FACTORS AFFECTING THE DEVELOPMENT OF NUMBER SENSE AND ITS INFLUENCE ON GRADE 12 LEARNERS' PERFORMANCE IN MATHEMATICS IN THE OSHANA EDUCATION REGION

ATHESIS SUBMITTED IN PARTIAL FULLFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF EDUCATION

OF

THE UNIVERSITY OF NAMIBIA

BY

SHIWANA T. NAUKUSHU

NOVEMBER 2011

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APPROVAL PAGE

This research has been examined and is approved as meeting the required standards for partial fulfillment of the requirements of the degree of Master of Education.

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Dean of Education Faculty Date

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External examiner Date

DECLARATION

I Shiwana Teeleleni Naukushu, hereby declare that The factors affecting the development of number sense and its influence on Grade 12 learners' performance in Mathematics in the Oshana Education Region is a true reflection of my own research, and that this work, or part thereof has not been submitted for a degree in any other institution of higher education.

_____ _____

Signature of Student Date

DEDICATION

This thesis is dedicated to:

My wife: Rachel Ndilimeke Tuwilika Naukushu

My son: Peter Shiningashike Praise Naukushu

My mother: Ndapunikwa Naukushu

My late father: Petrus Shiningashike Naukushu

For their patience, love, support and encouragement during the time that I stole from them as I was carrying out this study.

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ABSTRACT

Education in Namibia after independence remains a challenge, despite deliberate efforts made by the government. Many of the learners under perform in their Grade 12 Mathematics examinations, especially in the Oshana Education Region. This is allegedly because of a numerical deficiency. However; none of existing studies explain the influence of numerical deficiency on academic performance in Mathematics. Therefore this study purports to find out the state of number sense among the learners in the Oshana Education Region, its influence on academic performance in Mathematics, factors that affect the development of number sense among the Grade 12 learners in the Oshana Education Region and how teachers in Oshana Education Region plan and present lessons to aid the development of number sense. Consequently this study tried to seek answers to the following four questions:

1. What is the state of number sense among Grade 12 Mathematics learners in the Oshana Education Region?
2. What are the factors that affect the development of number sense among the Grade 12 learners in the Oshana Education Region?
3. What is the influence of number sense on academic performance in Mathematics among Grade 12 learners in the Oshana Education Region?
4. How do the Grade 12 Mathematics teachers in the Oshana Education Region plan and present their lessons to support the development of number sense?

This study used both quantitative and qualitative research designs. In order to determine the current level of number sense among the learners in the Oshana Education Region this study adopted and adapted the number sense test from McIntosh, Reys and Reys (1992). Marks of learners for their regional August Mock Examination were also used in this study.

Questionnaires with open ended and closed ended questions as well as lesson observations schedules were also used in this study for triangulation purposes.

Findings were that more than 50% of the learners have a numerical deficiency which could compromise their comprehension of Mathematical content and therefore might inhibit their academic performance in Mathematics. This study also found out that there is a strong positive correlation ($r = 0.702$) between the performance of learners on the number sense test and the academic performance in Mathematics. This study found that factors such as lack of teaching resources; teachers' competences; lack of materials by learners; and insufficient training in number sense given to the teachers during their initial teacher training. In addition, it was found that there was no significant difference between learners' performance in the Mathematics test and the number sense test.

It was concluded that more than 50% of the Grade 12 learners in the Oshana Region have a numerical deficiency which might affect their understanding and performance in Mathematics. In addition, the moderately high positive correlation coefficient found in this study indicated that the development of number sense in Mathematics had an influence on the academic performance of Grade 12 learners in Namibia. Teachers preferred different methods to aid the development of number sense such as discovery learning, question and answer, and collaborative learning. Teachers also indicated that they plan using different activities to aid sense making of numbers. Among the factors that affect the development of number sense the study found the following: learning content, teaching/learning materials, support given to teachers by the advisory services, class population and organization and teacher training.

There is therefore need for Mathematics teachers to ensure their learners are adequately exposed to number sense if better performance in Mathematics is to be realized. Simple calculators and other teaching resources need to be available for the teaching and learning of Mathematics in the country. Furthermore, initial teacher training should ensure that number sense is included in their curriculum.

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LIST OF ACRONYMS

DNEA	Directorate of National Examinations and Assessment
HoD	Head of Department
IGCSE	International General Certificate of Secondary Education
MBESC	Ministry of Basic Education, Sport and Culture
NPC	National Planning Commission
NSSC	Namibian Senior Secondary School Certificate
NSSCE	Namibian Senior Secondary School Certificate Examination
TIMSS	Third International Mathematics and Science Study
EBC	Educational Broadcasting Corporation
UNAM	University of Namibia
MoE	Ministry of Education
SAQMEC	Southern and Eastern Africa Consortium for Monitoring Educational Quality

CHAPTER ONE: BACKGROUND

Introduction

This chapter highlights the Namibian education system before and after independence. It also gives the theoretical framework, statement of the problem, research questions, significance of the study and limitations.

The overview of the Namibian education

Before Namibia got independence the education system was mainly characterized by inequalities brought about by apartheid. Amutenya (2002) states that three separate education systems existed before independence i.e. education for Whites, Blacks and for Coloureds. Teachers for the black (Bantu) education system were trained to teach for rote learning. Karlsson (1999) notes that Mathematics learners were trained using memorization as a tool of learning rather than making sense of numbers. Furthermore it was believed that blacks could only be competent in Mathematics up to a certain level, making it difficult for many black teachers to get to higher levels in Mathematics. This view is in line with Dewey's (1961) observation that black people have been oppressed in science education at its initial stage. Having been subjected to oppression this situation resulted in a numerical deficiency and lack of number sense among many Mathematics students, some of whom became Mathematics teachers in Namibia (Fireire, 1998).

After independence, the education system in Namibia was reformed and four main goals that entailed accessibility, quality, equitability and democracy in education were set (Ministry of Education and Culture (MEC), 1993). Namibia also developed Vision 2030 which anticipates that the country will be developed and industrialised by the year 2030 (National Planning Commission (NPC), 2003). NPC (2003) further states that development of Science and

Mathematics is crucial and needs to be strengthened in order to speed up the realization of vision 2030. The development and understanding of Mathematics and Sciences require considerable numerical sense.

In the Namibian context the level of number sense and its influence on academic performance in Mathematics is still under researched. Since the adoption of the International General Certificate of Secondary Education (IGCSE) curriculum, it is not clear whether there is enough number sense among the Namibian Grade 12 learners to enable them to cope with Mathematics (Clegg, 2008). Furthermore, it is also evident from Clegg (2008) that there are no studies done in the Namibian context to find out the current level of number sense and its influence on academic performance in Mathematics at Grade 12 level.

The Directorate of the National Examinations and Assessment (DNEA) (2009) indicated that over the past five years Mathematics has been among the subjects where learners showed poor performance at Grade 12 level. Oshana Educational Region was among the regions that did not perform well in Mathematics as compared to the rest of the other subjects. At least 75% of Grade 12 learners in the Oshana Education Region scored below a D symbol in Mathematics for the academic year 2007 (Aipanda, 2008). There is thus a need to inquire how the number sense influences the academic performance of Grade 12 learners in Mathematics.

Theoretical framework

Underpinning this study was the constructivism paradigm. According to George (1991) the constructivism theory refers to the idea that learners construct their own knowledge, i.e. each learner individually and socially constructs his or her own knowledge. George (1991) further states that the dramatic consequences of this view are twofold; i.e. firstly it focuses on thinking

about the learning and not on the subject or lesson. The second aspect is that there is no knowledge independent of the meaning attributed to experience (constructed) by the learner or community of learners.

Jonassen (2004) defined constructivism as a psychological theory of knowledge which argues that humans generate knowledge and meaning from their experiences. This study was aimed at finding out whether the experience of Grade 12 learners in the Oshana Education Region has equipped them with the mathematical experiences and meaning that will enable them to build enough number sense.

According to Jonassen (2004) constructivism theory is based on two main constructs: accommodation and assimilation. Assimilation refers to the way individuals incorporate new experiences into the already existing frameworks without necessarily changing these frameworks. It is envisaged that as learners experience new mathematical content they will assimilate it within their already existing knowledge thereby by creating new knowledge about the number sense. This study assessed the new knowledge constructed and assimilated by Grade 12 learners in Oshana Education Region learners about number sense over the past years of schooling. This study also assessed the classroom environment through lesson observation whether it favours Grade 12 learners in the Oshana Education Region to assimilate new knowledge about number sense.

Accommodation on the other hand is characterized by the way individuals learn from their failures (Jonassen, 2004). This study then assessed through lesson observations how the teachers encouraged the learners to learn from their failures. This study also evaluated the extent to which the interactions of Grade 12 learners among themselves enable them to learn actively from their mistakes.

Cobb (1999) states that constructivism is a learning theory that predicts that knowledge encoded from data by the learners themselves will be more flexible, transferable and useful than knowledge encoded for them by the experts and transferred to them by an instructor or other delivery agent. If this prediction is correct, then learners will have to be modeled as scientists and use the reasoning and technologies of scientists to construct their own knowledge. It is expected that if learners are given probing Mathematical problems, puzzles, assignments and tests that challenge their computations, thinking and predictions these will help in developing their ability to work independently and will gradually construct their own number sense.

The Educational Broadcasting Corporation (EBC) (2004) stated that in the constructivist classroom the focus tends to shift from the teacher ("expert") pouring knowledge into the empty vessels ("learners") without the learners taking part in their own learning. In the constructivism model the learners are encouraged to be actively involved in their own process of learning. The teacher functions mainly as a facilitator who coaches, mediates, prompts and helps the learners to develop and assess their own understanding, and thereby learning. One major task of the teacher in a constructivism class is to ask good probing questions. This study also evaluated by means of lesson observations the extent to which the teachers assume their facilitative and probing role in the presentation of their lessons. The prompting, coaching and mediation by the teacher will enable the learners to develop their number sense. EBC (2004) further states that in a constructivist classroom, learning has three main features:

Firstly learning is constructed; learners are not blank slates upon which knowledge is etched. They come to the learning situations with already formed knowledge, ideas, and understandings. This previous knowledge is the raw material for the new knowledge they will create. At Grade 12 level learners should have a Mathematical base from previous grades on which to build their

number sense. This study took the assumption that Grade 12 learners were equipped with enough foundation and experience over their years of schooling to enable them develop enough number sense.

The second feature of constructivism according to the EBC (2004) learning is active; a learner is the person who creates new understanding for him/herself. The teacher coaches, moderates, and gives direction for learning and asks questions. Learning activities require the learners' full participation. An important part of the learning process is that learners reflect on and talk about, their activities. Learners also help set their own goals and means of assessment. Lesson observations in this study were used to assess the strengths of the tasks and the methods the teachers use, whether they allow the learners room to experiment and consequently develop their number sense, by actively learning from each other during their Mathematics lessons. Learners control their own learning process, and reflect on their experiences. The number sense test and lesson observations were used as a tool to assess deductions and reflections on past Mathematical concepts among the Grade 12 learners in Oshana Education Region.

The third feature of constructivism is collaboration; that is, classroom relies heavily on collaboration among learners. There are many reasons why collaboration contributes to learning. The main reason why collaboration is used so much in constructivism is that learners learn about learning not only from themselves, but also from their peers. When learners review and reflect on their learning processes together, they can pick up strategies and methods from one another. This study assessed the method of lesson delivery by the teachers and their interactions with learners as well as interactions amongst learners themselves. The assessment will be the extent to which such interactions enable the Grade 12 learners in Oshana Education Region to construct their own number sense.

Statement of the Problem

The study identified a problem of persistent poor performance in mathematics at Grade 12 level in the Oshana Education Region (DNEA, 2009). This poor academic performance in Mathematics was attributed to many reasons. One of them was the lack of number sense. Wessel (2008) notes that there is a strong positive correlation between the understanding of Mathematics and number sense. However, studies in the Namibian context failed to address some issues about number sense of learners at grade 12 level. These include: assessment of the level of number sense of grade 12 learners, identification of factors affecting development of number sense among Grade 12 learners as well as studying the influence of number sense on academic performance.

Consequently, this study was done to assess the factors that influence the development of number sense and its influence on mathematical performance among Grade 12 learners in the Oshana Education Region.

Research questions

This sought answers to the following questions:

1. What is the state of number sense among the Grade 12 Mathematics learners in the Oshana Education Region?
2. What is the influence of number sense on academic performance in Mathematics among the Grade 12 learners in the Oshana Education Region?
3. What are the factors that affect the development of number sense among the Grade 12 learners in the Oshana Education Region?
4. How do the Grade 12 Mathematics teachers in the Oshana Education Region plan and present their lessons to support the development of number sense?

Significance of the study

This study was found to be important in contributing to the global knowledge bank by availing new information on the development of number sense and its influence on academic performance in Mathematics as a subject among Grade 12 learners in the Oshana Education Region. The findings of this study might be used for recommendations to policy makers for policy initiation and formulation to ensure reinforcement of number sense development in the Namibian education system. This study might provide valuable information on the status of number sense development at Grade 12 in Oshana Education Region and also reveal the draw backs which act as learning tools for improvement by both teachers and learners. The findings of this study might be used to compare similar studies in other regions. This might create a significant data base for the Namibian education system and for other researchers in the same field of study.

Limitations

In the number sense test, guess work might have played a role in the outcome of this study. The questions on the number sense are multiple choice. Students might have just guessed the answers without actually working out the questions. During the observation of lessons teachers might have changed their normal way of teaching knowing that someone was observing them. Learners might have suspected that number sense test had something to do with their examinations and might have communicated the questions to their friends at different schools especially with the advancement in technology e.g. cell phones and e-mails.

However, in both situations confidentiality and the importance of honest responses on the findings of this study were explained to the respondents in order to try and address these situations.

Delimitations

This study was carried out in the Oshana Education Region. It involved Mathematics teachers and learners at Grade 12 level in the Oshana Education Region.

Definition of terms

The following terms should be understood as defined below:

Number sense: Generally means a sound practical judgment of numbers (Robert, 2002). In this study number sense means the ability to do: computations; estimations; recognize effects of operations and the equivalence of expressions, (McIntosh, Reys & Reys, 1997, 356).

Development of number sense: Generally development means the process of producing or creating something so that it becomes advanced and stronger (Robert, 2007). In this study development of number sense means to acquire or cultivate the following skills do computations, estimations, recognize effects of operations and the equivalence of expressions (McIntosh, Reys, & Reys, 1997, p. 356).

Academic performance: Generally means achievements in education. In this study academic performance means percentages obtained by the Grade 12 learners of Oshana Education Region in Mathematics in August Examination of 2010.

CHAPTER TWO: LITERATURE REVIEW

This chapter provides the review of literature on number sense. This section analyses the meaning of number sense from the existing literature. Furthermore, brings out some issues pertaining to teaching and learning of number sense from the literature. There are few studies carried out in Namibia on number sense, therefore most of the literature comes from other countries.

The concept of number sense

Number sense has been defined in different ways. Menon (2004) defines number sense as an intuitive understanding of numbers, their magnitude and how they are affected by operations. Hilbert (2001) on the other hand defines number sense as the sense of what numbers mean, and the ability to perform mental Mathematics by thinking about numbers and making comparisons among the numbers. The two authors appear to hold common ideas about the meaning of number sense, i.e. the understanding of numbers, what they mean and how they function. For learners to claim possession of number sense, they should be able to understand what numbers mean and how they are related to the real world. The other common idea from the two definitions above is that of performing number operations. Numbers alone, without arithmetic operations, do not mean anything. Number sense therefore includes performing operations with numbers.

Burn (2004) defines number sense as a well-organized number information that enables an individual to understand numbers and number relationships and solve mathematical problems. From Burn's definition it follows that for a person to have a strong sense of numbers one needs more information on how numbers behave, and interrelate. This is in line with Greeno (2006)

who stated that in most cases learners' performance in Mathematics is compromised by their understanding of numerical principles.

