3. For each question there are four possible answers labeled A, B, C and D.
   Use pencil/pen to tick the appropriate box of your choice.
   Note: It is required that you show your working in the blank box next to each question. **Please do not guess the correct answers!**
4. You have **1hour 30 minutes** to answer the test

QUESTION	**SHOW YOUR WORKING**
1. Give the next two numbers of the pattern **1; 3; 5; 7; …; …** ☐ **A** 9 and 10 ☐ **B** 11 and 12 ☐ **C** 10 and 11 ☐ **D** 9 and 11	
2. Which of the following diagrams is a three-dimensional figure? ☐ **A**  ☐ **B**  ☐ **C**  ☐ **D** 	
3. Give two consecutive numbers with a **sum** of 11 and a **product** of 30. ☐ **A** 5 and 6 ☐ **B** 4 and 7 ☐ **C** 3 and 10 ☐ **D** 2 and 9	

4. There are 40 learners in the class, 28 of them are girls. Give the fraction of **boys** in the class (in simplest form). ☐ **A** $\frac{3}{10}$ ☐ **B** $\frac{6}{10}$ ☐ **C** $\frac{3}{20}$ ☐ **D** $\frac{7}{10}$	
5. Sara bought a 750ml of cooking oil at N$16.99. She paid with a single note and received a change of N$3.01. What **single note** did Sara pay with? ☐ **A** N$10 ☐ **B** N$20 ☐ **C** N$30 ☐ **D** N$40	
6. Peter is 5 years old while his sister Maria is 12 years old. Which of the following statements is correct? ☐ **A** Peter is 6 years less than Maria ☐ **B** Maria will turn 20 years old after 9 years ☐ **C** Maria will be 20 years old when Peter turns 12 years old ☐ **D** Their age difference remains the same	

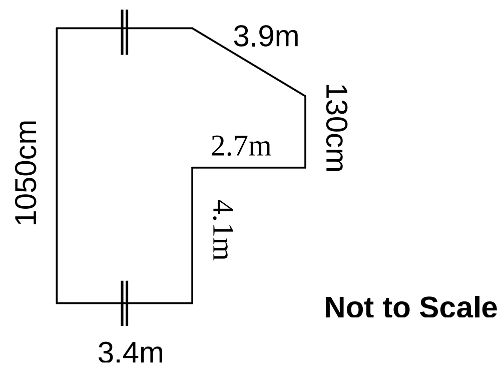
7. List ***all*** the **prime numbers** between 0 and 20 ☐ **A** 1, 2, 3, 5, 7, 9, 11, 13, 15, 17, 19 ☐ **B** 1, 3, 5, 7, 9, 11, 13, 15, 17, 19 ☐ **C** 3, 5, 7, 9, 11, 13, 15, 17, 19 ☐ **D** 2, 3, 5, 7, 11, 17, 19	
8. Calculate: $4 \div \frac{1}{2}$ ☐ **A** 2 ☐ **B** $\frac{1}{8}$ ☐ **C** 8 ☐ **D** $\frac{1}{2}$	
9. What is the place value of the digit **4** in 25.7**4**9 ☐ **A** Ten ☐ **B** Tenths ☐ **C** Hundredths ☐ **D** Hundred	
10. Work out the average of 6, 8, 13, 16, 17 ☐ **A** 10 ☐ **B** 12 ☐ **C** 15 ☐ **D** 60	

11. The graph below represents the number of learners absent in a day at Onamulenge Combined School. Give the total number of learners absent in a day.  ☐ **A** 5 ☐ **B** 10 ☐ **C** 11 ☐ **D** 15	
12. Give the geometrical name of the diagram below.  **NOT TO SCALE** ☐ **A** Triangle ☐ **B** Rectangle ☐ **C** Rhombus ☐ **D** Kite	

13. Express **300500** in words ☐ **A** Three million five hundred ☐ **B** Three thousand five hundred ☐ **C** Three hundred thousand five hundred ☐ **D** Thirty thousand five hundred	
14. Determine the size of angle ***x*** in the diagram  ☐ **A** 35° ☐ **B** 45° ☐ **C** 55° ☐ **D** 65°	
15. A school starts at 7:45 in the morning. There are four periods before the first break. Each period takes 35 minutes. At what time does the first break starts? ☐ **A** 09:50 ☐ **B** 10:00 ☐ **C** 10:10 ☐ **D** 10:05	

16. The diagram below represents a school garden.

Calculate the perimeter of the garden (*give your answer in **meters***).



☐ **A** 29.3m

☐ **B** 1197.5m

☐ **C** 1194.10m

☐ **D** 25.9m

17. What is the Highest Common Factor of 24 and 32?

☐ **A** 4

☐ **B** 2

☐ **C** 8

☐ **D** 6

18. What is three quarters of an hour? ☐ **A** 15 minutes ☐ B 30 minutes ☐ **C** 45minutes ☐ **D** 75 minutes	
19. What is the difference between N$5.95 and 345 cents ☐ **A** N$339.05 ☐ **B** 25c ☐ **C** 250c ☐ **D** N$250	
20. A cake has a mass of 3.65kg. What is the mass of the cake in grams? ☐ **A** 3.65g ☐ **B** 36.5g ☐ **C** 365g ☐ **D** 3650g	
21. Express 9:30 p.m. on a 24-hour clock. ☐ **A** 09:30 ☐ **B** 19:30 ☐ **C** 21:30 ☐ **D** 21:30 p.m.	

