TYPES OF STRATEGIES USED TO SOLVE ALGEBRAIC WORD PROBLEMS BY GRADE 12 ORDINARY LEVEL MATHEMATICS LEARNERS OF KAVANGO EAST REGION OF NAMIBIA

A THESIS SUBMITTED IN PARTIAL FULFILMENT

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APPROVAL PAGE

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

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ABSTRACT

This study investigated the types of strategies used by Grade 12 ordinary level mathematics learners to solve algebraic word problems in Namibian settings in the Kavango East Educational Region. The study used a descriptive qualitative research approach in which the researcher identified the strategies used by Grade 12 learners to solve algebraic word problems. The study used observations and focus group discussions as methods for data collection. The researcher independently conducted a typological analysis of the transcriptions of the Grade 12 learners 'observation and interviews to determine commonalities and trends.

The study revealed that the possible main cause of Grade 12 learners' difficulties with algebraic word problems was the language factor. This emerged in the literature which the researcher divided into four areas: *text difficulties, unfamiliar contexts, use of inappropriate strategies and lack of solving skills*. These were observed in the algebraic word problem exercise and confirmed in the focus group discussions. The results in this research demonstrated how ineffective teaching of problem-solving strategies may influence and change the focus of learners´ learning abilities from solving algebraic word problems.

Another finding of the algebraic word problems analysis showed that, learners used the strategies like identifying key words, underlining key words, re-reading the words, visualizing problems, guessing and checking, step procedures, looking for patterns and counting techniques. The study also pointed to possible recommendations to teachers to teach problem-solving strategies and strategic thinking within the limits of a mathematics classroom so that the learners learn about strategies without losing out on conceptual or procedural understanding knowledge. The study further found that the effective learning strategies used by the three sampled schools fell into four categories namely: making change in the phrasing of the problem context, identifying key words in the problem texts, concept clarification and building an experience.

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LIST OF ACRONYMS

DNEA	Directorate of National Examinations and Assessment
HoD	Head of Department
NSSC	Namibian Senior Secondary School Certificate
NSSCE	Namibian Senior Secondary School Certificate Examination
UNAM	University of Namibia
MoE	Ministry of Education
ELT	Experiential Learning Theory
CE	Concrete Experience
AC	Abstract Conceptualization
RO	Reflective Observation
AE	Active Experimentation
LSI	Learning Style Inventory

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DEDICATION

This Thesis is dedicated in memory of my beloved late mother Muronga Hellena Kapweru who brought me up in an environment characterised by hard work, shaped my aspirations towards maintaining the highest moral standards, and created opportunities for me to study throughout my entire career despite financial hardships. I salute her and may her soul rest in peace.

DECLARATION

I, Sikukumwa Ellion, hereby declare that the study, entitled "An investigation of the types of strategies used by Grade 12 ordinary level mathematics learners of Kavango East Region in Namibia in solving algebraic word problems"**,** 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. No part of this thesis may be reproduced, stored in any retrieval system or transmitted in any form or by means (e.g. electronic, mechanical, photocopying, recording or otherwise) without the prior permission of the author, or the University of Namibia in that behalf.

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CHAPTER 1: INTRODUCTION

1.1. Orientation of the study

Exposing learners to a variety of problem solving strategies early in their academic journey can help to enhance their reasoning skills and develop confidence in problem solving situations (Florida Department of Education, 2010). Problem solving skills have been at the centre of the Namibian mathematics examinations written by the Namibian Senior Secondary School learners (Ministry of Education, 2010). According to Sepeng (2013, p. 8), "major arguments for including word problems in the school mathematics curriculum have always been the potential role to promote realistic mathematical modelling and problem-solving and for the development in learners of the skills in being aware of when and how to apply classroom mathematical knowledge and everyday-life knowledge when solving problems". Cankoy and Darbaz (2010) argue that if a learner cannot understand a problem then he or she may not easily select an appropriate strategy to solve the problem and be aware of what he or she is doing. According to Sepeng and Madzorera (2014), the difficult part of solving mathematical word problems appear to be the process of understanding a problem and deciding what operation(s) need(s) to be performed in a certain problem. It is therefore reasonable to suggest that it success in solving algebraic word problems requires a learner to gain familiarity with the vocabulary of mathematics before he or she can solve mathematical word problems effectively.

In the Namibian mathematics classrooms little learning of algebraic word problems for understanding takes place and the discussion of learners' problem solving methods and correct solutions rarely occur (Miranda & Adler, 2010). Many learners in most of the Namibian schools lack mathematical vocabulary hence this might be a contributing factor to the poor performance in the algebraic word problems as

documented in the Directorate of National Examination and Assessment (DNEA) (2012 – 2015) reports. It is for this reason that this study investigated the types of strategies used by Grade 12 learners, in the Kavango East Region when solving algebraic word problems.

1.2. Statement of the problem

When one thinks of doing mathematics, their initial thoughts may involve working with numbers and symbols to find answers to problems. Solving word problems is a particularly important concept in the algebra topic and it is one of the important elements of mathematical problem solving which incorporate real life problems. According to Miranda and Adler (2010), "in many Namibian classrooms, engaging learners with algebraic word problem solving activities is only done through textbook exercises in which the learners are expected to complete lists of exercises and have them checked right or wrong by the teachers" (p.15). Miranda and Adler (2010) proceed to point out that there is little focus on helping the learners to make use of learning strategies for solving algebraic word problems either through debate and discussion or through the use of concrete learning aids.

A genuine concern in Namibian schools that has occupied the field of mathematics education is that many Grade 12 learners leave school with little algebraic understanding. One serious deficiency that has been identified is the learners' lack of fluency and accuracy in solving algebraic problems (Miranda, 2009). Many Grade 12 learners have the perception that mathematics has less word problems than other content subjects. However, the reality is that there is a large amount of words and concepts that Grade 12 learners must attend to in order to understand and solve mathematics problems (Miranda, 2009). This makes learning algebraic word

problems even more challenging as learners work toward mastering both basic mathematics concepts as well as problem solving skills.

The reports for national examinations for Grade 12 Mathematics (core level) indicate that learners always struggle to solve word problems especially algebraic word problems (Directorate of National Examination and Assessment, DNEA, 2011). DNEA (2012 -2014) further points out that algebraic word problems have proven to be difficult to many learners as they struggle to write down algebraic word problems and change word problems to numerical problems. This is supported by Sepeng (2013) who observes that solving algebraic word problems is a challenge to learners because of the unrealistic strategies that they tend to use in solving these problems. Sepeng goes further to acknowledge that in order to successfully solve algebraic word problems, learners need to know how to use text to identify missing information, construct number sentences and set up a calculation strategy for finding the missing information.

The researcher has been in the teaching profession for 8 years and has been a national examiner for Grade 12 mathematics and a National marker for Grade 12 mathematics Ordinary Level (core). From his experience he noticed that many Grade 12 learners struggle to understand and solving algebraic word problems. In addition, learners rarely attempt to understand the algebraic word problems. At best, they look for common basic key words in the text like 'division, multiplication, addition, subtraction, sum, difference and product'. This strategy is limited, because looking for key words does not always work to the learners' advantage. In many cases learners locate numbers in algebraic word problems and perform mathematical functions with

them without knowing why or if what they are doing makes sense (Miranda, 2009). As a teacher in the classroom, the researcher has seen learners struggle with understanding and solving algebraic word problems. Many Grade 12 learners whom the researcher has worked with over the years have had problems in comprehending mathematics word problems.

The learners are often unable to translate the words into number sentences in order to calculate the answers to mathematics word problems. For this reason the researcher carried out a study to have a deeper understanding of the Grade 12 learners' word problem solving abilities and the problems that they experience when solving algebraic word problems. It is in this context that the study investigated the types of strategies used by Grade 12 Ordinary Level mathematics (core) learners in Kavango East Region when solving algebraic word problems.

1.3. Research questions

In order to fully investigate learners' strategies for solving algebraic word problems and understand why they solve such problems the way they do, the study focused on the following research questions:

1. What strategies do Grade 12 learners use when solving algebraic word problems?
2. What difficulties do Grade 12 learners experience when solving algebraic word problems?
3. What approaches can teachers use to help Grade 12 learners solve algebraic word problems effectively?

1.4. Significance of the study

Learning and teaching algebra, especially with regard to algebraic word problems, has been a challenge for both teachers and learners for ages (Miranda, 2009). Therefore, this study was found to be important in contributing to the global knowledge body by availing new information on the strategies used by Grade 12 learners in solving algebraic word problems and its influence on academic performance in Mathematics as a subject among Grade 12 learners in the Kavango East region.

The purpose of the research questions was to guide the researcher in order to explore and understand how Grade 12 learners learn algebraic word problems. In terms of the researcher's own teaching, he wanted to know why most Grade 12 learners in Kavango East Region failed to solve algebraic word problems effectively. For instance in the first research question, the researcher wanted to find out how effective the strategies Grade 12 learners used, when they solved the algebraic word problems, especially whether these strategies help them to get the correct answers or not. The second research question was to identify the inadequacy of knowledge and skills that hindered these learners from solving algebraic word problems effectively. With the last research question, the researcher wanted to know how teachers could better help learners in the process of solving mathematical word problems in order for them to solve algebraic word problems effectively.