Zanzali (2005) views number sense as the sound understanding of numbers and relationships between magnitudes of numbers. Number sense should stress the importance of the magnitudes of numbers, i.e. a learner with enough number sense should picture in mind how much a given number represents. Jonassen (2004) on the other hand defines number sense as the ability to use numbers to compute accurately, to self-correct by detecting errors, and to recognize the result as reasonable. It is important to recognize the reasonableness of the results obtained and learners who possess number sense should be able to produce answers that are reasonable.

From literature such as Jonassen (2004), Zanzali (2005), Burn (2004), Hilbert (2001), McIntosh, Reys, and Reys, (1992) and Menon (2004) the definition of number sense consists of 5 key components:

- understanding meaning and size of numbers,
- understanding equivalence with numbers,
- understanding meaning and effects of operations,
- understanding counting and computation strategies and
- understanding estimation without calculating.

Understanding the meaning and sizes of numbers refers to the ability of an individual to recognise how much the numbers represent (McIntosh, Reys, and Reys, 1992). Understanding the use of the equivalent forms of numbers on the other hand refers to comparing the number sizes in different notations (McIntosh, Reys, and Reys, 1992). The meaning and effects of operations refer to the idea that learners should be able to understand what the different operations in Mathematics mean and the order that they should be carried in once, two or more

operations appear within one sum. This further means that the learners should be able to do mental computations (McIntosh, Reys, and Reys, 1992). The ability to estimate refers to the meaningfulness and accuracy of the estimations that the learners make. Learners should thus be able to use their number sense to make reasonable and accurate estimations which will help them to solve real life situation problems (McIntosh, Reys and Reys, 1992). Computing and counting strategies refer to the individual's ability to design strategies that will help them reach the desired outcome of a mathematical problem or sum.

The development of number sense

Number sense has been studied widely in other countries. In the United Kingdom (UK) the concept of number sense is usually developed from the beginning of primary school starting at Key Stage 1 (Grade 1-3) (Clegg, 2008). Clegg indicates that in Key Stage 2 (Grade 4 to 7) learners are expected to have a solid foundation of number sense and are expected to do most of the calculations mentally. There is thus a lot that Namibia can learn from the UK in terms of building strong number sense among the Namibian learners.

Singapore was third in the Third International Mathematics and Science Study (TIMSS) of 1998 (Wessels, 2008). Singaporean Mathematics teachers work hard with their learners as far as the development of number sense is concerned (Tansheng, 2007). The Netherlands have also worked hard on the development of Mathematical understanding as well as development of number sense and gained first position in the 1998 TIMSS (Schoenfeld, 2006). Teachers in Netherlands develop the number sense of their learners based on the Realistic Mathematics Education (RME) which stresses that the teaching of Mathematics should be connected to reality. Inclusion of number sense in the Mathematics curriculum appears to bear fruit as far as improved student performance in Mathematics is concerned. It is therefore important for Namibia to research on

what they can learn from these countries to see if adopting number sense at lower grades will help achieve reasonable mathematical academic performance at higher grades.

Factors affecting the development of number sense

There are some factors that are believed to have an effect on the development of number sense. This section will identify and discuss these factors. Pressures of examinations can have an influence on the development of number sense (Eugene, 2002). Eugene further indicated that learners can bring powerful mathematical knowledge to their formal high school settings. Thus learners can construct understanding of numbers from the early number sense teaching at primary schools where the emphasis is on manipulation of symbols and materials in order to understand Mathematics. However this is compromised by the pressure of examinations at secondary school level. If the anxiety of examination is eliminated teachers may concentrate on teaching real Mathematics rather than teaching for rote learning (Dole, & Beswick, 2001)

A strong number sense and its positive results depend on both the teachers and learners' perceptions and the value they put on the concept of number sense. Several research studies investigating successful instructional strategies which aim at developing number sense for example, Blöte, Klein, & Beishuizen (2000); Gravemeijer, Cobb, Bowers, & Whitenack, (2000) have indicated that instruction should be flexible by allowing students to explore, discuss, and justify their strategies and solutions so as to find the value of the subject matter. Other important aspects to consider in the development of number sense is to include room for learners to learn collaboratively, learners learning from their mistakes and by having a conducive classroom atmosphere (Blöte, Klein, & Beishuizen, 2000) and (Gravemeijer, Cobb, Bowers, & Whitenack, 2000).

Teacher's instructional expectations on learners' knowledge to cope with the mathematical content are also important in the development of number sense. In addition, competencies of the teacher also influence successful development of numerical principles. During the teaching and learning the teacher is expected to be clear and consistent in order to encourage, learning peers, learning by doing, thinking through answers, learning from mistakes (Ranson, & Wiliam, 2001).

The current emphasis on numeracy in schools requires facility with mental computation (Steen, 1999). According to Sowder (1988) one of the pre-requisites for mental computation facility is instant recall of basic facts. Other researchers such as Hope, & Sherrill (1987) suggest that basic facts knowledge is a related skill to mental computation and not a prerequisite. Nonetheless the provision of rich learning environments where explorations of number combinations and arrangements are encouraged, results in children to derive spontaneously their own strategies for basic fact combinations (Fusson, 1992) as well as developing number sense through exploration of number relationships (Wright, 1996).

However, other researchers such as McIntosh, & Dole (2000) and Heirdsfield, & Cooper (2004) have shown that many children do not develop efficient strategies for basic facts due to poor, inefficient and sometimes lack of mental computing/counting strategies in primary grades. On the other hand, Heirdsfield, & Cooper (2004) found that proficient mental computers used efficient number facts strategies when number facts were not known by recall but not necessarily by learning with understanding. Heirdsfield, & Cooper (2004) stated that absence and inadequacy of mental computing strategies should not be an excuse for not making provisions to develop numerical understanding of the children. Thus there should always be other alternatives for teachers to explore different materials and search and use to develop mental computing

strategies. These include; textbooks, Mathematical puzzles, Mathematics clubs, and posters for the learners to interact with and hence develop their number sense.

The development of number sense is fostered in stimulating and rewarding environments (Hope & Sherrill, 1987). This means that learners should be motivated to learn to develop their number sense. Positive reinforcement is therefore of outmost importance. A conducive environment helps learners to develop positive attitudes towards Mathematics. Language is one of the factors that may have an influence on the development of numerical sense. Klein, & Beishuizen (2000) indicated that the language used in class needs to be clear and accurate. The teachers need to express themselves in the language of instruction clearly in order to ensure the learners understand the numerical principles. The subject content is also another crucial factor in the development of number sense. Number sense activities and tasks that the teachers use need to be at the level of the learners. Contextualization of the content is very important as it helps the learners to see the sense in their context and become more encouraged in developing their own understanding of numbers (Klein, & Beishuizen, 2000).

In this section it has been shown that the following factors are directly involved in the development of learners' number sense; the teacher, the class organization and population, the learners, the resources and subject content and the level at which the learners are.

Teacher training versus the development of number sense

It is important for Mathematics teachers to have a good sense of numbers in order for them to be able to teach the learners to make sense of numbers. However in some cases teachers may not be competent enough to teach learners to make sense out of numbers. Fishebein (2007) indicates that 35% of the pre-service teachers in the New Jersey area also experience problems with

number sense. From Fishenbein's (2007) findings it is possible to predict a vicious cycle of innumeracy which the learners may be trapped in and may be difficult to get out of it. Such a vicious cycle of innumeracy is suggested in Figure 1.

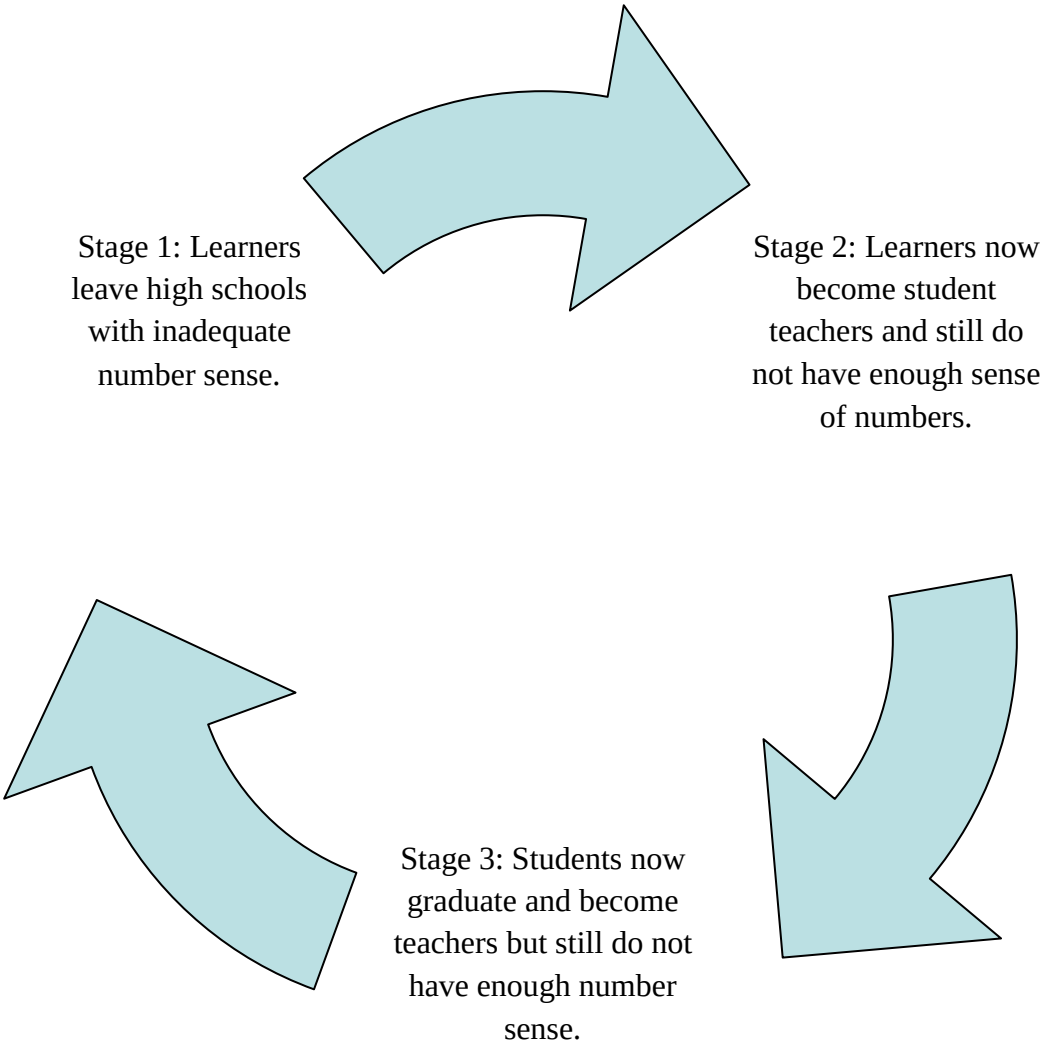

Fig. 1: The vicious cycle of innumeracy

From the vicious cycle of innumeracy it appears that the cycle begins with learners' lack of number sense, which leads to learners leaving high schools without adequate number sense. It all means that such lack of number sense can be carried over to their next stage of their education.

Once they enter teacher training institutions without adequate numbers sense and eventually graduate to become teachers with the lack of number sense, they pass on this inadequacy to their learners and the cycle continues. Once trapped in this circle, it will be difficult for Namibian learners to escape lack of number sense.

Similar to the above is the Namibian situation where junior primary school teachers are trained to teach across the curriculum. Some of the junior primary school teachers did not do Mathematics at Grade 12 level, and just end up teaching Mathematics at junior primary school level. This poses a risk in the sense that most of such teachers teach Mathematics to junior primary school learners since they have to teach Mathematics. Learners taught by incompetent teachers in Mathematics at their initial stage of their education may actually end up not being able to develop numerical abilities as the teachers may not be that competent to help them develop required numerical skills. It is against this background that research into the numerical sense should try to address this as it poses a potential risk to the learners at their initial stage of their education.

Other researchers such as Menon (2004), Hilbert (2001) & Greeno (2006) argue that there is a need for Mathematics teachers to take up a number sense course as part of their training. In Namibia the status of number sense among Mathematics teachers is not clearly known. It is therefore necessary to do further research and find out the status of number sense among the mathematics teachers.

Menon (2004) argues that teacher educators need to teach pre-service Mathematics teachers to understand how children develop number sense so that they will be able to effectively facilitate the development of number sense. It is therefore important for the teacher training sector in Namibia to ensure that the Mathematics teachers will effectively carry out their duties once they

enter the job market by providing them with a number sense course. Eugene (2002) suggests that teachers at all levels need to have a number sense module in their teacher training course in order to enable them develop the numerical sense among the learners that they will be teaching. Eugene further indicated that in South Africa number sense is a compulsory course for Mathematics teacher trainees.

Namibian Mathematics teachers are trained at different institutions to teach Mathematics at different grade levels. The University of Namibia trains senior secondary school Mathematics teachers under the Bachelor of Education (B. Ed.) programme while Colleges of Education train junior secondary and primary school Mathematics teachers under the Basic Education Teachers Diploma (BETD) programme. None of the said institutions offer number sense as part of the teacher training curricula (Clegg, 2008). It is therefore esssential to find out what strategies Mathematics teachers use during their teaching to aid development of number sense of learners to give feedback to the curriculum developers and the teacher training institutions.

Measuring the number sense of learners

It might be arguable to measure the number sense of learners. Literature did not seem to prescribe the best recipe of measuring the number sense of the learners. In order to determine the current level of number sense among the learners in the Oshana Education Region this study adopted the number sense test from McIntosh, Reys, and Reys (1992). McIntosh, Reys, and Reys identified four levels that depict different numerical abilities; i.e. (level 1- 4) which according to McIntosh, Reys, and Reys, (1992) are in the order of increasing strength. That is, weakest number sense is represented by level 1 and level 4 represents the strongest levels of number sense.

The following descriptions as adopted from McIntosh, Reys, and Reys (1992) were used to explain the levels of number sense among which learners fell:

Very strong number sense: A score from 60% and above in the number sense test.

Strong number sense: A score from 50% to 59% in the number sense test.

Weak number sense: A score from 30% to 49% in the number sense test.

Very weak number sense: A score below 30% in the number sense test.

Generally literature in the Namibian context did not provide an evidence of how the number sense of Namibian learners is, the factors that might impact the development of number sense in the Namibian context as well as the possible influence that number sense may have on the academic performance of the Namibian learners. Henceforth this study tried to address the latter issues.

CHAPTER THREE: METHODOLOGY

This chapter describes the methodology which was used in collecting and analyzing the data for this study. The research design, population and the sample and sampling techniques, research instruments and data analysis are also described in this section.

Research design

This study combined both quantitative and qualitative research designs. Quantitative research consists of those studies in which the data can be analysed in terms of numerical values (Loraine, 2004). The academic performance of learners in Mathematics and in the number sense test was assessed in terms of the numerical scores and hence this study encompassed characteristics of a quantitative study. Furthermore the study was also correlational as it tried to study the relationship between the number sense and the academic performance of the learners in Grade 12 in the Oshana Education Region. Correlational Research tries to study the relationship between variables (Loraine, 2004).

The teachers' experiences (qualitative) about number sense and the factors that influence the development of number sense among the learners were also studied. Qualitative studies deal with studies that reflect preferences, personal opinions, experiences or views of people to be studied (Loraine, 2004).

Population

The population of this study was all Mathematics teachers and learners at Grade 12 level in the Oshana Education Region.