22. A car has travelled a distance of 600 km in a time of 5 hours. At what speed was the car driven? ☐ **A** 140 km/h ☐ **B** 60 km/h ☐ **C** 2 km/h ☐ **D** 120 km/h	
23. Express $\frac{2}{5}$ as percentages ☐ **A** 20% ☐ **B** 30% ☐ **C** 40% ☐ **D** 50%	
24. Which of the following fractions is the **largest**? $\frac{1}{2}$; $\frac{1}{4}$; $\frac{1}{5}$; $\frac{2}{5}$ ☐ **A** $\frac{2}{5}$ ☐ **B** $\frac{1}{4}$ ☐ **C** $\frac{1}{5}$ ☐ **D** $\frac{1}{2}$	

25. Ben had N$ 3000 in his FNB account. He withdrew N$ 2500 and has charged a service fee of N$ 12.05. What is the available balance in his account now? ☐ **A** N$ 500 ☐ **B** N$ 512.05 ☐ **C** N$ 487.95 ☐ **D** N$ 5 512.05	
26. A bus trip from Windhoek to Ondangwa takes 6 hours 40 minutes. At what time did a bus arrive in Ondangwa if it left Windhoek at 06:30? ☐ **A** 13:10 ☐ **B** 12:10 ☐ **C** 12:40 ☐ **D** 13:40	
27. Work out: $3 + 5 \times 2 - 4 \div 2$ ☐ **A** 3 ☐ **B** 11 ☐ **C** 6 ☐ **D** 4.5 or $4\frac{1}{2}$	

28. Round-off **905** to the nearest **10**

☐ **A** 100

☐ **B** 910

☐ **C** 91

☐ **D** 900

29. The price of a loaf of brown bread at 5 local dealers is: N$7.00, N$6.95, N$7.10, N6.75 and N$7.20. Calculate the average price of a loaf of brown bread.

☐ **A** N$6.95

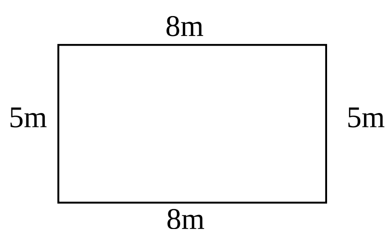
☐ **B** N$7.00

☐ **C** N$7.20

☐ **D** N$7.10

30. A classroom has length of 8 metres and width of 5 metres. Calculate the **area** of the classroom.

NOT TO SCALE



☐ **A** $40m^2$

☐ **B** $26m^2$

☐ **C** $89m^2$

☐ **D** $80m^2$

END OF TEST!

APPENDIX G

TABLE OF TEST SPECIFICATION

Q	Syllabus Topic and/Subtopic	Grade Level	Bloom's Taxonomy Levels of Cognitive Domain			Total
			Level 1	Level 2	Level 3	
1.	Numbers: Number Pattern	4	✓			1
2.	Geometry	4	✓			1
3.	Problem Solving: Add & Multiply	5		✓		1
4.	Common Fractions	5		✓		1
5.	Problem Solving: Money	5		✓		1
6.	Problem Solving	4/5	✓			1
7.	Numbers: Prime numbers	5	✓			1
8.	Numbers: Operations	5			✓	1
9.	Numbers: Place Values	5	✓			1
10.	Data Handling: Averages	5	✓			1
11.	Data Handling: Bar Graphs	4	✓			1
12.	Geometry	5	✓			1
13.	Whole Numbers: Expansion	5	✓			1
14.	Geometry: Angles	5		✓		1
15.	Problem Solving: Time	5			✓	1
16.	Measures: Perimeter & Area	5			✓	1
17.	Numbers: Factors	5	✓			1
18.	Measurement: Time	5		✓		1
19.	Operation with Money	4		✓		1
20.	Measures: Mass & Capacity	5	✓			1
21.	Measurement: Time	4/5	✓			1
22.	Measurement: Time	4/5			✓	1
23.	Fractions & Percentages	5	✓			1
24.	Ordering of Fractions	5			✓	1
25.	Problem Solving: Money	5		✓		1
26.	Measurement: Time	5			✓	1
27.	Operation with Numbers: BODMAS	4/5		✓		1
28.	Estimation	5		✓		1
29.	Data Handling: Averages	5			✓	1
30.	Mensuration	5		✓		1
Total number of questions			**13**	**10**	**7**	**30**

APPENDIX H

INTERVIEW QUESTIONS

The questions below are based on the proficiency test written by the lower primary teachers.

1. General Questions

1.1. Are there some topics in the mathematics syllabus that you do not understand; and if yes, which topics?

1.2. What kind of support do you receive from the school, circuit or regional office that strengthens your teaching of mathematics?

1.3. How often do you attend lower primary workshops/trainings? And when did you attend the last workshop/training at lower primary?

1.4. What do you think about the content of mathematics in the lower primary syllabus? Do you think it is suitable and appropriate for learners?

1.5. In your opinion, what hinders effective teaching and learning at lower primary? And what do you think could be possible solutions to the problems you have mentioned?

2. Test Specific Questions

2.1. What is your comment about the test?

2.2. Did you come across some questions in the test that you cannot able to answer; and if yes, which questions and what problems have you experience in those questions? Please explain.

2.3. In your opinion, do you think it is necessary for every lower primary teacher to have knowledge of mathematics? Motivate your answer.

2.4. Up to which level do you think lower primary teachers can have knowledge of mathematics? Motivate your answer.

2.5. In conclusion, what do you think about this research study to investigate lower primary teachers' knowledge of mathematics in Namibia, particularly in Ohangwena region?

2.6. Do you have any question, comment or suggestion to make?

Thank you very much

APPENDIX I

THE MAP OF NAMIBIA