The findings of this study may benefit learners, mathematics teachers and teacher educators in various ways. For example, the findings could help in directing mathematics teachers on how to teach learners more appropriate strategies for solving algebraic word problems. Finally, the teacher educators may also benefit

from the findings of this study, as they might be able to train student teachers by preparing and guiding them on the appropriate strategies that they can use to teach word problem solving effectively in their pedagogic practices.

1.5. Limitation of the study

During the classroom observations the learners might have changed their normal ways of answering questions due to the presence of the researcher and their responses might not have been as natural as possible knowing that an unfamiliar person was observing them. Inadequacy of English communication skills might have been a barrier to some of the learners in giving their views and ideas clearly during the focus group discussions. Finally, the study only focused on the learning strategies for solving algebraic word problems and targeted the Grade 12 Ordinary Level Mathematics (core) learners from three schools in the Kavango East region. This was due to limited time and financial constraints. The time that was available at the researcher's disposal was limited to cover all the 14 education regions in the country. Therefore, the findings are only generalisable to the three schools in Kavango East region not to the rest of Namibian secondary schools.

1.6. Delimitations of the study

Delimitations are the boundaries, within which the researchers decide to place their study (Amoonga, 2008). However this study only focused on the learning strategies for solving algebraic word problems and targeted the Grade 12 Ordinary Level Mathematics (core) learners from the Kavango East region. Only mathematics was included in the study as a subject because of the persistent poor learners' performance in mathematics over the years.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

Literature review s is a tool which enables researcher to position the research in the broader academic community, synthesise existing ideas and arguments without adding your own, and identify any gaps in the literature which your research is attempting to address (NTU Library, n.d). Hence, literature reviews provides a framework and focus for the research study.

The literature reviewed for this study is presented in the following way: definition of mathematical word problem solving, algebraic word problems solving strategies, challenges of learning strategies of solving word problem, effective ways of learning algebraic word problem solving strategies and theoretical framework for understanding the phenomenon on learners' skills on solving mathematical problems (Experiential learning theory).

2.2. Definition of Mathematical Word Problem Solving

Mathematical word problems can be defined as "textual descriptions of situations assumed to be comprehensive to the reader, within which mathematical questions can be contextualized" (Sepeng & Webb, 2012, p. ix). For instance "*Sam's truck weighs 4,725 pounds. The truck can carry 7,500 pounds of rocks. What is the total weight of the truck and full load?" To answer the problem mean the student has to add 4, 725 and 7, 500 to get the answer like this 4, 725 + 5,500 =10,225*. On the other hand, Verschafel, Greer and De Corte (2000) define word problems as verbal descriptions of problem situation wherein one or more questions are raised, the

answer to which can be obtained by the application of mathematical operations to numerical data available in problem statements. According to Palm (2009), mathematical word problems include pure mathematical tasks "dressed up" in real-world situations that require the learners to "undress" these tasks and solve them. The researcher is of the same opinion that in the process of solving mathematical word problem, learners who understand the problems should be able to translate the concrete to the abstract and apply the abstract to the concrete.

Lave (1992) defines word problem-solving as a stylized representation of hypothetical experience separated from learners' experience of doing mathematics through numerical approach to word problems. Montague (2006) defines mathematical word problem solving as a process involving two stages: problem "representation" and "problem execution". Montague further adds that Mathematical problem solving is a " cognitive activity" involving processes strategies. Therefore it is important that learners understand the problem before translating texts problem into numerical problems in order to solving the problems effectively.

Solving algebraic word problems

"Algebra word problems concisely describe a world state and pose questions about it" (Kushman et al., 2014, p.1). Therefore, solving algebraic word problems requires reasoning across sentence boundaries to find a system of equations that concisely models the described semantic relationships (Kushman and Barzilay, 2013; Lei et al., 2013). For example, an amusement park sells 2 kinds of tickets. Tickets for children cost $1.50. Adult tickets cost $4. On a certain day, 278 people entered the park. On that same day the admission fees collected total $792. How many children were

admitted on that day? How many adults were admitted? This means that the total ticket revenue computation in the second equation summarizes facts about ticket prices and total sales described in the second, third, and fifth sentences. Furthermore, the first equation models an implicit semantic relationship, namely that the children and adults admitted are non-intersecting subsets of the set of people who entered the park.

2.3. Algebraic Word Problems Solving Strategies

Strategy is the thinking aspect of organizing, by laying out goals and ideas that can produce a plan for a specific action (Fulop, 2015). But in order to actually achieve these goals, problem solving must also be about how learners will act at the operational level to get the correct answer, which moves they will make in the solving strategies or how carefully they need to follow the required procedure. Scheonfeld (1983) describes two different types of decision making involved in mathematical problem-solving situations. These are the "what to do" and the "how to do" decisions. The first of these types of the strategic decisions includes selecting goals and deciding which courses of action to pursue. The second one, the "tactics", includes decisions about how to implement the decisions of the first type, but at the end the learners need to apply the procedures relevant for arriving at the solution of the problem. So, to become a good problem solver in mathematics requires developing a personal and idiosyncratic collection of problem-solving strategies (Kushman, et al., 2014).

One of the most important responsibilities of educators should be to facilitate the development of proper problem-solving skills, which include knowledge about strategies (Polya, 1962). Polya (1962) presents four practical examples of elements

for mathematical problem-solving. These four elements or problem-solving heuristics are; understanding the problem, devising a plan, carrying out the plan and looking back. But these models do not give any general definition or general characteristics of strategies. It is in the same vein that good algebraic word problem solvers need to understand the problem first before deciding on how to execute the problems in order to solve the problems effectively.

Posamentier and Krulik (1998) present ten problem-solving strategies that seem to be prevalent in problem-solving situations in mathematics. The strategies are "*Visualization, Organizing Data, Finding a Pattern, Solving a Simpler Analogous Problem, Working Backwards, Adopting a different point of view, Intelligent Guessing and Testing, Logical reasoning*, and *Considering extreme cases"(* p.39). It is important to note that both Polya (1962), and Posamentier and Krulik (1998) argue that the importance of familiarizing both teachers and learners with these strategies, can help learners in their thinking processes.

Lee (2011) suggests that when learners are asked to write their own mathematical word problems and draw pictures to represent mathematical word problems they are likely to comprehend learning strategies more deeply and be able to explain their thinking about how they solved that problem. This will enable both successful and unsuccessful learners to develop rich mathematical ideas as well as skills and knowledge of algebraic word problem solving strategies. Seifi, Haghverdi and Azizmohamadi (2012) observe that the skills of looking for patterns, drawing pictures and rewording the problems help learners to develop effective strategies for solving word problems, because learners can learn key words that define a problem.

This study examined ways of learning problem-solving strategies in mathematics in senior secondary school, through algebraic word problem solving exercise and focus group discussion. The study focused on learning strategies for solving algebraic word problems. Learning how to solve story problems involves knowledge about semantic construction and mathematical relations as well as knowledge of basic numerical skills and strategies (Maryam, Amiripour & Rostamy-Malkhalifeh, 2013). However, it is important to note that word problems pose difficulties for many learners because of the complexity of the solution process, which is more than simply extracting numbers from a story situation to solve an equation.

There are several word problem solving strategies that can assist learners to solve word problems effectively. According Paulsen and IRIS Center (2006) the ability to solve word problems is dependent on the understanding of the language in the problems. The more learners understand algebraic word problem, the more they will be able to use effective strategies to solve algebraic word problem and the better they will have to organize a system of how to store that new information, such as mathematical texts (Clement, 2008). This requires teachers to instruct learners on numerous problem solving strategies and the vocabulary, which gives clues as to which one to use. The researcher could easily relate to this statement because whenever in practice, he gave more examples and explanations of the types of vocabulary that each problem strategy would use, the learners would look for those clue words.

Duru (2011) argues that one of the reasons problem-solving is hard to implement

in the mathematics lessons is the fact that the processes and language of problem-solving are not sufficiently clear to learners who use English as second language or third language and discussion on how to embed them in practice situation make it difficult for learners to fluently describe or solve the problem effectively. Peker (2009) also acknowledges that having a good understanding of a problem solving process is the first step in learning problem solving strategies. On the other hand, to solve the algebraic word problems effectively, it does not only need to understand the language the algebraic word problems are written in but also to choose the right strategies for the given problems.

2.4. Challenges of Learning Word Problem Solving Strategies

Word problem solving is one of the important elements of mathematical problem solving which incorporate real life problems (Linsell, 2008). However, many learners in Namibia are challenged to comprehend this skill (Miranda, 2009). The challenges that learners face when solving algebraic word problems are caused by their inability to read and understand the word problem itself. For example, in standardized testing, text difficulties always limit learners' comprehension of the problem (Pearce, Bruun, Skinner & Lopez-Mohler, 2013).