Sample and sampling procedure

To ensure equal representation of the population in the sample a random sample of 20 learners was selected from each school within the population defined in the previous subsection. Learners were assigned random numbers; consequently a random sample of 20 learners was drawn from each school according to the assigned random numbers. Due to the lack of a large number of Mathematics teachers in the schools two Grade 12 Mathematics teachers were conveniently selected from each school. Thus the sample of this study consisted of 181 learners and 18 Mathematics teachers at Grade 12 in the Oshana Education Region.

Research instruments

The study used the following instruments to collect the data from the sample:

Number sense test

In order to determine the current level of number sense among the learners in the Oshana Education Region this study adopted the number sense test from McIntosh, Reys and Reys (1992) to use. The number sense test consisted of the 5 sections with questions on key component indicated below:

- Meaning and size of numbers
- Equivalence of numbers
- Meaning and effects of operations
- Counting and computation strategies
- Estimation without calculating

Observation schedule

The second data gathering tool was the observation schedule. The researcher observed each Mathematics teacher teaching to find out how they developed the number sense among Grade 12

learners. The observation schedule was used in an attempt to better understand the world of the participants. According to Patton (1990, p. 13) to understand the world of participants one has to "Enter into their world. To understand the world you must be part of the world while at the same time remaining separate, a part of and apart from". The researcher was a non-participant observer during the observations to avoid subjectivity from the researcher.

Twenty-seven (27) lessons were observed in total (three lessons for each sampled teacher). Patton (1990) indicated that direct observations may be more reliable than what people may say in many instances. Therefore using observations clearly reflected what really took place in the classrooms of the sampled Mathematics teachers. The lesson observations were done to provide more information on the extent to which the Grade 12 Mathematics teachers present their lessons to support the development of number sense. Furthermore, the lesson observations helped to determine the classroom factors that influence the development of number sense of Grade 12 learners in the Oshana Education Region.

Mark sheets

The mark sheets of the August examination for the academic year 2010 in Mathematics were studied and the marks were extracted from these sheets and compared with the number sense marks. Scatter plots were plotted and correlation coefficients were also calculated for each scatter plot. The results of the scatter plots were interpreted (see Appendix 7).

Questionnaire

To address the question of factors that affect the development of number sense among the Grade 12 learners in the Oshana Education Region and that of how teachers plan and present their lessons, questionnaires with open ended and closed ended questions were used.

Pilot Study

The pilot study was conducted amongst learners from Oshakati Senior Secondary School which was closer to the researcher's workplace. Ten (10) learners from the school were used in the pilot study. Both 2 teachers and learners used in the pilot study were not included in the actual study.

As a result of the pilot study the following changes were made to the instruments:

The number sense test time was changed from its initial duration of 45 minutes to an hour, since most of the learners could not do it in the 45 minutes that was initially allocated to it. Questions 4, 6, 12, 15, 17 and 23 were rephrased as they did not make sense to the learners.

The interview schedule for the teachers was transformed into a questionnaire, since the teachers were not willing to be interviewed especially with the presence of the tape recording instruments.

Some sections from the observation schedule were moved to the questionnaire as the researcher was unable to observe the elements of those sections. It was observed from the pilot study that teachers could give more valuable information as compared to what the researcher was observing.

Validity

In this study face and content validity were determined. For face validity the instruments were submitted to three colleagues and the two supervisors, to evaluate the suitability of the questions and outline in relation to the objectives of the study as recommended by Polit, & Hungler (1997). This was done to ensure that questions actually assessed the characteristics that were targeted by the investigator. The responses were then compared with a standard measurement of the desired characteristics being assessed (Hulley et al., 2001). For content validity the literature and existing policies on number sense were utilised.

Reliability

In order to ensure consistency in measurement and to be quite sure that every change noted was observable and not due to the measurement process, the instruments were tested for reliability. The instruments were subjected to a test-retest technique, based on the assumptions that the phenomenon to be measured remains the same at two testing times and that any change is a result of random error (Dipoy, & Gitlin 1998). The information collected from various tools was used for triangulation purposes.

The number sense test was given to learners at Oshakati Senior Secondary School. For the same reason interview guides were also piloted with two of the Grade 12 Mathematics teachers at the same school. For all the instruments questions were duplicated with continuous numbering to test for consistency of measurement (reliability). The test-retest scores were subjected to the Kuder-Richardson coefficient of reliability and showed a strong positive correlation of 0.77.

This study could not consider Grade 11 learners as they do not write the same mock regional examination.

Data collection

Permission to carry out this study was sought from the University of Namibia Post Graduate Committee through the Faculty of Education, and from the Ministry of Education through the Regional Director of education. Appointments were scheduled in advance by the researcher for the data collection process to run smoothly. Data was collected from Grade 12 learners and their Mathematics teachers using the Number sense test, interview schedule and observation schedule.

The researcher conducted the test for the learners selected in the sample. The researcher then observed the sampled teachers from each school and subsequently the questionnaires were

administered after the lessons. The questionnaires were done after the lesson to avoid having an influence on the lesson presentations.

Data analysis

The quantitative data was presented in tables and graphs. The levels of number sense were studied and each individual school was ranked on which level of number sense it was. The following descriptions as adopted from McIntosh, Reys, and Reys (1992) were used to explain the levels of number sense among which learners fell.

Very strong number sense: A score from 60% and above in the number sense test.

Strong number sense: A score from 50% to 59% in the number sense.

Weak number sense: A score from 30% to 49% in the number sense test.

Very weak number sense: A score below 30% in the number sense test.

The results of the learners in both the number sense and in their Mock Examinations were analysed using descriptive statistics. The correlation between number sense and the academic performance of learners in Mathematics was analysed by using Pearson's correlation coefficient. The average scores of learners per school on the number sense test were calculated and interpreted to answer the question of how much the learners made sense of the numbers. The t-test was used to test if there were significant differences among the average performances of learners in Mathematics and in the number sense. The averages of learners in the number sense test and their academic performance were tested if they were significantly different.

The qualitative data was analysed using teachers' reflections and experiences by means of quotes on the responses of the teachers.

Ethical considerations

Teachers and learners participating in this study received full information about the purpose and objectives of the study so that they could make informed decisions about whether to participate. Participants were assured that their information will be treated with the strictest confidentiality and anonymity (Brink, & Wood, 2001). The schools teachers' or learners' names were not shown on the instrument, and any form of identification that made it possible to trace responses to schools, teachers or learners was eliminated by the use of codes.

CHAPTER 4: PRESENTATION AND DISCUSSION OF DATA

Introduction

This chapter presents the findings, interpretations and discussions of the research. The data presented in this chapter is both qualitative and quantitative. The results were collected from two sources the Mathematics teachers and learners in the Oshana Education Region.

This chapter is divided in five sections, namely:

- Biographical information of participants.
- The state of number sense among the Grade 12 Mathematics learners in Oshana Education Region.
- Influence of number sense of Grade 12 learners in Oshana Education Region on their academic performance in Mathematics.
- Factors affecting the development of number sense of Grade 12 Mathematics learners in Oshana Education Region.
- Planning and presentation of lessons by Grade 12 Mathematics teachers in Oshana Education Region to aid development of number sense.

Biographical information of participants

The Grade 12 teachers consisted of 10 male and eight female teachers whose age was between 23 and 45 years. Of the 181 learners who participated in this study were aged between 15 and 22 years. Most (154 out of 181) of the learners who participated in this study speak Oshiwambo. However, 27 out of 181 speak other languages as indicated below such as English (2), Silozi (9), Damara/Nama (4), Afrikaans (5) and Portuguese (7). Moreover, 111 out of 181 participants

(learners) were from rural locations and 70 out of 181 were from semi-urban locations. There were 98 female and 83 male participants (learners).

The state of number sense among Grade 12 Mathematics learners in Oshana Education Region.

In order to determine the state of number sense among the Grade 12 Mathematics learners in the Oshana Education Region, this study adopted and adapted the number sense test from McIntosh, Reys, and Reys (1992). Subsequently, the number sense test marks for all Grade 12 Mathematics learners in the Oshana Education Region who took part in the number sense test were categorized in four levels (Levels 1- 4) which according to McIntosh, Reys, and Reys, (1992) are in the order of increasing strength (these levels are defined in Chapter 2). That is, weakest number sense is represented by Level 1 and Level 4 represents the strongest levels of number sense.

Figure 2 illustrates the frequencies and percentages of all Grade 12 learners in the Oshana Education Region (N=181) who took part in the test according to their achievement levels in the number sense test.

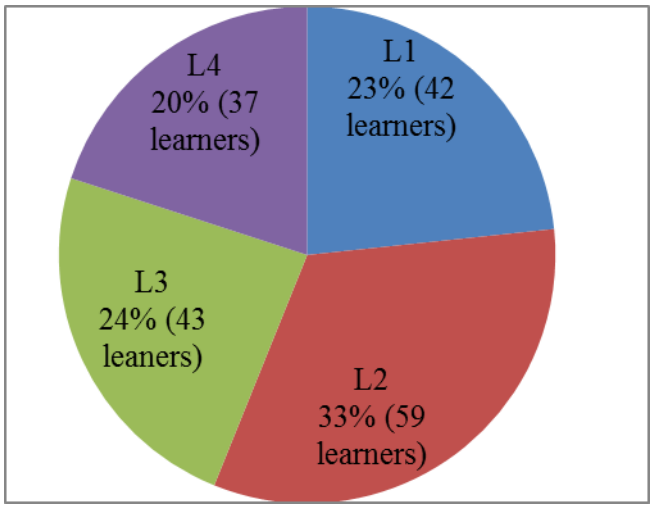

Fig. 2: Frequencies of all learners versus their attainment levels in the number sense test (N=181).

According to Figure 2 the overall number sense test results for all schools indicated that 56% of the learners scored marks which a rated in the weak levels of number sense. On the other hand only 44% of the learners achieved strong levels of the number sense test. This indicates a deficiency of numerical sense among the Grade 12 Mathematics learners in the Oshana Education Region.

To obtain a clear picture the frequencies and the percentage of attainment for each of the four levels of number sense in each school were noted and summarised in Table 1.

Table 1: The percentages of learners for each level of number sense in each school.

School	Levels (%)			
	1	**2**	**3**	**4**
A (N=20)	19	42	27	12
B (N=20)	30	29	12	29
C (N=20)	25	50	12	13
D (N=20)	15	10	65	10
E (Ordinary) (N=20)	32	26	37	5
E (Higher) (N=21)	0	7	0	93
F (N=20)	5	5	11	79
G (N=20)	32	26	37	5
H (N=20)	36	41	14	9
I (N=20)	24	48	16	12

Table 1 suggests the same trend (as in Figure 2) of numerical deficiency among many Grade 12 learners of Mathematics in the Oshana Education Region. Moreover, Table1 shows that 6 out of 9 (66.7%) schools in Oshana Education Region had more than half of their Grade 12 Mathematics learners scoring marks that are ranked weak according to the Levels of number sense. Furthermore, according to Table 1 only 3 out of 9 (33.3%) schools in the Oshana Education Region with more than half of their Mathematics learners at Grade 12 level scoring marks that are ranked in the strong Levels of number sense. The levels used in both Figure 2 and

Table 1 are as adopted from McIntosh, Reys, and Reys (1992) which were initially described in Chapter 2.

Furthermore, evaluation of the learners by their teachers was also an important point to consider whilst trying to assess the development of number sense of Grade 12 learners in the Oshana Education Region. Based on their assessment, teachers were asked to comment on the levels of the number sense of their learners and the responses of the teachers to this question are summarized in Table 2.

Table 2: Teachers' assessment of the number sense of their learners (N=18).

Level	**Frequency**	**Percentage**
Very strong	4	22.2
Strong	2	11.1
Weak	4	22.2
Very weak	8	44.4
Total	**18**	**100**

Table 2 shows that the teachers were of the opinion that there exists a numerical deficiency among the Grade 12 learners in the Oshana Education Region. Combining the two weak levels in Table 2 show that 66.7% of the teachers were of the opinion that the learners had a weak number sense while 33.3% indicated that their learners poses a strong number sense. Both Tables 1 and 2 as well as Figure 2 suggest a numerical deficiency among many of the Grade 12 learners in The Oshana Education Region.

Moreover, the assessment of teachers on the levels of number sense of their learners was compared with the results of the number sense test. Table 3 compares the teachers' assessment versus the actual attainment levels of learners on the number sense test.

Table 3: Actual performance of leaners versus teacher assessment of the same leaners in the number sense test.

Level	Performance of learners		Teacher assessment	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Very strong	43	23.8	4	22.2
Strong	37	20.4	2	11.1
Weak	59	32.6	4	22.2
Very weak	42	23.2	8	44.4
Total	**N=181**	**100**	**N=18**	**100**

Table 3 indicates that about 67% of the teachers observed a numerical deficiency among their learners. Table 3 further shows that about 56% of the learners manifested numerical deficiency in the number sense test. The results of Table 3 seem to suggest a number sense deficiency among Grade 12 learners in the Oshana Education Region.

If one compares the responses of the teachers in Table 2 with the learners' attainment levels as shown in the same table, minor differences in the assessments of teachers and what the learners scored in the number sense test might be noted. For instance 11.1 % of the 18 teachers responded that learners had a strong number sense. However, only 20.4% of the 181 learners manifested a strong number sense. Similarly 22.2% of the teachers indicated a weak level of number sense among their learners but 32.6% of the learners achieved a weak level of number sense. A small difference was observed in the very strong level of number sense shown in Table 3, the ratings were 22.2% and 23.8% for the teachers' assessment and learners' attainment levels respectively. Moreover 44.4% of the teachers indicated that their learners had a very weak number sense but only 23.2% (181) achieved a very weak number sense score.

The results portrayed by both Figure 2, as well as Tables 1, 2 and 3 agree with the claims by DNEA (2008) that there is a numerical deficiency among many Mathematics learners at Grade 12 level in Namibia. The numerical deficiency among the Mathematics learners of the Oshana

Education Region portrayed by Figure 2, Tables 1, 2 and 3 may compromise the comprehension of Mathematics by the Grade 12 learners in the Oshana Education Region.

Uniquely, there is only one school (school E) in Oshana Education Region where learners of Mathematics were taught and examined at the higher as well as the ordinary level of the Namibian Senior Secondary School Certificate (NSSC). Figures 3 and 4 indicate the frequencies of learners and the corresponding levels of attainment in the number sense test for the learners who were doing NSSC higher and ordinary levels respectively.

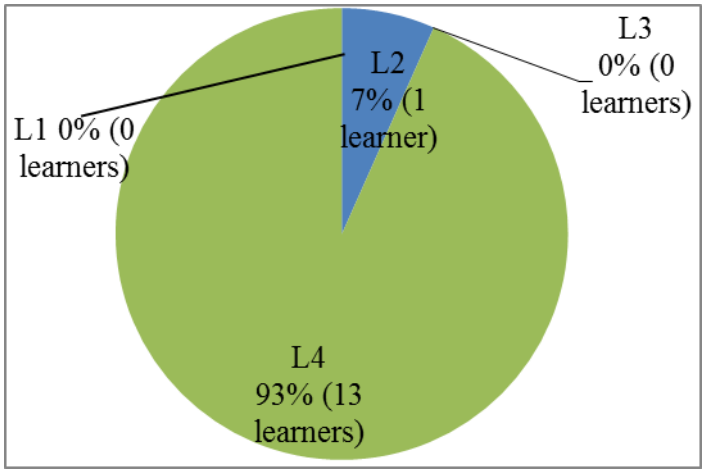

Fig. 3: Frequencies of High level Mathematics learners of school E according to their attainment levels in the number sense test (N=21).

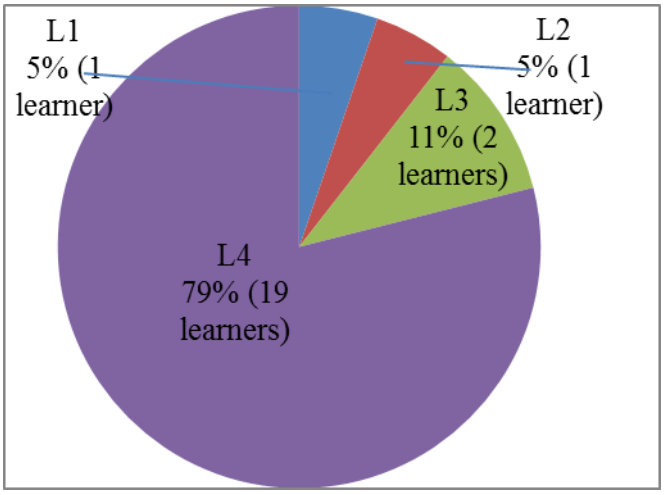

Fig. 4: Frequencies of Ordinary Level Mathematics learners of school E according to their attainment levels in the number sense test (N=20).

Figure 3 indicates that most of the learners (93%) who did high level Mathematics in school E scored marks that ranked in the strong levels of number sense. However, the number sense test results of Grade 12 learners taking Mathematics at an ordinary level in the same school displayed the same trend as the high level ones. Figures 3 and 4 established that most of the learners (about 90%) of Mathematics learners in school E scored marks that ranked in the strong levels of the number sense test.

Regardless of the results of School E, the overall results of the number sense test and the assessment of learners by the teachers portrayed a numerical deficiency among many of the Grade 12 Mathematics learners of the Oshana Education Region. Therefore, to answer the question on the "state of number sense among the Grade 12 learners in the Oshana Education Region", the results show a numerical deficiency among the Grade 12 learners. Remarkably, the majority of learners (56%) had a number deficiency. The weak number sense detected among the learners might negatively impact on how the learners grasp Mathematics content and their academic performance in Mathematics. Naukushu (2006) noted that learners need to be prepared in full if they are to excel in their academic challenges. There is thus a need to prepare learners in the numerical sense if they are to excel. The next section deals with the impact of number sense on the academic performance of the learners.

The Influence of Number Sense on Academic Performance of Grade 12 learners

This section deals with the influence of number sense on academic performance of the learners in Mathematics at Grade 12 level in the Oshana Education Region. It compares the performance of the Grade 12 Mathematics learners with their number sense test marks. The academic performance was assessed by analyzing the performance of learners in the Mathematics August mock examination of 2010 which was standard for every school in the Oshana Education

Region. Part of the data presented in this section was drawn from experiences of teachers as reflected from their teaching Mathematics to develop the number sense of their learners.

Teachers' perceptions of the influence of number sense on learner academic performance.

The teachers were asked to choose from three options that signpost the perceived influence of number sense on the academic performance of their learners in Mathematics at Grade 12 level. The three options were: 1. Positive, 2. Negative and 3. No influence. Table 4 shows the responses of teachers on how they perceive the influence of number sense of learners on their academic performance in Mathematics.

Table 4: Perceived influence of number sense on academic performance by teachers (N=18).

Influence of number sense on Mathematics	Frequency	Percentages
Positive	16	88.9
No influence	2	11.1
Negative	0	0
Total	**18**	**100**

Table 4 shows that 88.9% of the teachers perceive a positive influence of number sense on academic performance of learners in Mathematics. It further shows that 11.1% of the teachers perceived no influence of number sense on Mathematical academic performance.

Most of the teachers (88.9%) were of the views of Wessels (2008) who indicated that number sense holds an impact on the academic performance of learners in Mathematics.

A comparison of learners' number sense and their academic performance

The marks of the learners in the number sense test were compared with their 2010 August mock examination marks in Mathematics. Scatter plots comparing the August Mock Examination marks of learners in Mathematics versus the number sense test marks were computed for each

individual school (these are shown in Appendix 7). Table 5 shows correlation coefficients obtained from the scatter plots of each individual school as illustrated by Appendix 7.

Table 5: Pearson's Correlation coefficient: number sense versus academic performance for each school (N=9)

School	Correlation coefficient	Interpretation
A	0.67	Moderately high positive correlation positive
B	0.45	Weak Positive correlation
C	0.63	Moderately high positive correlation positive
D	0.63	Moderately high positive correlation positive
E (Higher level)	0.83	Very high positive correlation positive
E (Ordinary level)	0.81	Very high positive correlation positive
F	0.76	Very high positive correlation positive
G	0.63	Moderately high positive correlation positive
H	0.81	Very high positive correlation positive
I	0.70	Very high positive correlation positive

Table 5 indicates that in 1 out of 9 schools (school B) a correlation coefficient less than 0.5 (r = 0.45, a weak positive correlation) was observed between the performance of learners in the number sense test and their academic performance in Mathematics. Table 5 further shows that in 4 out of 9 schools the performance of the learners in the number sense test and their academic performance in Mathematics showed a correlation coefficient from 0.5 to 0.75 which indicated a moderately high positive correlation between number sense and academic performance in Mathematics. Furthermore, in another 4 out of 9 schools the relationship between the number sense of learners and their academic performance in Mathematics had a correlation coefficient more than 0.75, which seems to indicate a high positive correlation between number sense and academic performance in Mathematics.

Overall, the results from Table 5 supports the idea from literature (Menon 2004, Wessels, 2008, Menlosh, & Dole, 2000, Sowder, 1993, Steen, 1999, Tansheng, 2007, Thomas 2001) that

learners with a strong numerical grasp stand a good chance of performing better in Mathematics than those with a weak numerical grasp.

The overall scatter plot for all merged results for all schools comparing the average scores of all learners in their Mathematics August Mock Examinations and their number sense test scores was also drawn in Figure 5.

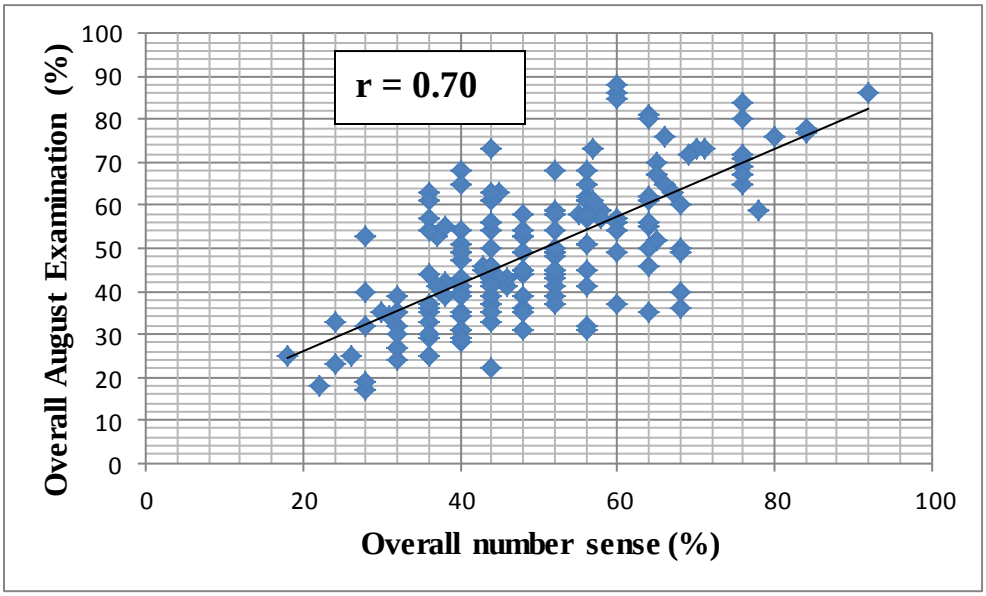

Fig. 5: Scatter plot of number sense test percentage versus the Mathematics August Marks (N=181)

Figure 5 indicates a correlation coefficient of 0.70. This depicts a moderately high positive relationship between the learners' number sense and their academic performance in Mathematics. This seems to be in line with the responses of teachers in Table 4, in which 88.9% of teachers observed a positive correlation between learners' number sense and their academic performance in Mathematics.

Learners are required to have a sound numerical grasp in order to cope with their high school Mathematics curriculum (Wright, 1996). Therefore, the results in Tables 3 and 4 as well as

Figure 3 seem to suggest that number sense influences the academic performance of learners in Mathematics.

The Schools in the Oshana Education Region were annually ranked according to the performance of their learners in Mathematics NSSC (Mock and Final) Examinations (Ministry of Education, 2010). This study compared the rankings of schools in the Oshana Education Region in Mathematics NSSC 2010 Mock Examinations versus the rankings of schools in their performance in the number sense test. The Spearmans's rank of correlation coefficient (ρ) = 0.85 was obtained which depicts a high positive correlation between the rankings of schools in Mathematics in the region and the rankings of schools in the number sense. This suggests that the schools with the learners doing well in the number sense test seem to do well in Mathematics August 2010 examitions.

For each school, the average of learners' scores in the number sense test as well as their academic performance are given in Table 6.

Table 6: Average number sense scores against Mathematics scores for each school (N=9)

School	Average Number sense scores	Average Mathematics scores
A	46	48
B	53	58
C	47	49
D	39	53
E	64	64
F	45	42
G	49	54
H	44	41
I	49	48

A t-test was carried out using the data presented in Table 6 to find out whether there are significant differences in the average scores of learners in the number sense test and the average August Mock Examinations Mathematics scores for every school.

For this study the null hypothesis (H_0) stated: There are no significant differences between the average number sense scores (μ_1) and the average Mathematics scores (μ_2). i.e. H_0: $\mu_1=\mu_2$. The alternative Hypothesis (H_1) stated: There are significant differences between the average number sense scores and the average Mathematics scores i.e. H_1:$\mu_1\neq\mu_2$. The critical t = 3.35 value was determined at level of significance (α) = 0.01 with degrees of freedom (df) = 8.

From the calculations; $t_{calculated}$ = 1.94 which is smaller than $t_{critical}$ of 3.35. Thus the null hypothesis was accepted and concludes that no significant differences between the number sense of Grade 12 in the Oshana Education Region learners and their academic performance in the Mathematics August 2010 Examinations.

The data collected in this study therefore, supports the view that the number sense of learners has an influence on their academic performance in Mathematics at grade 12 level.

Factors affecting the development of number sense

This section presents the responses of the teachers as well as the results from the lesson observations on the factors that influence the development of number sense.

Literature by Wessels (2008), Menlosh, & Dole (2000) and Sowder (1993), indicate that teacher experience was one of the crucial factors that contribute to the developemnt of number sense. This study therefore, compared the experience of teachers with the learners' performance in the number sense test to see whether how the two correlate. The teachers were asked to indicate the number of years they taught Mathematics at Grade 12 level and the number sense of their learners. The experience of teachers in terms of years of teaching Mathematics was compared with the performance of their learners in the number sense test (see Table 7).

As indicated earlier, two Mathematics teachers at Grade 12 level were selected from each school to participate in this study, for each school the average of their years of teaching experience in Mathematics was worked out and it was compared with the average number sense test scores of their learners.

Table 7: Teaching experience of Mathematics teachers versus number sense scores (N=18)

School	Number of teachers	Average number of teaching (years)	Average number sense test score (%)
A	2	4	46
B	2	2	53
C	2	1.5	47
D	2	3	39
E	2	5	64
F	2	2	45
G	2	5.5	49
H	2	4	44
I	2	3	49

Table 7 it shows that the average teachers' experience of teaching Mathematics at grade 12 level varies from 1 year to about 6 years. However, Table 7 does not seem to indicate a pattern of how the teaching experience of Mathematics teachers correlates with the number sense of their learners (see also Figure 6).

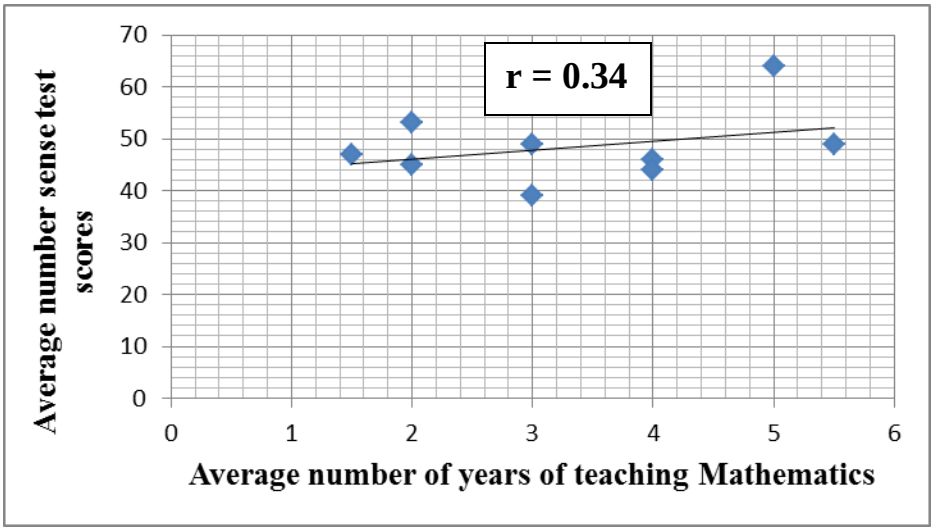

Fig. 6: Average number of years of teaching experience for teachers versus number sense (N=9)

Figure 6 shows the relationship between the experience of teachers in years and the number sense scores of the learners. A correlation coefficient (r) of 0.34 was obtained. This suggests a weak relationship between the experience of teachers and the number sense of their learners. The results shown in Figure 6 do not seem to agree with the claims by Wessels (2008), Menlosh & Dole (2000) and Sowder (1993), that the more experienced teachers are likely to have learners with a better grasp of number sense.

Schools were ranked according to the ones with the most experienced teachers in terms of how many years the teachers have been teaching Mathematics. This ranking was compared to the ranking of each school according to the performances of learners in the number sense test.

Spearman's rank correlation coefficient, rho (ρ) of 0.28 was obtained (see Appendix 9). This suggests a very weak correlation between the teachers experience in terms of the number of years in teaching Mathematics at Grade 12 level and the number sense scores of their learners. From the results (Figure 6, Appendix 9 and Table 7), the number of teaching years of experience of Mathematics teachers bears a very minimal or no influence on the development of number sense.

Several writers (Wessels, 2008, Menlosh, & Dole, 2000; Sowder, 1993) indicate that the development of number sense depends on the following factors: Teacher training, curriculum, and also passion and interest of teachers in the subject matter. Other factors crucial to the development of number sense include teachers' perceptions and expectations about their learners' abilities, availability of relevant teaching and learning resources, support and mentoring given to teachers, class population and arrangement (Steen, 1999; Tansheng, 2007; Thomas, 2001). This study investigated the fore going factors on the development of number sense.

At the time of this study, the teachers for Grade 1 to 10 were mainly trained at the teachers' colleges while the senior secondary school teachers (i.e. Grades 11 and 12) were trained at the University of Namibia. This study also tried to find out whether the teacher training institutions and the curriculum they followed in achieving their teaching qualifications influenced the development of number sense. The teachers were asked to indicate the type of tertiary institution where they received their training (see Table 8).

Table 8: Type of raining institutions where teachers were trained (N=18)

Tertiary institution	**Number of teachers (frequency)**	**Learners' average number sense scores.**
University	12	53.5
College	5	67.8
Others	1	39.1
Total	**18**	-

Table 8 shows that most (12 out of 18) of the teachers received their training at the University of Namibia, five teachers received their training at the teachers' colleges and one teacher received training at other institutions of higher learning. Table 8 seems to indicate that learners taught by teachers from Colleges of Education scored the highest average marks in the number sense test. A comparison of the teacher training curricula was carried out between the Basic Education Teachers Diploma (BETD) offered at Colleges of Education and the Bachelor of Education (B.Ed.) curriculum offered by the University of Namibia. The following observations were noted:

- *Both curricula have the content and methodology courses.*
- *The BETD curriculum had few topics of courses as compared to the B.Ed. Curriculum.*
- *The content of the BETD seems to be shallow as compared to the B.Ed. curriculum.*

- *BETD has more topics related to the development of number sense and these are at the level of learners as compared to the B.Ed.*

- *The B.Ed. curriculum covers topics relevant to number sense in a more in-depth manner and the content shows no relevance of number sense at Grade 12 level as it is more based on proving theories and corollaries.*

The analysis of the curricula suggests that the BETD curriculum fosters the development of number sense as compared to the B. Ed. This implies that teachers graduating from Colleges of Education stand a better chance of developing the number sense among their learners as compared to the teachers graduating from the University of Namibia.