In Namibia, a mathematics teacher is expected to be creative and innovative enough to ensure that the teaching and learning of algebraic word problem strategies is as much learner centered as possible (Miranda & Adler, 2010). However, "many teachers of mathematics are unable to imagine what a learning algebraic word problem strategies lesson could look like in a learner centered lesson and one of the main tenets

argued for by those who call for learner-centred teaching is that learners should be actively engaged with the subject content as they try to relate it to their life experiences" (Miranda & Adler, 2010, p.15). The researcher agrees that Namibian teachers especially the mathematics teachers are failing to implement learner-centred approaches in the classroom in most cases dues to overcrowded classrooms, lack of text books and other stationeries for learners.

Tuckman and Monetti (2011) argue that challenges with solving word problems are caused by lack of logical connectors of concepts which makes learners struggle to understand the problem that needs to be solved. Seifi, *et al* (2012) also acknowledge that learners' difficulties to solve word problems are mostly related to their inability to understand and represent word problems in order to define related vocabulary in such problems. Therefore, the problems associated with poor vocabulary knowledge and words with multiple meaning may affect achievement in mathematical word problems (Sepeng & Madzorera, 2014). As a result, the appearance of words with multiple meanings in mathematical texts can hinder the majority of the learners' achievement levels in solving word problems (Adams, 2003). Adams further suggests that teachers should use practical examples that relate to the learners' living experiences and teach these words in the mathematics lessons. Seifi *et al* further observe that "the causes of the learners' difficulties with solving word problems are text difficulties, unfamiliar contexts in problems and using in-appropriate strategies" (p. 2923). The researcher agrees with Seifi *et al* (2012) that the background of learners is important, as it helps the learners to relate their reasoning to their prior knowledge in order to solve any problems effectively.

2.5. Effective ways of learning algebraic word problem solving strategies

Miranda (2009) argues that the Namibian mathematics school curriculum does not stipulate possible strategies that can be used in teaching and learning algebraic word problems. Therefore, learners are forced to solve only textbook problems or problems that have been written by their teachers. However the use of learners' personal experience in creating mathematics word problems is not used during the learning process (Hott, Isbell & Montani, 2014).

Langeness (2011) advocated for learners writing their own algebraic word problems as a way of increasing their ability to comprehend and solve such problems, as well as to increase their problem solving ability in general. Furthermore, learning how to write their own algebraic word problems can have a positive effect on learners' motivation and interest, if mathematical word problem solving skills are linked to learners' personal experience and background knowledge, and allow learners and teachers to work collaboratively to create the algebraic word problem activities. It is particularly beneficial to Grade 12 learners to whom English is a second or third language. Moreover, linking content to personal experience and background knowledge is especially crucial for non-native speakers of English who are trying to navigate the language of mathematical word problems.

One reason why it is important for learners to write their own mathematical word problems related to interest is that learners tend to get excited when word problems are about them or their classmates as opposed to the word problem being too remote and far from their own pre-knowledge. Learners have a natural curiosity that can be tapped into during the mathematics lesson by making the content of word problems

more relevant (Langeness, 2011).

Winograd and Higgins (1995) argue that, learners who write their own mathematical word problems tend to be more interested in the problem solving process. This leads to a captive audience for teachers, who can provide direct problem solving instruction to learners who are more receptive to learn the skills of solving word problems.

Winograd (1992) conducted a case study with mainstream fifth grade learners at urban Colorado public school. In this, he observed one class as they wrote, solved, and shared mathematical word problems in small groups. He found that learners were more willing to accept problem solving instruction from teachers if the instruction was directly related to solving their self-authored word problems. In addition to the above, Winograd also discovered that when learners were given the opportunities to write their own word problems they often wrote more complicated word problems than they actually have in their mathematics text books.

Langeness (2011) observes that when learners write their own problems, they make use of contexts and situations with which they are intimately familiar. This helps to alleviate the problem of learners having to solve word problems that are culturally unfamiliar to them. When learners are exposed to setting their own algebraic word problems they are able to incorporate their background experience so that mathematical word problems are more comprehensible to them. Generally, when learners author mathematical word problems, they tend to include information about their actual experience, their hobbies, information from other content areas, objects

in the classroom environment, or they write about topics that come from their imaginations (Winograd, 1992).

Problems written by learners are more familiar to other learners, because they reflect the background knowledge and personal experiences that learners bring from their own lives (Chapman, 2006). In this way, learners are not only solving problems that teachers and textbooks create for them, but they are also able to solve problems that they create for each other. Hence, these approaches might also benefit learners to learn and master a variety of strategies in order to solve algebraic word problems.

In the Namibian context, Miranda (2009) intervened with a professional development project aimed at educating teachers' awareness of the need to help learners make meaning of algebraic problems. In this project the teachers were actively involved in the decision-making process concerning what activities were to be explored and where the project should be headed after each in-service session. In order to make sure that the teachers' voices were at the centre of the progression of the study, she regularly gave explicit questions as a guide to help teachers in drawing their reflections on the project. One such question invited the participant teachers to explicitly discuss the ways in which the mathematical activities explored contributed to their learning of algebra and how it may later, impact their decisions of what approaches to take when teaching algebra. For example, all the teachers and students who took part in the study acknowledged that the project helped them to discover different approach to solving algebra.

Miranda (2009) discusses the role that multiple representations (example the use of

manipulation to create algebraic meanings) play in the effectiveness of learning and teaching mathematical word problems. The study further revealed that the participant teachers realized and acknowledged that their role, and the use of tiles was observed as the most appropriate way of learning algebraic problems. "Due to this new learning about teaching and learning, the participant teachers, indicated that having worked on the activities that they did, will, in one way or the other, make a positive change in their approaches to teaching algebra and helping students better understand algebra"(Miranda, 2009, p. 203).

2.6. Theoretical Framework: Experiential Learning Theory

The study was guided by the experiential learning theory. Experiential learning theory draws on the work of prominent 20th century scholars who gave experience a central role in their theories of human learning and development. Kolb (1984) defines, learning as "the process whereby knowledge is created through the transformation of experience (p.41). According to Kolb, "knowledge results from the combination of grasping and transforming experience" (ibid.). Experiential learning theory (ELT) provides a holistic model of the learning process and a multi- linear model of adult development, both of which are consistent with what we know about how people learn, grow, and develop. The theory is called "Experiential Learning" because it emphasizes the central role that experience plays in the learning process, an emphasis that distinguishes ELT from other learning theories.

Sternberge and Zhang (2000) state that the term "experiential" is used to differentiate ELT from both cognitive learning theories, which tend to emphasize cognition over

learning process, and behavioural learning theories that deny any role of subjective experience in the learning process. Another reason the theory is called "experiential" is its intellectual origins in the experiential works of Dewey, Lewin, and Piaget. Taken together, Dewey's philosophical pragmatism, Lewin's social psychology, and Piaget's cognitive-developmental genetic epistemology form a unique perspective on learning and development (Kolb, 1984).

From Dewey's point of view experiential learning theory can be understood as an instructional approach based on the idea that, ideal learning occurs through experience and that learning tasks require the active participation of the learners in hands-on opportunities and must connect to the learner's life (Dewey, 1938). Experiential learning combines active learning with concrete experiences, abstract concepts, and reflection in an effort to engage all learning styles (Houle, 1980).

Dewey (1938) further argues that there is an intimate and necessary relationship between the processes of actual experience and education. Therefore, in order for the learning to be meaningful, there has to be an experiential component to the lesson. In the case of learning meaningful strategies for solving algebraic word problems, learners should be given algebraic word problems which are related to their real world situations for them to reflect on own experiences.

From Lewin (1951) point of view ELT is seen as a concept of learning space. This concept of learning space emphasizes that learning is not one universal process but a map of learning territories, a frame of reference within which many different ways of learning can flourish and interrelate. It is a holistic framework that orients the many

different ways of learning to one another (Kolb, 1984). The process of experiential learning can be viewed as a process of locomotion through the learning regions that is influenced by a person's position in the learning space. One's position in the learning space defines their experience and thus defines their "reality" (Kolb & Kolb, 2008).

The work on the ecology of human development has made significant sociological contributions to Lewin's life space concept (Bronfrenbrenner, 1979). Lewin defines the ecology of learning or development spaces as a topologically nested arrangement of structures each contained within the next. Lewin (1951) is of the opinion that, the learner's immediate setting such as a course or classroom is called the micro-system, while other concurrent settings in the person's life such as other courses, the dorm or family are referred to as the meso-system. The meso-system encompasses the formal and informal social structures that influence the person's immediate environment, such as institutional policies and procedures and campus culture. Finally, the macro-system refers to the overarching institutional patterns and values of the wider culture, such as cultural values favouring abstract knowledge over practical knowledge, that influence actors in the person's immediate micro-system and meso-system (Kolb & Kolb, 2008). For example, a theory provides a framework for analysis of the social system factors that influence learners' experience of their learning algebraic word problem solving skills.

Kolb, Boyatzis and Mainemelis (2000) argue that when a teacher focuses only on content without considering learners background the opportunity for learners to develop their own opinions of learning algebraic word problem strategies based on

interaction with the information is easily eliminated. Each learner's experience should be individualized based on past experiences, because not all learners will take away the same outlook of the learning strategies. Thus, the experiential learning classroom mimics society, where all people have different views of topics and information.

2.6.1. The Experiential Learning Model and Learning Styles

As highlighted earlier, Experiential Learning Theory (ELT) defines learning as "the process whereby knowledge is created through the transformation of experience. From this theoretical stance, it is believed that knowledge results from the combination of grasping and transforming experience" (Kolb, 1984, p.41). The ELT model which was designed by Kolb (1984) is shown below in Figure 1 portraying two dialectically related modes of grasping experience - Concrete Experience (CE) and Abstract Conceptualization (AC) as well as two dialectically related modes of transforming experience - Reflective Observation (RO) and Active Experimentation (AE). As can be seen in figure 1, Active Experience, Concrete Experience, Abstract Conceptualization and Reflective Observation are perceived as the four-stages of the learning cycle.

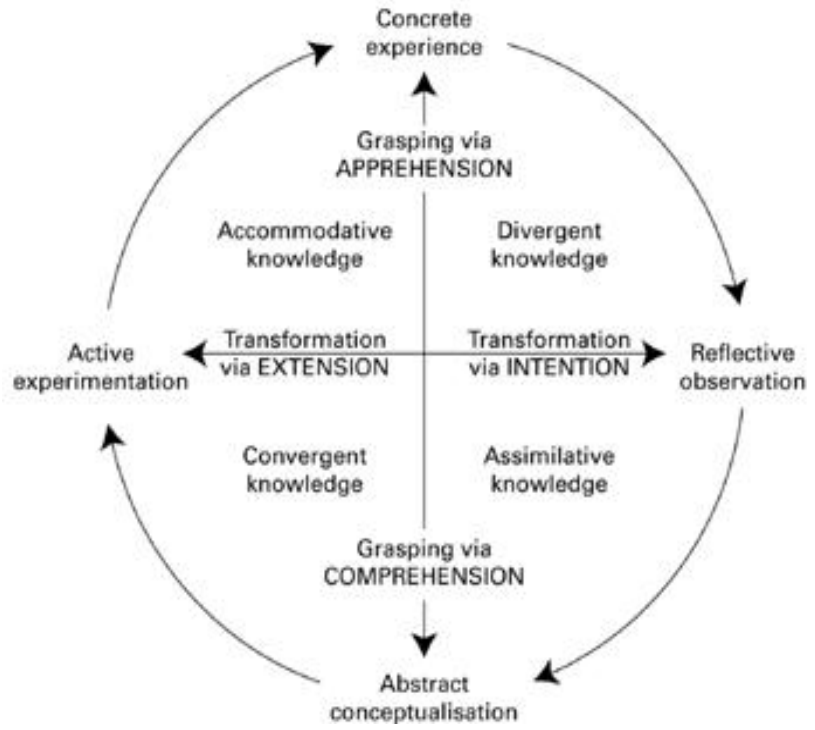

Figure: 1 Structural dimension underlying the process of experiential learning and resulting basic knowledge (Sources: Kolb, 1984, p.42)

According to this four-stage learning cycle the immediate or concrete experiences are the basis for observations and reflections. These reflections are assimilated and distilled into abstract concepts from which new implications for action can be drawn. These implications can be actively tested and serve as guides in creating new experiences (Kolb & Kolb, 2008). For instance, in a mathematics classroom learners should be given an appropriate task that can lead to experiential mathematical learning or creative dialogues. Well-chosen concrete context problems offer opportunities for the learners to develop informal, highly context-specific solution strategies. Getting stuck for a while is very helpful because it provide an opportunity to experience the creative side of mathematical word problem thinking (Linsell, 2008). It therefore is important that the concrete algebraic word problems that are given to learners to solve encourage them to reflect and create new knowledge.

Abstract conceptualization thinking is a process whereby learners create knowledge through symbolic reasoning in a systematically planning (Mason, Burton, & Stacey, 1982). For instance giving learners mixed algebraic word problems exercise to solve will benefit the entire learner in the mathematics classroom. While reflective observation refers to learners in the same classroom who prefer to watch others learn and reflect on what fellow learners has done in the classroom.

Therefore, learning algebraic word problems in pairs, groups or peer teaching can help these types of learners to be actively involved in the learning of algebra effectively (Fulop, 2015). The last stage of four stages of the learning cycle according to Kolb (1984) is active experimentation which refers to learners who experiment in their learning process, where they learn through trial and error. In the case of learning algebraic word problems solving strategies, these learners mostly use guess and check, trial and error strategies.

A closer examination of the ELT learning model suggests that learning requires abilities that are polar opposites, and that the learner continually chooses the set of learning abilities he or she will use in a specific learning situation. This is to say in grasping experience some people perceive new information through experiencing the concrete, tangible, felt qualities of the world, relying on their senses and immersing themselves in concrete reality. Others tend to perceive, grasp, or take hold of new information through symbolic representation or abstract conceptualization thinking about, analyzing, or systematically planning, rather than using sensation as a guide.

Similarly, in transforming or processing experience some people tend to carefully

watch others who are involved in the experience and reflect on what happens, while others choose to jump right in and start doing things. The watchers favour reflective observation, while the doers favour active experimentation (Kolb, 1984).

Each dimension of the learning process outlined in Figure 1 presents a choice. Since it is virtually impossible, for example, to simultaneously drive a car (Concrete Experience) and same time analyze a driver's manual about the functioning of the car. The abstract Conceptualization, refer to the conflict that can only be resolved choosing. However, because of our heredity (inheritance knowledge and skills through genes), our particular past life experiences, and the demands of our present environment, people develop a preferred way of choosing of what they are exposed to. They resolve the conflict between concrete and abstract and between active or reflective in some patterned, characteristic ways. The patterned way is call ways "learning styles" (Kolb & Kolb, 2008). In referring to learning algebraic word problem solving strategies, learners should not be forced to apply only given strategies but should be given choices where they can choose strategies from given the strategies or to create their own strategies in order to solve given algebraic word problems provided that they yield sensible solutions.

2.6.2. The Learning Style Inventory and the Four Basic Learning Styles

Kolb (1976) developed the model Learning Style Inventory (LSI) for assessing individual learning styles. While individuals tested on the LSI showed many different patterns of scores, research on the instrument has identified four statistically prevalent learning styles namely Diverging, Assimilating, Converging, and accommodating (see Figure 1 on page 22).

The Diverging style's dominant learning abilities are Concrete Experience (CE) and Reflective Observation (RO). Learners with this learning style are best at viewing situations, in this case algebraic word problems with concrete points of view. A learner of this ability performs better in situations that call for generation of ideas, such as a "brainstorming" session. Learners with a Diverging learning style have broad cultural interests and like to gather information (Kolb *et al*, 2000). Therefore in algebraic word problems learning situations, learners with the Diverging learning style are likely to prefer working in groups, listening with an open mind and receiving personalized feedback from the teacher or others learners.

The Assimilating style's dominant learning abilities are Abstract Conceptualization (AC) and Reflective Observation (RO). Learners with this learning style are best at understanding the situation in a wide range and can solve problems solving with several strategies, because they are able to put information into a logical and concise form. Individuals with an Assimilating style are less focused on other learners' views and more interested in creating ideas and abstract concepts. Generally, people with this learning style find it more important that a theory has logical soundness and has practical value. The Assimilating learning style is important for effectiveness in learning mathematics (Kolb, 1984). In formal learning situations, learners who possess this learning style prefer reading, peer teaching and learning, exploring analytical models, and also applying their logical reasoning in problem solving situations (Kolb, *et al*, 2000).

The Converging learning style on the other hand, is dominated by learning abilities

of Abstract Conceptualization (AC) and Active Experimentation (AE). Learners with this learning style are best at finding practical uses for ideas and theories. They have the ability to solve problems and make decisions based on the solutions to specific problems. Particularly when solving algebraic word problem, these learners prefer technical ways, whereby steps of solutions are clearly shown. These learning skills are important for effectiveness in specialist and technology careers. In addition learners with this style prefer to experiment with new ideas.

Kolb *et al* (2000) add that the Accommodating learning style's dominant learning abilities are Concrete Experience (CE) as well as Active Experimentation (AE). Learners with this learning style have the ability to learn from primarily "hands-on" experience. They enjoy carrying out plans and involving themselves in new and challenging activities. In solving problems, individuals with an Accommodating learning style rely heavily on other learners and teachers for information than on their own solutions. Learners in the subject of Mathematics with the Accommodating learning style would therefore prefer to learn algebraic word problems with others in pairs, groups or through peer teaching and learning.