A reflection of teachers on how the training they received prepared them to help develop the number sense of their learners was considered when assessing how teacher training given to them influenced the development of number sense. The teachers were asked to indicate how their initial teacher training prepared them to acquire number sense using: Excellent, Not so well and Not at all. Their responses are given in Table 9.

Table 9: How teacher training helped teachers to develop number sense (N=18).

Descriptor	Frequency	Percentage	Average number sense of their learners (%)
Excellent	3	16.7	56.3
Not so well	15	83.3	47.8
Not at all	0	0	-
Total	**18**	**100**	**-**

Table 9 indicates that more than 83.3% of the teachers said their teacher training did not prepare them, “not so well” to develop number sense. This suggests that such teachers may not be able to help their learners develop in number sense if they become Mathematics teachers. This seems to

support the findings by Fishebein (2007) that the world trend is that 35% of the pre-service teachers do not gain enough numeracy skills from their teacher training.

Other researchers such as Menon (2004), Hilbert (2001) and Greeno (2006) argue that there is a need for Mathematics teachers to take up a number sense course as part of their training. There is therefore need to find out whether the numerical deficiency detected among the Grade 12 Mathematics learners in the Oshana Education Region in this study was attributable to the lack of number sense among the teachers.

This study supports the work of Menon (2004) who argues that teacher educators need to teach pre-service Mathematics teachers to understand how children develop number sense so that they will be able to effectively facilitate the development of number sense. It is therefore important for the teacher training sector in Namibia to ensure that the Mathematics teachers are equipped with numerical sense that will enable them to develop the number sense of their learners.

The findings of this study seem to suggest that teachers did not seem to have gained a lot from their teacher training as far as number sense teaching is concerned. The BETD curriculum had more links to the development of number sense as compared to the B. Ed. curriculum.

Passion and interest for the teaching career is one of the factors that affect the development of number sense among the learners (Wessels, 2008; Menlosh & Dole, 2000; Sowder, 1993). The teachers were asked to state whether teaching was their initial preferred career. Their responses were compared with the average performance of their learners in the number sense test. This was done to infer whether the teachers' preferred career choice of the teaching profession bears an influence on the development of number sense in the learners. Their responses are given in Table 10.

Table 10: Preferred careers of Mathematics teachers versus number sense of their learners (N=18).

Anticipated career	Frequency	Percentage	Average % number sense
Teaching	7	38.9	50.3
Others	11	61.1	48.7
Total	**18**	**100**	**-**

Table 10 shows that not all of the teachers had interest in teaching, particularly teaching Mathematics at high school. According to Table 10, 61.1% of the teachers had no intention of being teachers. This may have an impact on the way they teach to ensure the development of number sense among their learners. Learners taught by teachers whose teaching was a preferred career scored slightly high average marks than those taught by teachers whose teaching was not a preferred career.

The results in Table 10 do not seem to suggest as to whether the career preference of Mathematics teachers really influence on the development of number sense. Literature e.g. Fishebein (2007) suggest a pattern between interest of teachers in their profession and the development of number sense; that is, it influences the development of number sense positively.

Other researchers such as Steen (1999), Tansheng (2007) and Thomas (2001) hold the idea that the Mathematics teachers' interests on the profession and Mathematics itself also bear an effect on the professional practices of the teachers, including their practice and the development of number sense. Yet Table 10 does not seem to indicate the relationship between the career choice of the teacher and the development of number sense.

The availability of resources is one of the factors that influence the development of number sense among the learners (Wessels, 2008; Menlosh & Dole, 2000; Tansheng, 2007; Thomas, 2001; Sowder, 1993). Since teachers directly deal with the teaching and learning resources, they were asked to give their opinions on the availability of teaching and learning resources that are related

to the development of number sense at their schools. The teachers were asked to rate the availability of resources using: More adequate, Adequate and Not adequate. Their responses are given in Table 11.

Table 11: Teachers' opinions on the availability of teaching and learning resources (N=17).

Availability of resources	Frequency	Percentages	Average learners' number sense
More than Adequate	2	11.1	64.3
Adequate	2	11.1	53.4
Not adequate	13	77.8	44.5
Total	**17**	**100**	**-**

Table 11 indicates that as much as 77.8% of the teachers held the view that there were inadequate resources at their schools. The data shown in Table 11 appears to suggest a low level of number sense for the schools with inadequate resources. Heirdsfield, & Cooper (2004), Hope, & Sherrill (1987) and Wright (1996) hold the view that the development of number sense is compromised by the lack of resources to a great extent.

Table 11 does not show what resources were unavailable in the schools. Accordingly teachers were asked to indicate on the types of teaching and the learning materials related to the development of number sense that their schools had. The responses of the teachers are shown in Table 12. These were compared with the performance of their learners in the number sense test.

Table 12: Availability of teaching resources to aid development of number sense (N=9).

Material	Available	Percentage	Not available	Percentage
Computers with software related to the development of number sense	1	1.1	8	99.9
Extra learning materials that promote the development of number sense	1	1.1	8	99.9
Audiovisual equipment that help the development of number sense	1	1.1	8	99.9
A library with Mathematics books and extra resources to aid the development of number sense	4	44.4	5	55.6
Photocopying machine that can be used to multiply the resources about the development of number sense	6	66.7	3	33.3
Internet which is accessible to the learners for searching some materials about the development of number sense	1	1.1	8	99.9

Table 12 indicates that most of the schools had no resources relevant to the development of number sense. Almost all; that is 99.9% of the schools lacked the following resources to aid in the development of number sense; computers with software including internet, extra learning materials, and audiovisuals. It was also noted that photocopying machines were only available in 6 out of 9 schools. Moreover only 4 schools had libraries with relevant books to the development of number sense.

The theoretical framework of this research emphasised the primacy of learning by interacting with the environment for the learners to gain knowledge. The learners' number sense might therefore be compromised if the environment lacks enough number sense resources that might be used in developing the learners' number sense.

The literature on the development of number sense emphasised the importance and role of resources in developing number sense among the learners. For instance Fusson, (1992) notes that the provision of a rich learning environment with relevant resources to explore the combinations

and arrangements of number results in children deriving their own strategies for basic numerical fact combinations and this will result in the development of number sense. Moreover resources contribute significantly to the development of number sense. Their role in the development of number sense is remarkable and cannot be compromised at all. (Heirdsfield, & Cooper, 2004; Hope, & Sherrill, 1987; Wright, 1996).

The results shown in Table 12 seem to suggest that schools have inadequate resources. The results collected suggest that 99.9% of the schools in the Oshana Education Region lacked resources that might aid the development of number sense. This lack of resources might compromise the development of number sense among the learners, because learners might not interact with other materials that might help them develop their number sense further.

In order to facilitate the development of number sense the teachers also need support in the form of mentoring offered by the advisory service and their senior colleagues (Fusson, 1992). The teachers were asked to indicate how they valued the support and mentoring given to them through the advisory service in development of number sense. The responses of the teachers are given in Table 13.

Table 13: Support needed by teachers in the development of number sense (N=18).

Type of support	Frequency					
	Very Valuable	(%)	Valuable	(%)	Not valuable	(%)
One week workshop during holidays	12	66.7	3	16.7	3	16.7
Regular cluster-based sessions on the development of number sense	14	77.8	2	11.1	2	11.1
Follow-up visits by trainers after training sessions	2	11.1	5	27.8	11	61.1
Advisory service offered by the regional (ministry) advisory service.	9	50	3	16.7	6	33.3
Number sense to be made a compulsory module in the training curriculum of Mathematics teacher trainees	16	88.9	2	11.1	0	0

Table 13 shows that 88.9% of the teachers supported the necessity for a number sense module to be added to the curriculum of teacher training programmes and 77.8% of the teachers valued regular cluster-based sessions on the development of number sense where sharing ideas on how to help teach Mathematics to enhance the number sense of the learners. Moreover, 66.7% of the teachers value the advisory support offered by the Ministry of Education through its regional advisory services. Most 83.4% of the teachers indicated a necessity of a one week workshop during holidays to help them develop their own number sense in order to facilitate the development of the number sense among their learners. Table 13 indicates that many of the teachers 61.1% did not indicate the necessity of follow-ups by the teacher trainers once the teachers enter the teaching career.

Generally the data collected showed that teachers valued the support in order to facilitate the development of number sense among their learners. The teachers also indicated the need for teacher training institutions to incorporate a number sense course in the teacher training

curriculum. Furthermore, the teachers indicated the need for mentoring by senior colleagues and the advisory service. The results generally agree with those by Fishebein (2007), Menon (2004), Hilbert (2001) and Greeno (2006) who indicated that a need for Mathematics teachers to take up a number sense course as part of their initial teacher training was necessary.

Among the factors affecting the development of number sense is class population and arrangement (Menon, 2004; Hilbert, 2001; Greeno, 2006). From the lesson observations the class populations for each of the 9 schools were captured. These were compared with the average performances of their learners in the number sense test (see Table 14).

Table 14: Class population versus number sense test scores (N=9)

Class Size	**Frequency**	**(%)**	**Average % number sense**
Above 40 learners (Large)	5	27.8	45.3
30-39 learners (Moderate)	11	61.1	57.3
0-30 learners (Small)	2	11.1	61.2

Table 14 suggests low number sense among the classrooms with more learners. The Classes with many learners had learners achieving low marks in the number sense test. Literature indicates that it becomes difficult to develop number sense in an overcrowded classroom. It is quite difficult to give attention to individual learners (Greeno, 2006; Menon, 2004; Hilbert, 2001). In addition Hilbert (2001) says that in most of the overpopulated classrooms only the "gifted" learners gain more numerical skills compromising the learning of "less gifted" learners. Shinyemba (2010) indicated that one of the biggest challenges Oshana Education Region is faced with is the high teacher-learner ratio which makes it difficult for the teachers to give individual attention to the learners. Teacher learner-ratio might therefore be a crucial factor to consider if the development of number sense is to be enhanced.

The classroom arrangement is among the factors that have an influence on the development of number sense in the classroom. The arrangement of the class has an impact on whether the teacher can be able to help the individual learners and help them according to their needs (Klein & Beishuizen, 2000). Individualized attention is part and parcel of the learner centred teaching which is advocated by the constructivism theory.

Different classroom seating arrangements were observed by the researcher, these are summarised in Table 15. This study observed the: half-circular, one big circle, round table, small groups of four, rows and columns. For each of these sitting arrangements the frequencies of teachers that used it. These frequencies of teachers with different classroom seating arrangements were compared with the average performance of their learners in the number sense test. This was done to find out the possible influence of different sitting arrangements on the development of number sense.

Table 15: Classroom arrangement versus the number sense scores (N=9)

Class Size	**Frequency**	**Average % of learners' number sense**
Half-circular	2	56.7
Small groups of four	4	54.3
Rows by columns	9	44.9
Total	15	-

Table 15 indicates three sitting arrangements found in the Mathematics classrooms as well as the learners' corresponding average number sense test scores. Literature suggests that the choice of a particular arrangement of furniture in the classroom could be influenced by the school of thought of the teacher (EBC, 2004). For instance sitting in rows by columns is a manifestation of teacher centredness, while classroom arrangements into smaller groups or round table shows the openness of the teacher and how ready he/she is to accommodate learning from learners (EBC, 2004).

From Table 15, the classroom arrangement did not appear to have a major impact on the development of number sense. Some interesting trends were noted which supported the ideas cited in EBC (2004). For instance many nine out of 18 teachers preferred arrangements of classroom furniture into rows and columns, learners taught in classes arranged in rows and columns scored an average number sense of 44.9%. The average number sense scores of learners from the classrooms of rows and columns appeared to be low as compared to those learners taught in classrooms arranged in smaller groups and half circles (i.e. 54.3% and 56.7% respectively). The sitting arrangement in small groups and half-circles appeared to have influenced the development of number sense of the learners positively during teaching.

Generally the results did not manifest major differences among the average number sense scores of learners from different classrooms with different classroom arrangements. Moreover, the results suggest that the arrangement of classrooms into rows by columns was favoured 50% by the teachers. However learners taught in classrooms arranged in rows and columns scored lower average marks in the number sense test (see Table 15).

EBC (2004) does not seem to suggest a recipe for arrangement of seats that best aids the development of number sense. But, the factor to consider is that the arrangement of furniture in the classroom should be in line with the conducive environment for the development of number sense as suggested by the results in Table 15. These could be small groups and half circles. The learners should thus be seated in such a way that they might be able to attain maximum benefit from the teacher, and should be able to interact among themselves and the whole learning environment at large. It is thus crucial for the teachers to facilitate such an arrangement to help the learners benefit from the education.

How Mathematics teachers plan and present lessons to aid the development of number sense.

This section presents the findings on how grade 12 teachers of the Oshana Education Region plan and present their lessons to aid the development of number sense among their learners. It further presents responses by teachers on their competencies at designing lesson activities that aid the development of number sense. The section includes the value teachers attached to the use of different methods that aid the development of number sense among their learners.

The development of number is facilitated by using different activities with different materials hence teachers should demonstrate competencies on such activities to aid the facilitation and interaction between the teacher and the learners as well as the number sense materials in order to enhance learning (Hilbert, 2001) and (Greeno, 2006). Teachers were asked to indicate how often they made use of teaching and learning aids and related activities to the development of number sense in their teaching of Mathematics. Their responses are shown in Table 16.

Table 16: Frequency of teachers using number sense related activities to aid the development of number sense versus number sense scores of their learners (N=18).

Activity	Frequency (%)					
	Very often	**Average No. Sense (%) of learners**	**Often**	**Average No. Sense of learners (%).**	**Not often**	**Average No. Sense of learners (%)**
Assessment activities dealing with number sense. E.g. worksheets, class work as well as the home work.	9 (50)	64.4	8 (44.4)	47.5	1 (5.6)	42.2
Activities based on locally made teaching materials about number sense.	6 (33.3)	45.3	9 (50)	49.3	3 (16.7)	39.6
Practical activities about number sense that involve learning by doing.	5 (27.7)	64.2	1 (5.6)	45.9	12 (66.7)	42.2
Activities about number sense that are friendly with mixed abilities teaching.	7 (38.9)	44.5	5 (27.8)	49.8	6 (33.3)	49.7
Compensatory (remedial) teaching about number sense.	7 (38.9)	49.2	7 (38.9)	48.1	4 (22.2)	39

Table 16 indicates that many teachers 50% taught through the use of assessment activities related to the development of number sense; their learners' average number sense score was 64.4%. This seems to suggest that learners taught by teachers using number sense related assessment activities scored better in the number sense. Furthermore, Table 16 (first row) suggests a

decrease in the average number sense scores of the learners with the decreased use of assessment activities related to the number sense decrease. Many teachers (83.3%) indicated that they make use of teaching/learning materials related to the development of number sense and for these the appeared to have helped learners gain a better grasp of number sense. This was manifested by the high number sense scores.

Most of the teachers 66.7% indicated that they did not make use of practical activities where learners manipulate physical objects which might aid them develop their own number sense. Their learners appeared to have obtained lower (42.2%) average scores in the number sense test as compared to learners from other teachers who used practical activities related to the development of number sense. Teachers who very often used practical work in their teaching to aid the development of number sense had learners who scored high (64.2%) average scores in the number sense test (see Table 16).