In conclusion the chapter discussed the definition Mathematical Word Problem Solving in general and looked at types of Algebraic Word Problems Solving Strategies from other scholars. Equally, the study also discussed the Challenges of Learning Word Problem Solving Strategies and Effective ways of learning algebraic word problem solving strategies. Finally, the study used Experiential Learning Theory as guide frame, whereby it included the experiential leaning model and learning styles, the learning style inventory and the four basic learning styles.

CHAPTER 3: RESEARCH METHODOLOGY

3.1. Introduction

This chapter describes the various methodologies which the researcher used to collect, organise and analyse the data for this study. The research design, population and the sample with sampling techniques, research instruments, pilot study, data collection procedures, and data analysis are also described in this section.

3.2. Research Design

The study was descriptive in nature. Polit, Beck, and Hungler (2001, p. 180), state that descriptive methods are used when the researcher seeks to "describe, observe, and document a naturally occurring phenomenon which cannot readily be ascribed an objective value". In other words, descriptive research deals with questions that seek to explain what things are like and describe relationships but do not predict relationships between variables or the direction of the relationships.

The study used a descriptive qualitative research approach which enabled the researcher to identify the strategies used by Grade 12 learners to solve algebraic word problems. This approach allowed the researcher to assess learners' strategies as they solved algebraic word problems (Mack, et al, 2011). The data for this study were gathered from learners' engagements with a mathematics exercise through observations followed by focus group discussions.

In the same vein Borg, Gall and Gall (1996) suggest that a descriptive study is a

description of natural and man-made phenomena and is mainly based on individual's opinion. DeVaus (2002) believes that descriptive research can play a key role in highlighting the existence and extent of problems which can stimulate interventions and actions that can lead to new pedagogical approaches to teaching and learning algebraic word problems.

The study used the algebraic word problem exercises, focus group discussion and observation as data for to collected and processed to understand the view of learners on what might be the effective ways of learning algebraic word problem and establish the algebraic word problems solving strategies used by Grade 12 learners in their classrooms. In order to answer all the research questions of the study, a qualitative method of enquiry was employed. The qualitative method design involves an interpretive, naturalistic approach to the world. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them (Denzin & Lincoln, 2005).

During the process of data collection the researcher relied on the views and understanding knowledge of participants to collect open-ended emerging data with the primary intention of developing themes from the data. The collected data consist mostly of words (or text) from the participants (Creswell, 2009).

3.3. Population

Best and Kahn (1998) define population as any group of individuals that have one or more characteristics in common that are of interest to the researcher. The population

of this study included all the 3524 Grade 12 ordinary level mathematics (core) learners in Government secondary schools in Kavango East region. There were eight secondary schools in Kavango East region. Due to the fact that the time that was available at the researcher's disposal was limited to enable the researcher to cover all the 14 Educational regions in the country, the researcher had to limit himself to only one Educational region, namely Kavango East region.

3.4. Sample and Sampling Procedures

To obtain participants for this study, the researcher used criterion purposive sampling because random sampling was not possible due to the study design. Criterion purposive sampling, involves the researcher in making a conscious decision about which members of the population would best provide the desired information for phenomena under study (DeVaus, 2002).

This type of sampling was chosen in order to provide the researcher with the most useful data to understand the current situation of the learning of algebraic word problem solving strategies used by the Grade 12 learners in Kavango East region. The criterion purposive sampling technique was appropriate and advantageous for this study because the researcher required only schools that have taught mathematics for five years and above, and it was not practical or economical for the researcher to include a large sample of Grade 12 learners throughout Kavango East Educational Region.

The goal of using the criterion purposive sampling in this study was to provide relatively equal numbers of different learners from selected schools to enable the researcher to explore and identify the types of strategies Grade 12 learners use to solve algebraic word problems. The three schools that took part were purposively selected as follows: School A was the best performing school; school B was the average performing school and; school C was the school with the poorest performance in mathematics exanimation for 2013 to 2014 in the region.

Six Grade 12 learners from each school were then purposively selected to engage in a mathematics exercise focusing on algebraic word problems. The six learners from each school were purposively selected as follows: two best performing learners, two average performing learners and two poorest performing learners. This selection was based on the learners' August 2015 examination results from each school. Therefore the sample of the study consisted of a total of 18 Grade 12 learners who were doing ordinary level (core) mathematics in the three selected schools in Kavango East Region.

3.5. Research Instruments

The instruments used in the study were: a mathematics activity with the algebraic word problems, an observation guide, and an interview schedule to guide questions for the focus group discussions.

The researcher used an observation guide during the algebraic word problem exercises that were given to Grade 12 learners to solve. A non-participant observation is a

method in which a researcher simply observes behaviour in a systematic manner without influencing or interfering with the behaviour (Patton, 1990). The researcher as non-participant observer in general record the behaviour that he or she observes. There may be rating scales that the researcher would use when observing the behaviour. Observational studies can involve naturalistic observation or laboratory observation. Naturalistic observation involves observing behaviours in the natural environment while Laboratory observation involves observing behaviours in a research laboratory (Mack, Macqueen, Guest & Namey, 2005). Therefore this study used naturalistic observation in order to identify the strategies used by Grade 12 learners in solving algebraic word problems.

The observation schedule was used in an attempt to better understand the world of the participants. According to Patton (1990) one must be part of the world while at the same time remaining separate, a part of and apart from the participants in order to understand the world of participants. To this end, the researcher was a non- participant observer during the time when participants were solving algebraic word problems. This was necessary for the researcher because he wanted to understand the world of the participants with regard of strategies they used to solve the algebraic word problems.

The researcher visited each of the three schools and gave a mathematics activity with algebraic word problems to the six selected learners from each school. The algebraic word problem exercise consisted of six questions (see Appendix 1). The researcher observed learners as they solved every algebraic word problems exercise from each school to find out the learning strategies used by Grade 12 learners in

solving algebraic word problems.

The other tool the researcher used for data collection was an interview schedule to guide the discussion of the focus groups. Focus group discussion is a qualitative data collection method effective in helping researchers to learn the social norms of a community or subgroup, as well as the range of perspectives that exist within that community or subgroup (Patton, 1990).

Johnson and Christensen (2012) describe an interview schedule as a common protocol that an interviewer follows while interviewing participants. The inclusion of an interview protocol and a series of open-ended questions allowed the interviewer to obtain the necessary data for this study.

Before data collection, the completed interview guide was examined by two supervisors who checked the guide and questions for clarity and completeness. Based upon their feedback, all dichotomous or unclear questions were eliminated or revised. The final interview guide protocol consisted of 7 open-ended questions (see Appendix 2), which were then asked to Grade 12 learners in the three sampled schools in Kavango East Educational Region. The researcher adhered to the guide for asking questions while interviewing participants. In total, 18 Grade 12 learners were interviewed by the researcher. Each interview was audio-recorded and transcribed. In addition, the researcher took notes during the interviews.

A principal advantage of focus groups is that they yield a large amount of information over a relatively short period of time and is also effective for accessing a broad range

of views on a specific topic, as opposed to achieving group consensus (Mack *et al*, 2005). Because focus groups seek to illuminate group opinions, the method is especially well suited for the study of learning strategies used by Grade 12 learners to solve algebraic word problems.

These two tools, namely observation and focus group discussion helped the researcher to identify the types of strategies used by Grade 12 ordinary level mathematics (core) learners when solving algebraic word problems.

3.6. Pilot study

A pilot study is a small scale version of the main research that one intends to carry out and it involves the use of a small sample of the population of interest that have similar characteristics to the sample that will be involved in the main study (Patton, 1990).

The pilot study was carried out to find out whether the research instruments to be used were credible and trustworthy and to provide appropriate information to the research questions. Questions were revised on the basis of the responses obtained from the pilot. Both focus group discussion questions and algebraic word problems exercise were scrutinised and revised by the supervisors of the study before their use in research. The pilot study was conducted amongst learners from one of the schools in Kavango East Region which was the researcher's workplace. Six (6) learners from the school were used in the pilot study. The school used in the pilot study were not included in the actual study. This was done to avoid bias in the findings.

3.7. Data Collection Procedure

The following steps were taken into consideration in collecting data. Firstly, a letter of ethical clearance was obtained from the University of Namibia Research and Publications Office (see Appendix 3). Secondly, the researcher wrote a letter to the Director of the Kavango East Education Region to seek permission to carry out the study in the region (see Appendix 4). Thirdly, after permission was granted at the regional level, the researcher wrote another letter to the principals of the three selected schools to ask further permission to carry out the study at their schools (see Appendix 5). Fourthly, the researcher visited the sample schools, and collaborated with school principals to make appointments with the participants to inform them about the study as well as to establish good rapport between the researcher and the participants. Participants were given the study's information letter to ascertain informed consent voluntary participant and confidentiality.