The use of number sense activities for mixed abilities teaching was made by 66.7% of the teachers. The other 33.3% of the teachers did not use mixed abilities teaching activities. The average performance of the learners did not seem to suggest a pattern as it appeared to be the same throughout, regardless of whether the teachers used mixed abilities teaching activities or not.

According to Table 16 remedial teaching was found to be used among 77.8% of the teachers whose learners scored generally better average scores (about 49%) in the number sense test as compared to 39% of teachers who did use to practice remedial teaching. Generally there was a decrease in the average scores of learners with the decrease of remedial teaching.

A comparison of the average number sense test scores was made with the frequency of how often the teachers used various activities with various teaching and learning aids to aid the development of number sense of their learners as shown in Figure 7.

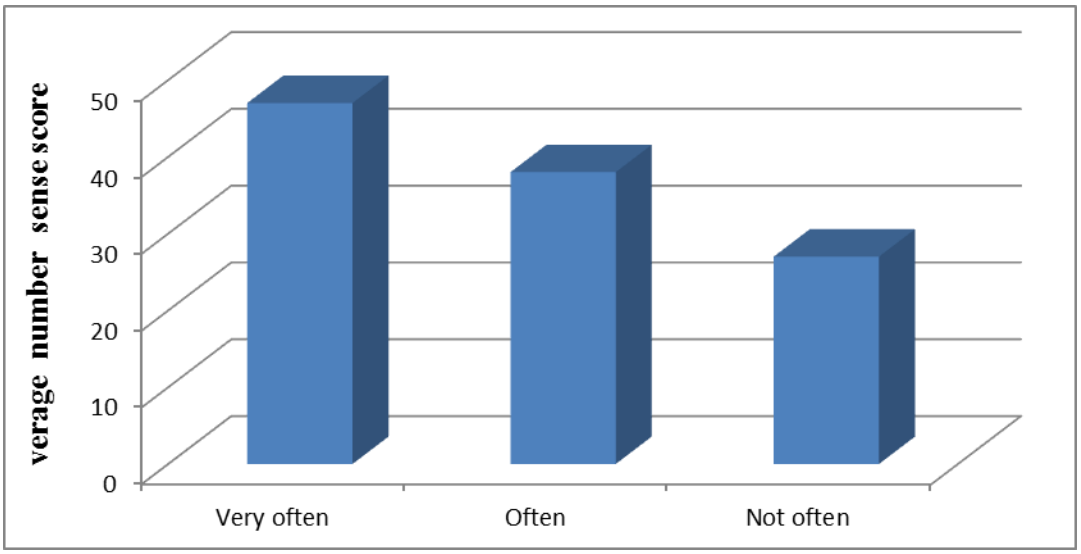

Fig. 7: The comparison of teachers' self evaluation with the number sense test results of their learners.

Figure 7 suggests a decline in the average number sense scores of the learners with the decrease in the use of various activities related to the development of number sense. The learners' number sense might be enhanced by the presence of various teaching and learning activities (Klein, & Beishuizen, 2000).

The foregoing data (Figure 7 and Table 16) suggest that teachers made use of different activities with various teaching and learning media. The data further indicated that the development of number sense might be enhanced by the use of different activities. This study found a decrease in the average number sense of the learners with the decreased use of various activities that are related to the development of number sense. According to Table 16 and Figure 7, the teachers that often nerver made use various activities had learners scoring lower average marks in the number sense test.

Number sense was defined in Chapter 2 by giving five key components on which the development of number sense should focus (Burn, 2004; Zanzali, 2005; Jonasen 2004). The teachers need compentencies and confidence on all five key components that constitute number sense in order to transfer number sense proficiency to their learners. The teachers were therefore asked to evaluate their competencies on teaching to develop all the five key areas of number sense, their evaluations were compared with the average number sense performance of their learners for each of the 5 key components (Table 17).

Table 17: Evaluation of teacher confidence on 5 areas of number sense (N=18).

Key area	**Frequency (%)**		**Average % Number sense**
	Confident	**Not confident**	
Understanding the meaning and size of numbers	10 (55.5)	8 (44.4)	45.4
Understanding equivalence with numbers	11 (61.1)	7 (38.9)	57.6
Understanding the meaning and effects of operations	18 (100)	(0)	61.2
Understanding counting and computation strategies	13 (72.2)	5 (27.8)	48.6
Estimation without calculating	10 (55.5)	8 (44.4)	39.2

The results presented in Table 17 suggest that teachers were confident in many areas of number sense. There are few cases where teachers indicated that they were not confident. For instance 44.4% of the teachers indicated no confidence in two key areas of number sense (meaning and size of numbers as well as estimation without counting). These were the two areas where learners scored lower scores in the number sense test as well. All teachers had confidence in understanding the effects of operations, the average number sense scores of learners in this area was also the highest. The general pattern observed from Table 17 shows a decrease in the average number sense scores of learners with the decreasing confidence of the teachers. This

appears to suggest that learners taught by teachers with low confidence in the five key areas of number sense might not get a better grasp of competencies in those areas, hence such learners are likely to score lower in those areas of number sense.

One important aspect in developing number sense is the teaching method that teachers use (Dole, & Beswick, 2001; Blöte, Klein, & Beishuizen, 2000; Gravemeijer, Cobb, Bowers, & Whitenack, 2000). The choice of a teaching method is influenced by several factors. For instance Blöte, Klein, & Beishuien (2000) pointed out two main factors that influence the choice of the method of teaching, i.e. the teacher and the content that is being taught. The later refers to the fact that the content being taught sometimes suggests a method that one should use when teaching. Similarly teachers have different preferences over different methods. The teachers were thus asked to indicate how they valued the effectiveness of different teaching methods on the development of number sense. These were done based on the professional practice of teachers as reflective practitioners of education. The responses of the teachers are summarised in Table 18.

Table 18: Effectiveness of teaching methods on development of number sense (N=18).

Method	Frequency (%)			
	Very Effective	**Average No. sense (%)**	**Not Effective**	**Average No. sense (%)**
Collaborative learning	17 (94.5)	64	1 (5.6)	51.5
Exam driven teaching	1 (5.5)	44	17 (94.5)	46.7
Discovery learning	18 (100)	55.2	0 (0)	None
Question and answer	3 (16.7)	49	15 (83.3)	44.3
Chalk and talk	1 (5.5)	49	17 (94.8)	45.6

Table 18 shows that when trying to develop the number sense of their learners, teachers indicated the use of a variety of methods. According to Table 18 the discovery learning was rated the most effective method in facilitating the development of number sense. One hundred percent of the teachers indicated discovery learning as the most effective method. The average number sense

test scores for the learners whose teachers valued the effectiveness of discovery learning was 55.2%. Collaborative learning was rated as the second preferred method. Most of the teachers (94.5%) preferred collaborative learning in facilitating the development of number sense. The average number sense test scores of learners whose teachers mostly preferred collaborative method scored higher (64%) average scores on the number sense test.

Other methods such as chalk and talk, examination driven teaching as well as question and answer methods were not considered as very effective in developing learners' number sense. As indicated by Table 18 collaborative and discovery learning methods appeared to be effective in developing number sense of the learners. The average number sense of learners whose teachers valued these two methods was higher than the average number sense of other learners.

Learners taught by teachers who often used collaborative and discovery methods as well as those who encouraged learning by interacting with the environment among their learners had higher scores in the number sense test. Table 18 further seems to suggest that the constructivism theory appeared to enhance learners' grasp of numbers.

Generally, Table 18 suggests that collaborative and discovery learning methods might assist learners to gain a better grasp of number sense. It further suggests that the use of chalk & talk and examination driven teaching methods were not effective in facilitating the development of number sense. Table 18 seems to be in line with the idea that the development of number sense would be best aided or explained by the theory of constructivism which suggests that knowledge is best acquired by interacting with the social environment where the learners might find themselves. Generally; there seems to be a relationship between constructivist learning and the number sense scores as shown in table 18.

This section presented the data that was aimed at finding out how the Mathematics teachers in the Oshana Education Region planed and presented their lessons to aid the development of number sense in their learners. The data indicated use of various activities to aid the development of number sense in the teaching of Mathematics by teachers, such as: Assessment activities dealing with number sense, activities based on locally made teaching materials about number sense, practical activities about number sense that enhanced learning by doing, activities about number sense that might support with mixed abilities teaching and compensatory (remedial) teaching about the development of number sense.
The learners' number sense was found to decrease with the decrease in the use of various activities by teachers to support the development of number sense. The number sense of learners was also influenced by the confidence of the teachers to present and plan lessons across all the five key areas of number sense.

The teachers also indicated the different methods that would directly benefit the development of number sense. Methods such as collaborative and discovery learning appeared to aid the development of number sense in the learners as compared to other methods such as chalk and talk as well as examination driven teaching. The ideas behind the theory of constructivism also appeared to be effective in helping learners gain a better grasp of number sense.

CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the summary, conclusions and recommendations of the study as per the findings and discussions of the results.

The purpose of this study was to find out the state of number sense as well as the factors that affect the development of number sense among the Grade 12 learners in the Oshana Education Region. This research also tried to study the influence that number sense has on the academic performance in Mathematics among the learners in the Oshana Education Region. The study further tried to study the ways that Mathematics teachers use to plan and present their lessons to aid the development of number sense Mathematics at the Grade 12 level.

This sought answers to the following questions:

1. What is the state of number sense among Grade 12 Mathematics learners in the Oshana Education Region?
2. What is the influence of number sense on academic performance in Mathematics among Grade 12 learners in the Oshana Education Region?
3. What are the factors that affect the development of number sense among the Grade 12 learners in the Oshana Education Region?
4. How do the Grade 12 Mathematics teachers in the Oshana Education Region plan and present their lessons to support the development of number sense?

In order to seek answers to the stated questions, this study used both quantitative and qualitative research designs. Quantitative research consists of those studies in which the data can be analysed in terms of numerical values (Loraine, 1998). To assess the academic performance of learners in Mathematics and in the number sense test the study used numerical scores and hence

this study had characteristics of a quantitative study. Particularly the study was correlational in nature as it tried to study the relationship between the Grade 12 learners' number sense and their academic performance in Mathematics. Correlational Research tries to study the relationship between variables (Loraine, 1998).

In order to determine the current level of number sense among the learners in the Oshana Education Region this study adopted and adapted the number sense test from McIntosh, Reys and Reys (1992). The learners' marks on the regional August Mock Examination in 2010 were also used in this study. Questionnaires with open ended and closed ended questions as well as lesson observation schedules were used in this study. The instruments were used in order to provide answers to the question of what factors affected the development of number sense among the Grade 12 learners in the Oshana Education. The information collected from various tools was used for triangulation purposes.

This study found that more than 50% of the learners had numerical deficiency which might compromise their comprehension of Mathematical content and therefore might inhibit their academic performance in Mathematics. This study also found a strong positive correlation ($r = 0.70$) between the performance of Grade 12 learners in the Oshana Education Region on the number sense test and the academic performance in Mathematics. In addition, it was found that there were no significant differences between learners' performance in the Mathematics test and the number sense test ($t = 1.938$ at $\alpha = 0.01$ with $df = 8$). This finding supports the idea that number sense performance influences academic performance. Learners performing lower on the number sense test also performed lower in their August Mathematics Mock examination. Thus the performance of learners in Mathematics appeared to be influenced by their facility to comprehend numerical principles.

This study found that the factors such as lack of teaching resources; teachers' experience; and insufficient training in number sense given to the Mathematics teachers during their teacher initial training, confidence, passion for teaching, teachers assumed knowledge of the learners, support given to the Mathematics teachers through advisory service of the Ministry of Education, classroom arrangement and size have an influence on the development of learners' number sense.

It was also found that the Mathematics teachers in the Oshana Education Region used activities such as; compensatory (remedial) teaching to help the slow learners, activities about number sense that might support mixed abilities teaching; practical activities about the number sense for learners to learn by doing; teaching/learning resources for self-enrichment of learners about numerical concepts; assessment activities dealing with number sense to enhance development of number sense.

Conclusions

It was concluded that more than 50% of the Grade 12 learners in the Oshana region had a numerical deficiency which might affect their understanding and performance in Mathematics. The Grade 12 learners in the Oshana Education Region lacked the feel and understanding of numbers. This should be addressed for their performance in Mathematics to improve.

From the moderately high positive correlation coefficient ($r = 0.70$) one could conclude that the development of number sense in Mathematics had an influence on the academic performance of Grade 12 learners in the Oshana Education Region. Furthermore it was concluded that learners with weak number sense test scores stood a greater chance of scoring lower grades in the Mathematics examinations and those with strong number sense stood a greater chance of scoring higher grades in the Mathematics examinations.

In addition the lack of teaching and learning resources such as games and computer aided software reduces the impact that teachers would make on the development of number sense. It was concluded that there was a very weak association between the teachers' experience and the development of number sense in their learners.

In this study the teachers tried their best to plan and present their lessons to aid the development of number sense. In addition the use of various activities aided the development of number sense.

Recommendations

This study recommends the following to the various stakeholders in the teaching and learning of Mathematics in order to enhance the development of number sense:

Teachers

1. Teachers should design teaching and learning aids from the local materials that are within their reach that could foster the development of number sense in the teaching of Mathematics.

2. Examination driven teaching should not be used at the expense of other effective teaching such as discovery learning and collaborative learning that enhance the development of number sense. Mathematics lessons should allow learners to explore and discover knowledge on their own, hence learner centred teaching should be used in aiding the development of number sense

3. Sitting arrangements in the classrooms should be in such a way that they encourage the sharing of ideas by learners to enhance the development of number sense. Desks in the classroom should be arranged in a semi-circle or small groups to allow learners interact

by learning from each other and therefore develop number sense through interaction with their peers.

Ministry of Education (Advisory Service)

1. The Ministry of Education should try to work hand in hand with the teachers to ensure that they receive the best support. Teachers should be given continuous professional development in the area of number sense and other topics in the teaching of Mathematics.

2. The Ministry of Education should also avail the teaching and learning materials to schools to enable the teachers use in the development of number sense. The teaching aids should be accessible to all teachers so that they will be able to make use of them.

3. Curriculum developers from the Ministry of Education should include aspects of number sense in the Mathematics curriculum to enhance the development of number sense through the teaching and learning of Mathematics.

4. The Ministry of Education should lower the teacher-learner ratios by employing more qualified teachers. Teachers found it difficult to incorporate the aspects of number sense in the teaching of Mathematics because of large classroom sizes. These should be reduced to about 25 to 30 learners in the classroom to aid the development of number sense.

5. The advisory teachers should organise some forums where teachers can meet and talk about different issues affecting the teaching and learning of Mathematics the development of number sense could be enhanced.

Teacher training institutions

1. The Mathematics teacher training curriculum should be revised to aid the development of number sense. There should be a module that helps teachers enhance their own number sense and enable them to understand the value and position of number sense in the teaching of Mathematics.

2. Teacher training should equip teacher trainees with skills that are necessary for one to become a fully equipped teacher. For instance the teachers should be given sufficient training on how to plan for lessons, designing teaching and learning aids, and how to run extra mural activities such as Mathematics clubs, hold Mathematics Olympiads among others which might be beneficial to the development of number sense of the learners.

3. Opinions of teacher trainees should also be looked at and on their merit be considered to help aid the training of Mathematics teachers that are able to develop numerical skills of the teacher trainees and to ensure that the teacher trainees benefit from the training that they receive.

Further research

1. Further research needs to be done to identify ways and means, of how number sense could be incorporated in the teaching of Mathematics.

2. Research should be carried in both the teacher training and secondary school Mathematics curriculum to identify gaps that exist to harmonise the development of number sense through the teaching and learning of Mathematics in the country.

3. Research on the number sense of junior primary school teachers needs to be done to ensure that ways and means of helping such teachers are identified as they are the ones that are laying a foundation to the sense making of numbers among the learners.