Before the researcher gave the algebraic word problem exercise the participants to solve in the classroom, the participants were first assigned pseudonyms with the purpose of maintaining confidentiality and anonymity. Data were collected from Grade 12 learners using the mathematical word problem exercise and focus group discussions. The researcher came to each selected school and gave the mathematics exercise in the afternoon during school days. The activity consisted of six algebraic word problems (see Appendix 1). Each activity per school lasted approximately one hour. While learners were solving the algebraic word problems the researcher observed them in order to identify the types of strategies that they were using to solve each problem and after the exercise was completed marked and graded, the same learners were involved in the focus group discussion.

Each focus group discussion per school lasted approximately one hour and was audio recorded. In total, three focus group discussions were conducted. These discussions occurred after participants worked out the algebraic word problem exercises. The focus group discussions were not compulsory; however, all participants present were encouraged to contribute during the discussion sessions.

3.8. Data analysis

The researcher used two tools to gather data: the mathematics exercise and the interview schedule for the focus group discussions. During the data analysis of the mathematics exercise the researcher used typological analysis that guided him to create a checklist with items numbered from 1 up to 6 (see Appendix 6). Typological analysis is a strategy for descriptive qualitative data analysis of which the goal is to develop a set of related but distinct categories within a phenomenon of the study (Ayres & Knafl, 2008).

The researcher observed learners while they were solving the six algebraic word problems. The researcher identified all strategies that learners used to answer questions and recorded them on a pre-designed checklist (see Appendix). The non-verbal behaviours that learners demonstrated while solving the problems were also noted. The algebraic word problems solved by the learners were marked and the results were presented in bar graph per school (see Figure 4, 5, & 6 in Chapter 4).

In the analysis of learners' discussions the researcher created a checklist that contained categories of possible strategies as identified in the literature. The researcher independently conducted a typological analysis of the transcriptions of the Grade 12 learners' discussion to determine the commonalities and trends. All explanations that learners provided in the discussions were recorded in the checklist in their appropriate categories. The first step in the analysis was the creation of a pre-checklist that contained 16 categories of algebraic word problem of learning strategies (see Appendix 7) and 7 categories of challenges (see Appendix 8) based on the open-ended questions and the purpose of the study. The researcher then did an initial typological analysis using the pre-categories on three of the transcripts of group discussions. This was done to determine whether the pre-categories were appropriate.

The coding process consisted of the researcher's independent reading of the three transcripts data, also used identification of units of meaning where he designating the data into the appropriate categories. The researcher then compared coded information on the three transcripts analyzed. The researcher examined the coded information and arrived at an amended set of categories. The typological checklist was modified from the original 16 categories of learning strategies into three categories of learning algebraic word problem strategies and 7 categories of challenges into one category of learning challenges.

In total, four categorical areas concerning algebraic word problems were identified that related to the research questions. The four refined categories were: 1) effects of mathematical language in solving algebraic word problems; 2) learning strategies

used by learners to solve algebraic word problems; 3) the challenges experienced by learners in solving algebraic word problems; and 4) learners' perspective of classroom practices for solving algebraic word problems in general. The researcher then independently reread all three transcripts and placed the coded text into the appropriate revised categories. The merged analyses of data for researcher's observation and the learners' discussion were consolidated into a narrative that was used in making meaning of the strategies used by the learners to solve algebraic word problems. Lincoln and Guba (1985) suggest that these checks and balances inherent in merged data analysis increase the trustworthiness of the analysis.

3.9. Credibility and trustworthiness of the research

Credibility trustworthiness is defined as the confidence that can be placed in the truth of the research findings (Vicent, 2014). For that reason, the study can only be Credible if it can establish the research findings that represent plausible information drawn from the participants' original data and are a correct interpretation of the participants' original views (Vicent, 2014; Graneheim & Lundman, 2004). Therefore, the researcher established a rigour of inquiry by adopting the following credibility strategies: Dependability, confirmability and transferability.

Dependability According to Bitsch (2005), dependability refers to "the stability of findings over time" (p. 86). Dependability involves participants evaluating the findings and the interpretation and recommendations of the study to make sure that they are all supported by the data received from the informants of the study (Vicent, 2014; Cohen, Manion & Morrison, 2011; Tobin & Begley, 2004). During the research process the researcher seeks support from professionals that provide scholarly guidance, such a

members of academic staff (supervisors), the postgraduate dissertation committee and the department. The feedback from these professional personnel helped the researcher to improve the quality of the inquiry findings.

The researcher use confirmability as a technique strategy to validate the finding. Confirmability is "concerned with establishing that data and interpretations of the findings are not figments of the inquirer's imagination, but are clearly derived from the data" (Tobin & Begley, 2004, p. 392). Hence, confirmability of qualitative study is achieved through an audit trial, reflexive journal and triangulation(Vicent, 2014, Bowen, 2009; Koch, 2006). According to Bowen (2009) an "audit trail offers visible evidence from process and product, that the researcher did not simply find what he or she set out to find" (p. 307). The researcher used triangulation technique to reduce bias from the finding. According to Onwuegbuzie and Leech (2007) triangulation "involves the use of multiple and different methods, investigators, sources and theories to obtain corroborating evidence" (p. 239). The researcher triangulated the data finding by cross examines the integrity of participants' responses from the three sites (schools). The searcher also uses two sources of data or research instruments, such as focus group discussion and participant observation, which utilizes different informants to enhance the quality of the data from different source.

The study also used transferability as technique strategy for credibility and trustworthy of study finding. Transferability refers to the degree to which the results of qualitative research can be transferred to other contexts with other respondents it is the interpretive equivalent of generalizability (Bitsch, 2005; Tobin & Begley, 2004). According to

Bitsch (2005), the "researcher facilitates the transferability judgment by a potential user through 'thick description' and purposeful sampling" (p. 85). During the study, the researcher provides a detailed description of the enquiry and participants were selected purposively. Hence, the researcher provided thick description of all the research process, from data collection, context of the study and the production of the final report. This thick description might help other researchers to replicate the study with similar conditions in other settings and facilitated the transferability of the inquiry (Vincent, 2014).

3.10. Ethical Considerations

Before the actual research took off, the researcher developed an 'informed consent form' (see Appendix 12) that was completed by the participants. The researcher indicated how the participants were selected, explained verbally and in writing, the purpose and nature of the study, as well as the benefits for participants in the study. The researcher also made it clear that the participants' information would be kept confidential. The researcher further informed the participants that their participation was voluntary and that they were free to withdraw from the study, should they not wish to continue taking part at any stage.

Throughout the study, the researcher used pseudonyms to ensure the anonymity of the participants and research sites, in order to protect the participants' identity. After the data were collected, the researcher stored the raw data in a lockable cabinet to which only he had access. The raw data will be kept in the lockable cabinet for a period of 5 years after the study is completed. After that, the researcher will destroy

all the raw data: soft copies will be deleted from all hard drives and hard copies containing raw data and participants' information will be destroyed using a papers shredder. The data collected from the participants would be used for example for the purpose of this thesis and other publications in the form of conference presentations and journal articles.

CHAPTER 4: PRESENTATION AND DISCUSSION OF FINDINGS

4.1. Introduction

The researcher carried out the study in Kavango East Educational Region whereby three schools were involved in the study. Six Grade 12 learners were selected from each school and were given a mathematics exercise of six algebraic word problem exercises. The data were obtained through the use of two research methods: observation of learners solving the algebraic word problems in the assigned exercise and focus group discussion used with focus group discussions. Data emerging from both the mathematics exercise and the focus group discussions were presented in five subheadings, namely: 1) Biographical information of the participants; 2) Effect of mathematical language in solving algebraic word problems; 3) Specific learning strategies used by learners to solve algebraic word problems; 4) The challenges experienced by learners in solving algebraic word problems; and 5) Learners' perspectives of classroom practices for solving algebraic word problems in general. The results were presented, analysed and interpreted according to the research questions of the study outlined in Chapter 1.

4.2. Biographical information of the participants

Biographical information of the participants such as gender, age, and the subjects they were doing in Grade 12, marks obtained in the algebraic word problem exercise and the August examination marks for mathematics have been presented under the following subtitles.

4.2.1. Sex of the respondents

A total of 18 Grade 12 learners from three Senior Secondary Schools in the Kavango East Education Region participated in this study. Nine (50%) of the participants were males and the other nine (50%) were females (see Figure 2). The criterion purposive sampling was used to obtain a sample of 50% male and 50% female from the whole population in terms of sex. This was done to eliminate any possibility of gender bias.

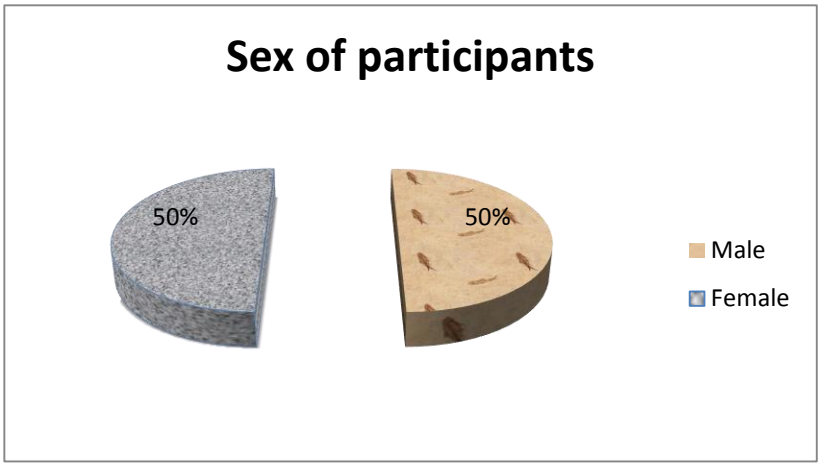

Figure 2: Sex of the participants

4.2.2. Ages of the respondents

The participants were also asked to indicate their ages. The results are given in Figure 3.

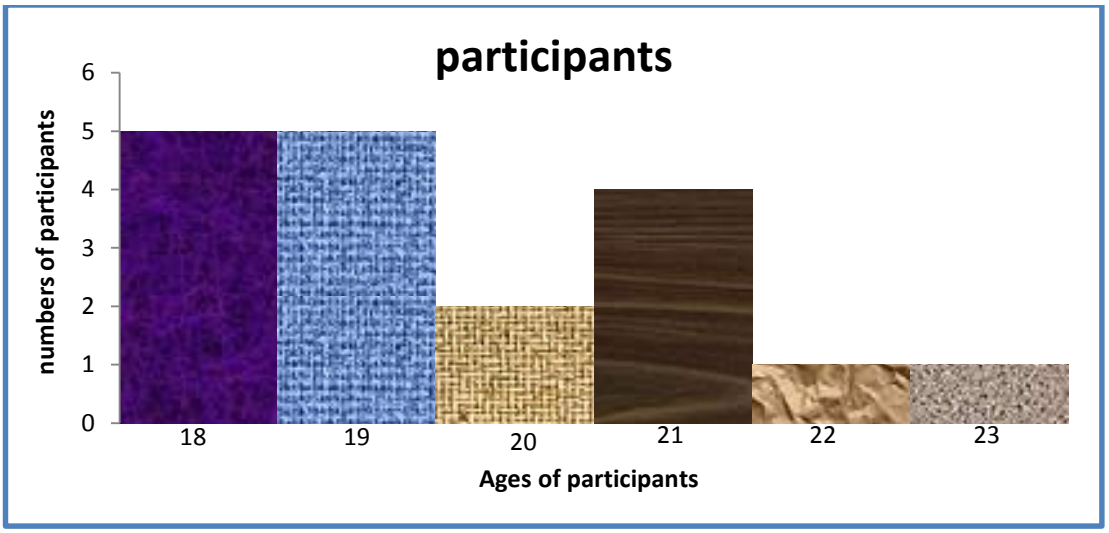

Figure 3: Ages of the participants (n=18)

Figure 3 above shows that ten (55. 6%) of the learners were aged between 18-19 years, two (11.1%) of the learners were 20 years old, four (22.2%) were of the ages of 21 years and, two (11.1) were between the ages of 22-23 years old.

Within the above age groups, there were: four female and one male learners of the age of 18, three female and three male of the age of 19, one female and one male of the age 20, one females and two males of the age 21, one male of the age 22 and one male of the age 23 participated in the study.

Figure 3 shows that all learners who participated in the study were of the ages between eighteen and twenty three. This means that they were old enough to sign the consent form without the permission of their parents since they had all attained the majority age according the Namibian constitution.

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4.2.3. Subjects participants were doing in Grade 12

The participants were sampled from three schools which were given pseudonyms: School A; school B; and school C. The participants from school A were all doing the same subjects, namely English 2nd language (core), Rumanyo 1st language (ordinary level), Mathematics (core), Biology (ordinary level), Physical science (ordinary level) and Agriculture (ordinary level).

The participants from school B were also doing same subjects, namely: English 2nd language (extended) Rukwangali 1st language (higher level), Mathematics (core), History (ordinary level), Geography (ordinary level) and Development studies (ordinary level). School B performed better than other two sampled schools in the August examination 2015.

On the other hand, participants from school C were all doing the following subjects: English 2nd language (extended), Rukwangali 1st language (higher level), Accounting (ordinary level), Business studies (ordinary level), Economics (ordinary level) and Mathematics (core).

It is important to notes that, Mathematics was only made a compulsory subject to all grade 12 learners in 2012 by the Ministry of Education in all schools in Namibia. Before that, in the Kavango East Educational region mathematics was compulsory only in the following two fields of study namely: sciences (Physical science; Biology; Agriculture or Geography) and commerce (Accounting; business studies; economics). The three fields of study from the three sampled schools presented above were important for the researcher as they helped the researcher to see any commonalities

in the performance of the learners in mathematics especially in algebra word problems that were given to the participants to solve.

4.2.4. Results of the algebraic word problem exercise and August 2015 mathematics examination

Figure 4 on page 48, figure 5 on page 49 and figure 6 on page 50 show the results of the participants of school A, school B and school C for their algebraic word problems exercise results and their August 2015 mathematics results. The participants from each of the three schools were given the same algebraic word problem exercises to solve individually. The exercise consisted of six algebraic word problems (see Appendix 1). The results for all the schools are presented bellow in bar chart together with their August 2015 mathematics examination. This was done to have a better understanding of how good or poor these learners were, in solving algebraic word problems compared with their mathematics skills in general.

Figure 4: Results of algebraic word problem and August mathematics result for 2015 for school A.

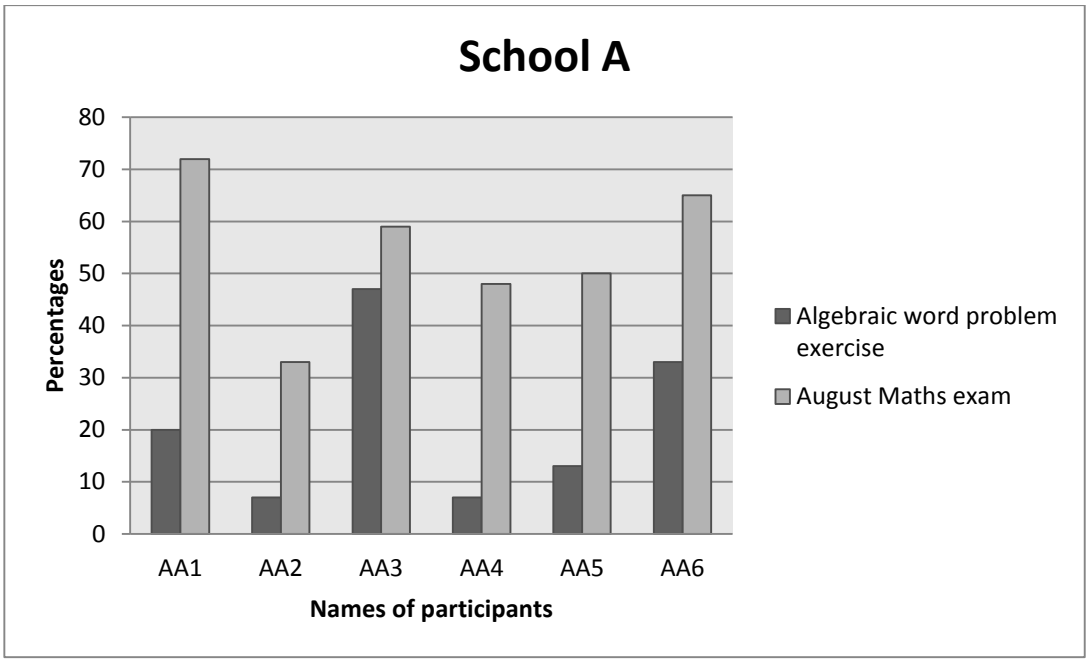

Figure 4: Results of the algebraic word problem and August mathematics result for 2015 for school A.

Figure 4 above shows the results for school A. the result show that 66.7% of the participants from this school got 50 % and above in their August 2015 mathematics examination while in the algebraic word problem exercise none of these participants got 50 % or more. The closest was learner AA3 who got 47% while the rest of the participants got below 40 % in the algebraic word problem exercise.