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Appendix 1: Letter requesting permission

UNIVERSITY OF NAMIBIA

NORTHERN CAMPUS

P.O. Box 2654, Oshakati, Namibia, Eliander Mwatale Street

Telephone: (++264) (65) 2232000, Fax: (++264) (65) 2232271

08 March 2010

Enq: Mr. Naukushu S.T.

The Regional Director
Oshana Education Region
Private Bag 5543
Oshakati

Dear Sir/Madam

APPLICATION TO CONDUCT RESEARCH IN OSHANA EDUCATION REGION.

I am a young Namibian man. I am currently pursuing my studies as a final year student for a Master of Education in Science and Mathematics through the University of Namibia. In partial fulfillment of my qualification, I am required to do a school based research.

I have drafted a proposal to carry out research on how the numerical understanding of learners at senior secondary school level influences their academic performance. I have targeted to do this in Oshana Education Region. It is therefore for this reason that I am writing to kindly request to be granted a chance to carry out such a project in your education region. I would like to make use of the following schools: Gabriel Taapopi Secondary School, Andimba Toivo yaToivo Secondary School, Oshakati Secondary School, Iipumbu Secondary School, Oshakati Combined School, Onamutai Combined School, Evululuko Secondary School, Erundu Combined School, Eheke Secondary School, Meshipandeka High School, Iihenda Combined School, and Nangolo Junior Secondary.

I have enclosed the permission letter from the permanent secretary in the ministry of education.

I trust that my request will receive your favourable consideration and am looking forward to hearing from you.

Your's truly

.....

Mr. S.T. Naukushu

Appendix 2: Principal's memo

UNIVERSITY OF NAMIBIA

FACUlTY OF EDUCATION

The Permission memo by the school Principals.

I…….have granted Mr. S.T. Naukushu (a student of Med. At UNAM) the persmission to conduct research at our school as he was already granted that permission by the Permanent Secretary of the Ministry of Education and the Regional Director of Oshana Education Region. The persmission is thus granted on condition that it does not disturb the academic activities for the school.

Signature:…….

Mr (s) ……. Principal of …….

Appendix 3: Permission letter from the Director of Education Oshana Region.

11-MAR-2010 07:35 From:MINISTRY OF EDUCATIN 065229834 To:02232271 P.1

REPUBLIC OF NAMIBIA

MINISTRY OF EDUCATION
OSHANA:
PRIVATE BAG 5518 TEL.: 065 229800, FAX: 065-229834

Enq: M. N. Nambala

10 March 2010

Mr. S. T. Naukushu
P.O. Box 2654
Oshakati

Dear Mr. Naukushu

We hereby acknowledge your letter of 8 March 2010 requesting permission to conduct your research in the listed schools. In as much as permission has been granted for you to carry out your research as planned, we earnestly ask you to do it at the most convenient time for the school, so that the school program is not in any way disrupted through your interactions with them.

You are also requested to discuss logistical matters with the schools concerned.

Again we wish you all the best in your studies and hope that your findings will be shared with us.

Yours sincerely

(Acting) 10/03/2010

DUTTE N. SHINYEMBA
REGIONAL DIRECTOR

OSHANA REGIONAL COUNCIL
OFFICE OF THE DIRECTOR OF EDUCATION
2010 -03- 1 6
P/Bag 5518, Oshakati
REPUBLIC OF NAMIBIA

All official correspondence should be addressed to The Director

Appendix 4: The interview guide for teachers.

University of Namibia

Faculty of Education

Tool No.2: Interview Guide for teachers

A questionnaire designed for the teachers to find the teachers' views about the development of number sense among the grade 11 and 12 learners in Oshana Education Region.

Instructions:

Teacher ……a Mathematics teacher at School …….Kindly respond to these questions. There will be no wrong or right answer. Please be assured that whatever information you will give in this document will be treated with maximum confidentiality and will only be used for the purpose of this study.

1. Experiences of teachers in teaching Mathematics

1.1. For how many years have you been teaching?

……

……

1.2. For many of these years have you been teaching Mathematics?

……

……

1.3. What are the teaching subjects that you have specialized in?

……

……

……

Where did you do your teaching qualification (s)?

University □
Teachers College □
Technikon □
Others (please specify):……..

1.4. Did you major in Mathematics as a teaching subject during your training as a teacher?

Yes □ No □

If no why are you teaching it?

……

……

……

1.2. Have you always wanted to be a teacher in your life?

Yes □ No □

If no what was your dreamed career? Why did you eventually end up teaching?

……

……

……

1.3. To what extend did your teacher training prepare you very well to help the learners acquire the number sense?

Excellent □

Very well □

Not so well □

Not at all □

Explain the reason for your choice.

……

……

……

2. The expectations of teachers on the competencies of learners to selected topics which are related to the development of number sense:

2.1. In your opinion how is the number sense of your learners?

Excellent □

Very good □

Good □

Average □

Below average □

2.1. How competent do you feel your learners are prepared in the following concepts from their previous grades? …. (Check one box in each row.)

	Very competent	*Average competent*	*Not competent*
Place values	□	□	□
Addition and subtraction of whole numbers	□	□	□
Multiplication and division of whole numbers	□	□	□
Number patterns	□	□	□
The fraction concept	□	□	□
The concept of percentages	□	□	□
The four operations with common fractions	□	□	□
The decimal fraction concept	□	□	□
Operations with decimal fractions	□	□	□
Operations with units of time	□	□	□

Mental arithmetic	□	□	□
Estimation	□	□	□

2.2. Do you think there is a relationship between number sense and the performance of learners in the NSSC Mathematics curriculum?

Yes □ No □

If yes explain the type of relationship.

……

……

……

2. Teacher's opinions on the teaching methodology that is suitable for the development of number sense.

2.3. What teaching Methods do you use to help your learners grasp the understanding of numerical concepts?

……

……

……

2.4. How do you value the effectiveness of the following teaching methods in helping learners gain sense of numbers?

	Very Valuable	Valuable (Average)	Not valuable
Collaborative learning	□	□	□
Exam driven teaching	□	□	□
Discovery learning	□	□	□
Question and answer	□	□	□
Rote learning	□	□	□

2.5. What role do you play in order to help your learners grasp the understanding of numerical concepts?

……

……

3. Competencies of teachers in designing materials that aid the development of number sense:

3.1. How competent do you feel you are to aid the development of number sense in the following ways…. (Check one box in each row.)

	Very competent	*(Average)*	*Not competent*
Design tests and other forms of assessment about number sense	□	□	□
Develop your own teaching materials about number sense	□	□	□
Do practical work and use teaching aids to help learners make sense of numbers	□	□	□
Differentiate in the classroom(teach learners make sense of numbers but yet catering for all learners with all abilities)	□	□	□
Offer compensatory teaching to the learners that are struggling with number sense about numbers	□	□	□

3.2. Which teaching activities do you normally design to help your learners understand the numerical concepts?

……

……

……

3.3. Do you think the teaching and learning resources are enough to adequately support the development of number sense? Yes □ No □

Explain your responses?

……

……

……

4. Teachers' opinions on the factors that affect the development of number sense.

4.1. What factors do you consider important when helping learners to develop their number sense?

……

……

……

4.2. What factors in your opinion do you think hinder the development of number sense? Explain.

……

……

……

4.3. To what extend is the support that is offered by the ministry of education through the advisory service adequately useful to help the learners understand the Mathematical principles?

……

……

……

4.4. Who in your opinion do you think has the responsibility towards the development of number sense? Explain.

……

……

……

5. Confidence in of teachers in some topics related to the development of number sense.

How confidence do you feel you are to teach your learners to make sense of numbers on the following …. (Check one box in each row.)

	Very confident	*Confident (average)*	*Not confident*
Place value	□	□	□
Addition and subtraction of whole numbers	□	□	□
Multiplication and division of whole numbers	□	□	□
Number patterns	□	□	□
The fraction concept	□	□	□
The concept of percentages	□	□	□
The four operations with common fractions	□	□	□
The decimal fraction concept	□	□	□
Operations with decimal fractions	□	□	□
Mental arithmetic	□	□	□
Estimation	□	□	□
Overall development of number sense	□	□	□

6. Opinions of teachers on how they can be helped to be able to aid the development of number sense:

6.1. The following points are suggestions about how the teachers can be helped to aid the development of number sense. How do you value them….. (Check one box in each row.)

	Very valuable	*Somewhat valuable*	*Not valuable*
One-week workshops during holidays, twice a year.	□	□	□
Regular cluster-based professional development afternoons about number sense.	□	□	□
Follow-up visits by a teacher educator in the classroom after in-service training events.	□	□	□
Advisory service offered by the regional advisory teacher	□	□	□
Number sense should be a compulsory course in the training of Mathematics teachers.	□	□	□

6.2. What other form of support do you need in that will help you develop the number sense among your learners?

……

……

……

7. Teachers' opinions on the availability of resources that are related to the development of number sense.

Please indicate whether the following resources are available at your school.	***Yes***	***No***
Computers with software related to the development of number sense.	□	□
There are extra learning materials that promote the development of number sense. E.g. ABACUS, Mathematics games etc.	□	□
Audiovisual equipment that can help the development of number sense e.g. recorded Mathematical videos, to help learners gain their number sense.	□	□
A library with Mathematics books and extra resources to help the development of number sense.	□	□
Photocopying machines that can be used to produce the materials that will encourage the development of number sense.	□	□
Internet which is accessible to learners for searching materials about the development of number sense.	□	□

Appendix 5: Lesson Observation Schedule

University of Namibia
Faculty of Education
Tool No.3: Lesson observation schedule

Lesson observation designed for the teachers to find the classroom factors that affect the development of number sense and its effects on the academic performance among the grade 11 and 12 learners in Oshana education region.

1. **GENERAL INFORMATION**

School code: _____ Date: _____
Grade:_____ b) Topic: _____
Number of learners in class: _____Number of learners with calculators:_____

2. **CLASSROOM ORGANIZATION**

CLASS SIZE	**TICK THE APPROPRIATE**
Large (40+ learners)	
Medium (35-39 learners)	
Small (30 learners)	
No. of male learners	
No. of female learners	
ORGANISATION	**TICK THE APPROPRIATE**
Half-circular	
One big circle	
Round table	
Small groups (3-5 learners)	
Rows by columns	

3. RELATIONSHIP BETWEEN THE TEACHER AND LEARNERS TOWARDS THE DEVELOPMENT OF NUMBER SENSE:

STATEMENTS	YES	NO
The teacher speaks kindly to the learners when explaining the numerical concepts.		
Learners are friendly with each other there as they try to develop their number sense.		
The teacher speaks harshly to the learners when they try to understand the numbers.		
Learners speak harshly to each other when they try to understand the numbers.		
The teacher the learners to understand the meaning of numbers by using different examples to help the learners understand numbers.		
The teacher motivates and rewards the learners to learn more about numbers.		
The teacher allows time for learners to think about the numbers and try to understand them when doing calculations.		
The teacher and learners support the development of number sense in the lesson.		
Teacher treats all learners with respect regardless of their level of number sense.		

4. OUT SIDE-CLASSROOM FACTORS AND THE DEVELOPMENT OF NUMBER SENSE:

STATEMENTS	YES	NO
Classroom surroundings support the development of number sense.		
The weather conditions (E.g. temperature or rain) do not distract the learners from developing number sense.		

5. TEACHING STRATEGIES USED IN THE CLASSROOM:

TEACHING STRATEGIES USED BY THE TEACHER	YES	NO
1. Question and answer: *The teacher asks probing questions (e.g. by using words such as how, why, what, etc) and learners respond to these questions with confidence.*		
2. Collaborative learning: *Learners work together and share ideas about number sense with their classmates.*		
3. Discovery learning: *The teacher guides learners to discover the concepts of number sense rather than teaching directly.*		
4. Exam driven teaching: *The teacher emphasizes the past question paper rather than teaching learners to understand number concepts.*		
5. Rote learning: *The teacher teaches learners to memorize numbers rather than emphasizing the understanding of numbers.*		
6. Others: *Other strategies used by the teachers in order to enhance the development of number sense.*		

6. TEACHER FACTORS AFFECTING DEVELOPMENT OF NUMBER SENSE:

STATEMENTS	YES	NO
The content taught about number sense is at the level of the learners, and matches with the syllabus objectives.		
Teacher demonstrates competency of number sense and leads by example. E.g. Only		

uses a calculator when only necessary.		
Teacher encourages mental computation as a way of reaching the answer.		
The teacher motivates and encourages learners to develop their number sense.		
Teacher is able to express him/herself clearly and does not hinder the development of number sense by expressing him/herself.		
Teacher uses a clear language to aid the development of number sense among learners.		
Teacher uses local language to aid the development of number sense among learners.		
The teacher gives examples that are contextualized the development of number sense.		

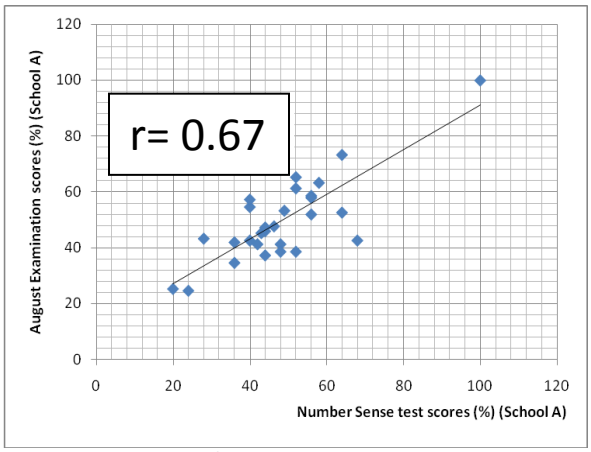
7. **RESOURCES TO SUPPORT THE DEVELOPMENT OF NUMBER SENSE :**

STATEMENTS	**YES**	**NO**
The available resources related to number sense are enough for every learner.		
The available resources related to number sense resources are shared.		
The classroom wall has displays of posters related to the development of number sense.		
There are Mathematical activities that encourage the development of number sense within the classroom; e.g games, multiplication tests etc.		
There are other three dimensional resources that help facilitate the development of number sense, e.g. deice, cardboards etc.		
Each learner has a Mathematics text book.		
Learners are sharing a text book. (…….. learners per text book)		
Math quizzes/puzzles and extra resources that learners can use to enhance their thinking skills. E.g. the teacher gives quizzes/puzzles at regular intervals during the lesson.		
If there are reference books textbooks in addition to the prescribed text book.		
The teacher uses the chalk board to help the development of number sense among the learners.		
The teacher provides extra handouts for the learners to go and work at home or in class to help the learners understand numerical concepts better.		
Furniture in the classroom is enough learners can concentrate to develop their number sense.		
Furniture in the class room is not enough and this distracts the learners' development of number sense.		
Teacher rewards learners by giving them something to encourage them understand numbers better.		

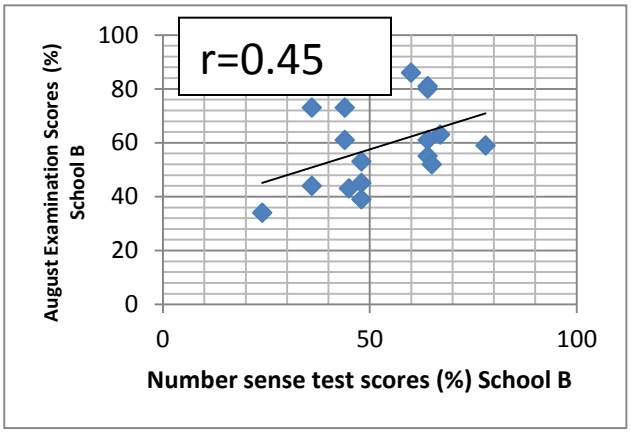
8. **ROLE OF THE TEACHER IN THE DEVELOPMENT OF NUMBER SENSE**

STATEMENTS	**YES**	**NO**
Teacher facilitates learning of number sense.		
The teacher generates new knowledge about numbers for learners to use.		
The teacher talks all the time and does not allow the learners to participate in the development of numbers sense.		

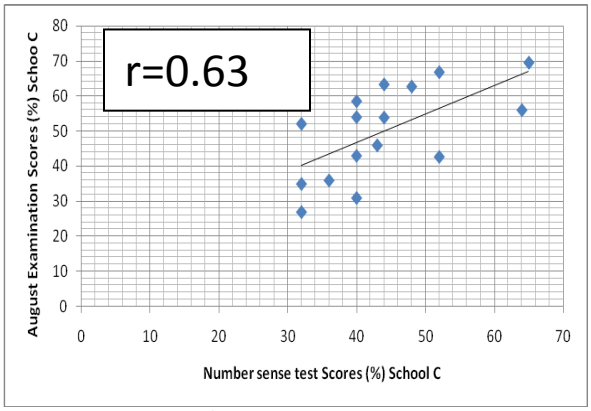
Appendix 7: The Scatter plots of number sense versus academic performance for all the 9 schools.



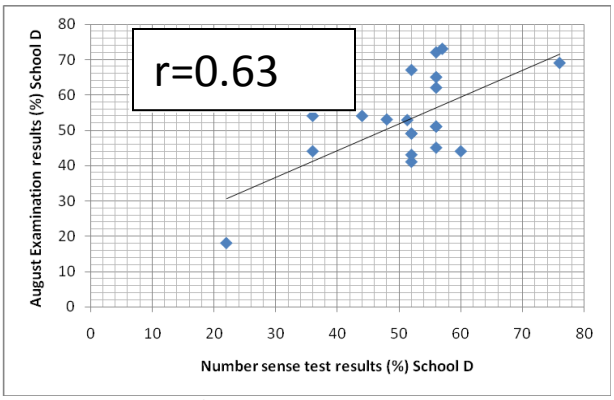
Scatter plot of number sense August Mathematics marks school A



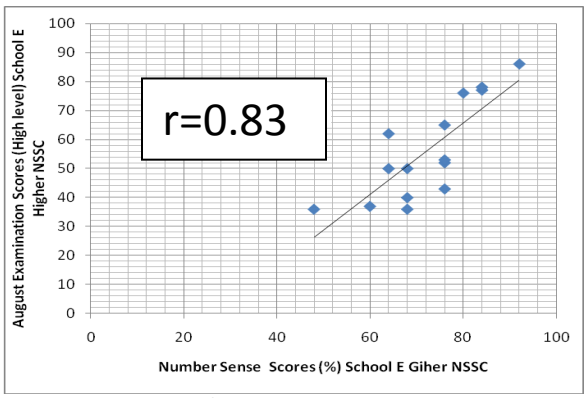
Scatter plot of number sense August Mathematics marks school B



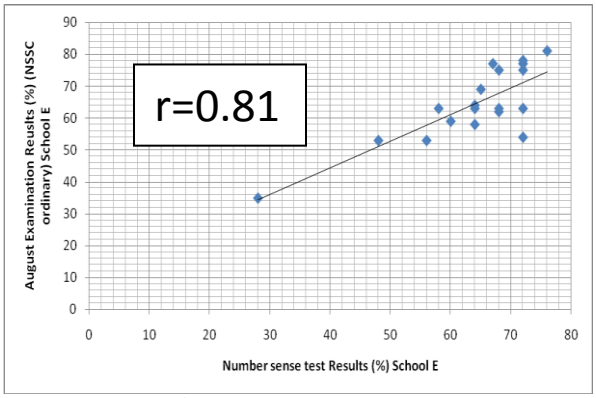
Scatter plot of number sense August Mathematics marks school C



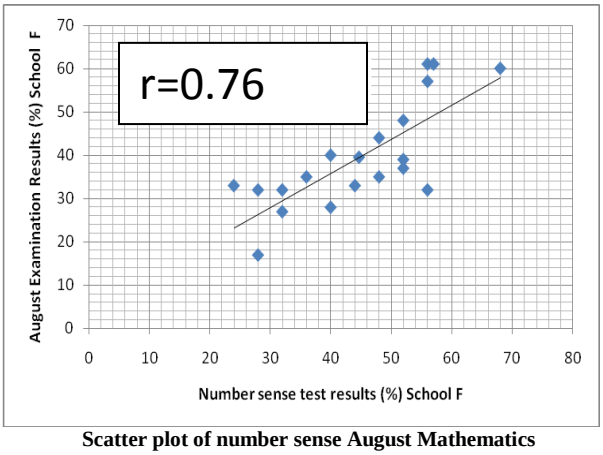
Scatter plot of number sense August Mathematics marks school D



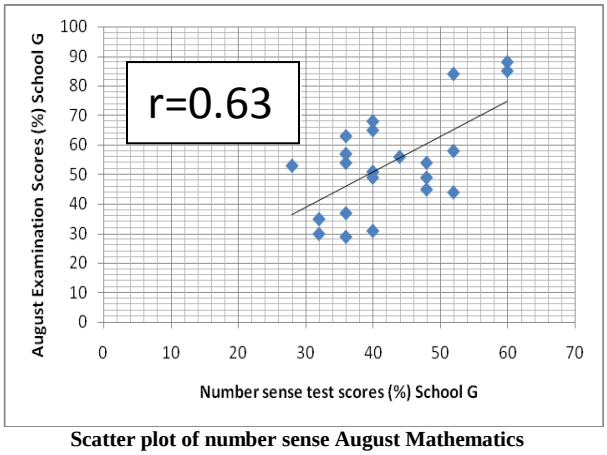
Scatter plot of number sense August Mathematics marks school E (Higher Level)



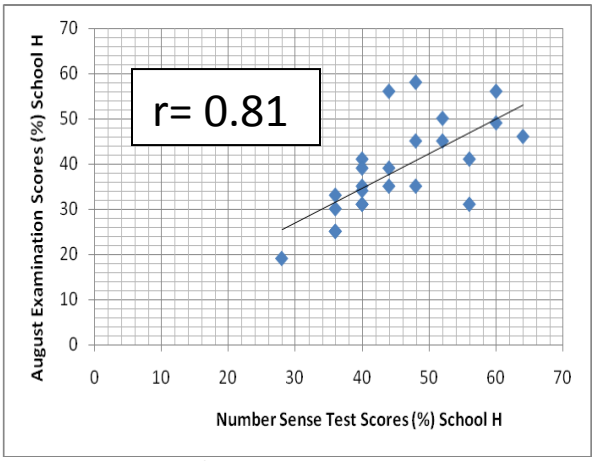
Scatter plot of number sense August Mathematics marks school E (Ordnary Level)



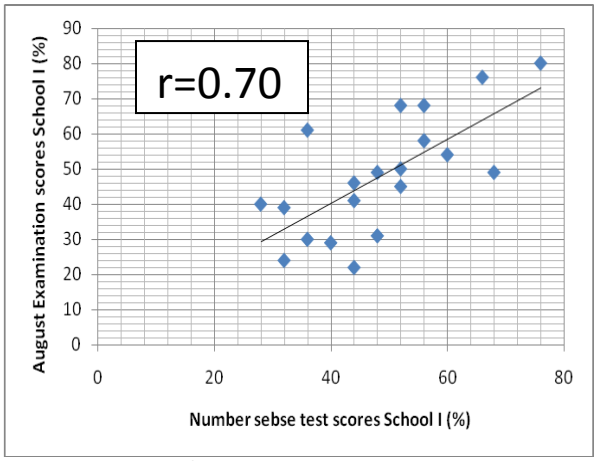
Scatter plot of number sense August Mathematics marks school F



Scatter plot of number sense August Mathematics marks school G



Scatter plot of number sense August Mathematics marks school H



Scatter plot of number sense August Mathematics marks school I

Appendix 8: Spearman's correlation coefficient of schools ranking in mathematics and number sense.

School	R1	R2	d=(R1-R2)	d^2
A	6	7	-1	1
B	2	2	0	0
C	5	4	1	1
D	3.5	3	0.5	0.25
E	1	1	0	0
F	7	9	-2	4
G	3.5	5	-1.5	2.25
H	8	8	0	0
I	9	6	3	9
				17.5
				$6\sum d^2 = 0.1458$
				$\rho = 0.8542$

Appendix 9: Spearman's correlation coefficient between the number sense performances and teacher experience for each school (N=9).

School	R_1	R_2	D	D^2
A	3.5	6	-2.5	6.25
B	7.5	3	4.5	20.25
C	9	5	4	16
D	5.5	3.5	2	4
E	2	1	1	1
F	7.5	7	0.5	0.25
G	1	3.5	-2.5	6.25
H	3.5	8	-4.5	20.25
I	5.5	9	-3.5	12.25
				86.5
				$6\sum d^2 = 0.720833$
				ρ = 0.28

Appendix 10: Specimen of the number sense test.

University of Namibia

Faculty of Education

Tool No. 1: Number Sense test.

Name:_____ Grade:_____

An assessment test to find out how much number sense do the grade 11 and 12 learners in Oshana Education Region have.

Instructions:

- Circle the letter that carries the correct answer.
- Only **one** answer should be selected for each question.
- This Paper consists of **Seven (7)** pages including this one.

Question 1

40% means:

a) 4 out of every 100.
b) 40 out of every 1000
c) 4 out of 10
d) 40 out of 10000

Question 2

One quarter means:

a) 1 out of every 4
b) 1 out of every quarter
c) 1 out of every 40
d) 1 out of every 400

Question 3

Putting <, = or > in the box to make the statement $\frac{5}{6} \square \frac{9}{12}$ true.

a) <
b) >
c) =
d) None of the above

Question 4

Which statement is true about the number $\frac{2}{5}$?

a) Greater than $\frac{1}{2}$.
b) The same as 2.5
c) Equivalent to 0.4
d) Less than $\frac{1}{3}$

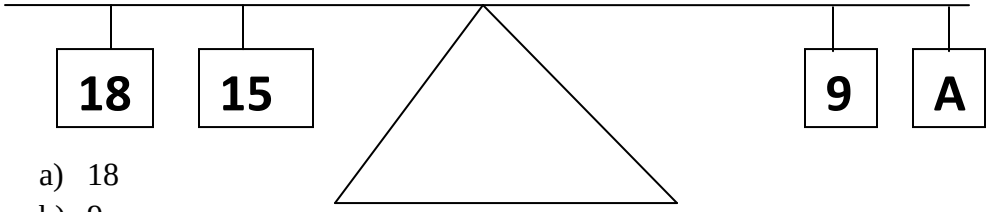
Question 5

Which number is the best estimate of the shaded region of the block below?

a) 0.65
b) 0.45
c) 0.75
d) 5.0

Question 6

Circle the number that should be contained in box A below to balance the scale.



a) 18
b) 9
c) 15
d) 24

Question 7

Which sign should be inserted in the box to make the calculation true?

456 ÷ 8 ☐ 456 × $\frac{1}{8}$

a) <
b) =
c) >
d) None of the above

Question 8

Which sign can be inserted in the boxes to make the statement true: 25% ☐ 0.025?

a) >
b)
c) =
d) <
e) None of the above

Question 9

Which letter shows the correct ascending order for: 2.5; $\frac{2}{5}$; 2.5%;0.25?

a) 2.5%; $\frac{2}{5}$; 0.25; 2.5;
b) 2.5%; $\frac{2}{5}$; 2.5; 0.25;
c) 2.5%; 0.25; $\frac{2}{5}$ 2.5;
d) 0.25; $\frac{2}{5}$; 2.5; 2.5%

Question 10

For the calculation: $16 \times \square = \square$ the number in the box must be.

a) Must be 0

b) Must be $\frac{1}{15}$

c) Must be 1

d) Must be 15

Question 11

Which numbers should be in both boxes respectively to make the correct equation?

$57.2 \times \square = 0.572 \div \square$

a) 0.1 and 1

b) 0.1 and $\frac{1}{10}$

c) 1 and $\frac{1}{100}$

d) $\frac{1}{100}$ and 0.1

Question 12

The calculation 0.5×840 is the same as:

a) $840 \div 2$

b) 5×840

c) $\frac{0}{5} \times 840$

d) 0.5×84

Question 13

Circle the calculation which gives the largest answer:

a) $\frac{3}{4} \times \frac{1}{100}$

b) $\frac{3}{4} \div \frac{100}{1}$

c) $\frac{30}{400} \div \frac{1}{10}$

d) $\frac{30}{40} \times \frac{10}{1}$

Question 14

For the numbers $\frac{3}{4}$; $\frac{1}{2}$; $\frac{1}{20}$ and $\frac{3}{40}$ the largest difference is given by subtracting which two numbers?

a) $\frac{3}{4} - \frac{1}{20}$

b) $\frac{3}{4} - \frac{3}{40}$

c) $\frac{1}{2} - \frac{1}{20}$

d) $\frac{1}{2} - \frac{3}{40}$

Question 15

For the numbers: $\frac{1}{10} \square 0.1=1$, which arithmetic operation should go in the box?

a) $\times$

b) $+$

c) $\div$

d) $-$

Question 16

A child starts school in Namibia at the age of 6 years. About how many days has a child lived when she starts school?

a) 200

b) 2000

c) 20 000

d) 200 000

Question 17

Use $930 \times 134 = 124\ 620$ to find the answer to the calculation $124\ 620 \div 93$.

a) 13.4

b) 1340

c) 13400

d) 134

Question 18

Each one of the five children in a class has exactly five sweets. Which calculation shows the correct total number of sweets?

a) 5 + 15

b) 15 + 5

c) 15 + 15 + 15 + 15+15

d) 5 + 5 + 5 + 5 + 5

Question 19

Simon has $50 and spends $ 29. He gets $24 change. Which calculation can be used to check if he has the correct change?

a) 29 — 24
b) 24 — 50
c) 50 — 29
d) 29 — 50

Question 20

A shirt costing N$ 120-00 was reduced by 12%. Which calculation can be used to find the price after the discount was issued.

a) 0.088×120
b) $\frac{88}{100}\% \times 120$
c) 0.88×120
d) $\frac{12}{100} \times 120$

Question 21

Which rectangle has a shaded area of about $\frac{8}{15}$?

a)

b)

c)

d)

Questio

Without calculating; which letter tells the correct estimation for the calculation 29 ÷ 0.8?

a) Slightly less than 29
b) Equal to 29
c) Bigger than 29
d) Impossible to tell without calculating

Question 23

Which decimal is approximately the size of the shaded area?

a) 0.098
b) 0.78
c) 0.456
d) 0.96

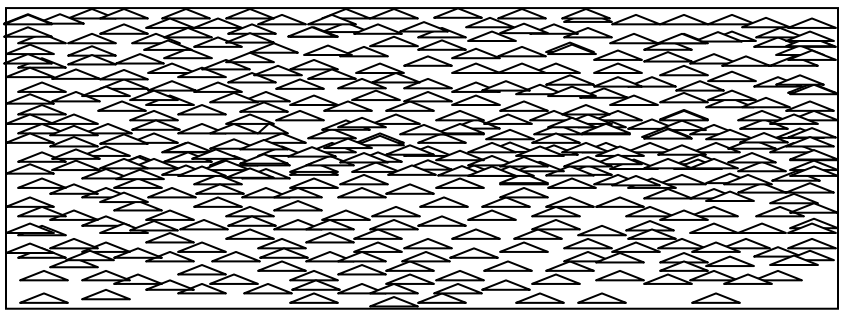
Question 24

Mary spent 90 % of her N$ 426-00 on food. Circle the best estimate of how much money she will be left with.

a) Less than 426
b) Equal to 426
c) Impossible to tell without calculating
d) More than 426

Question 25

About how many triangles are enclosed in the rectangle below?



a) 20 000
b) 10
c) 10 000
d) 500