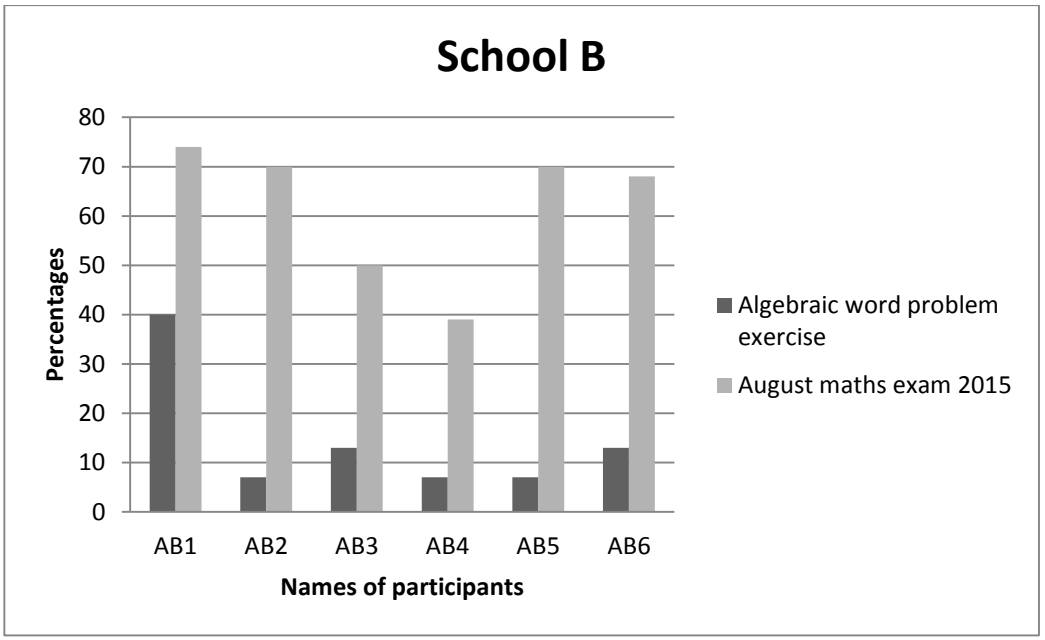

Figure 5: Result of the algebraic word problem and August mathematics result for 2015 for school B.

As can be seen in Figure 5 above representing school B, 83.3 % of the participants got 50 % and above in their August 2015 mathematics exanimations, while none of the participants managed to obtained even 40 % in the algebraic word problem exercise. Only learner AB2 managed to get 40 %. The rest of the participants got below 40 % in the algebraic word problem exercise.

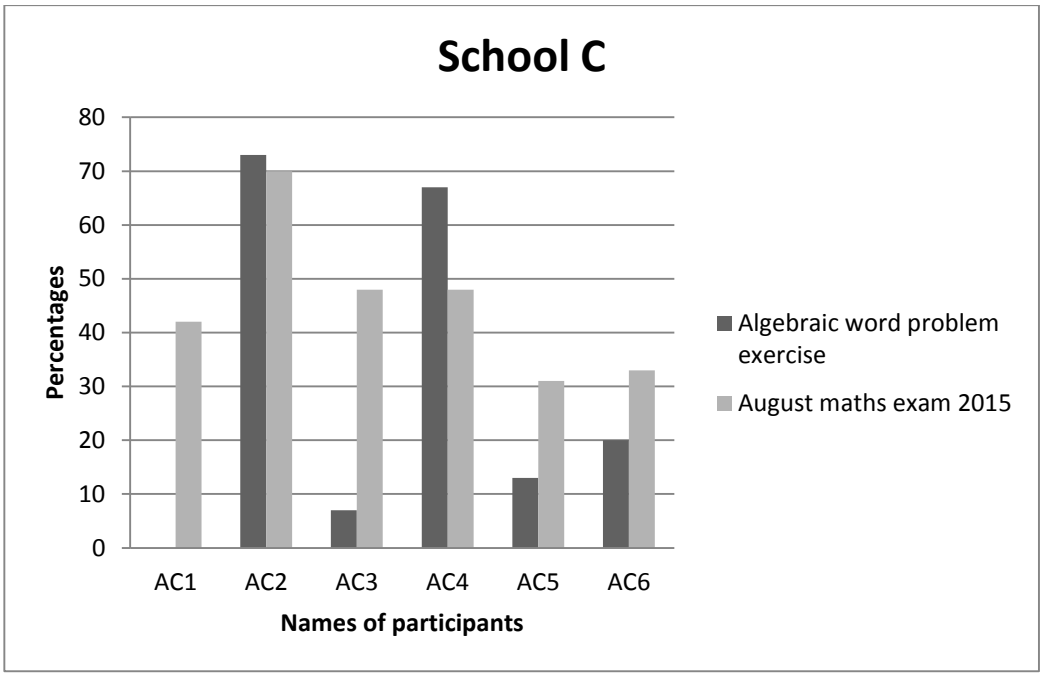

Figure 6: Result of the word problem and August mathematics result for 2015 for school C.

Figure 6 above shows the results of school C. this figure shows that only one participant got above 50% in their August 2015 exanimation whilst the rest of the participants scored below 50%. Two participants scored 67% and 73% in the algebraic word problem exercise respectively. The rest of the participants scored below 30% and one participant (AC3) scored 0% in the algebraic word problem exercise.

It is crucial to highlight the fact that school C was initially rated as the poorest performing school in the August 2015 mathematics examination. However from the three sampled schools, school C did better in the algebraic word problem exercise compared to the other two schools. School C was the only school with learners getting more than 50% in the exercise as shown in Figure 6 above. While the other two schools show that, all learners' performance in the algebraic word problem exercise was poorer than that of their performance in the August 2015 examinations. The researcher specifically observed that learners like AC2 and AC4 were able

to visualise the problems, identifying key words and most of all were able to choose correct procedures which they followed to solve the algebraic word problems.

The analysis of the results from the algebraic word problems in all the figures shown above demonstrate that solving algebraic word problems is difficult for Grade 12 learners in the selected schools in Kavango East region. When learners were solving the algebraic word problems, the researcher observed in the learners worksheets that they were unable to apply appropriate strategies to solve the problems. From the researcher's observation it was also clear that, the lack of relevant vocabulary had a negative effect on learners' understanding and the ability to solve algebraic word problems exercises. This was very apparent in question 6 where all learners from school B had no idea that the algebraic word problem was simply a simultaneous equation.

One could say this poor performance of learners from school B was caused by lack of exposure to simultaneous words concepts. This is further evidenced by the results of one of the learners from school B when they attempted one of the algebraic word problems. The researcher observed that learners mostly experienced difficulties/challenges with word problems that were contextualised (e.g. "*of the normal price*") and comparison (e.g. *"longer than; divide a number by; younger than"*). Learners who seemed to have understood the questions failed to set up appropriate strategies to solve the problems. The questions that learners did better in the exercise were question 2, 3 and 4.

The following are samples of the answers given by three of the participants in this study:

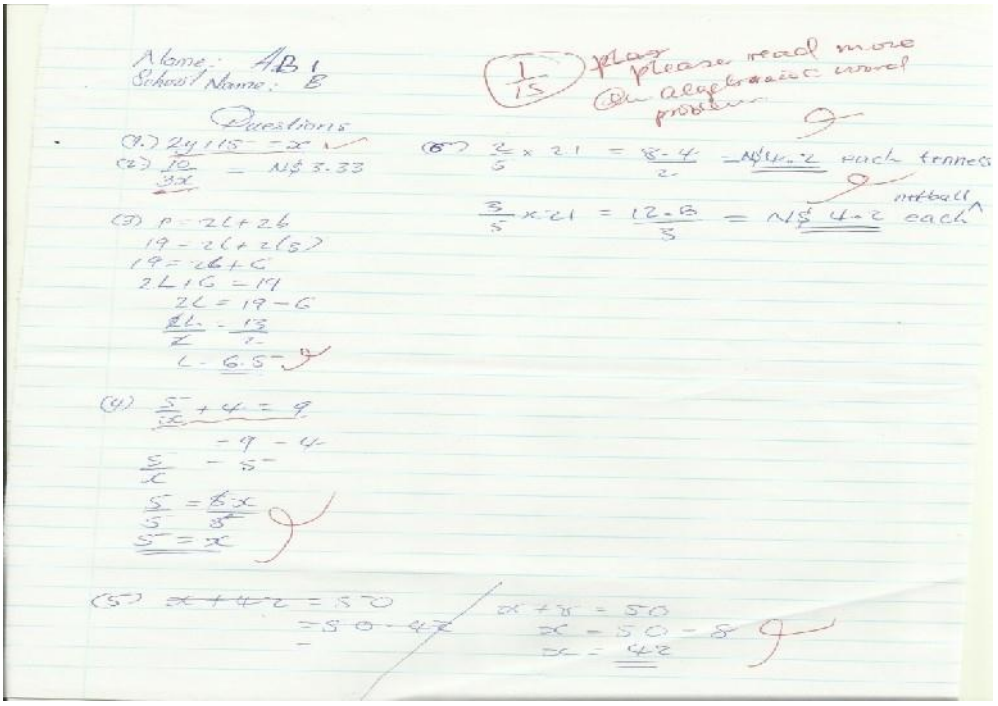

Figure 7: Algebraic word problem exercise result of learner AB from school B

The figure above clearly showed that learners AB from school B, could only answer question 1 correct that had only one strategy (*choose operation*). The rest of the questions were proved to be difficulties to solve because they have more than one strategies use in order to get the correct solution.

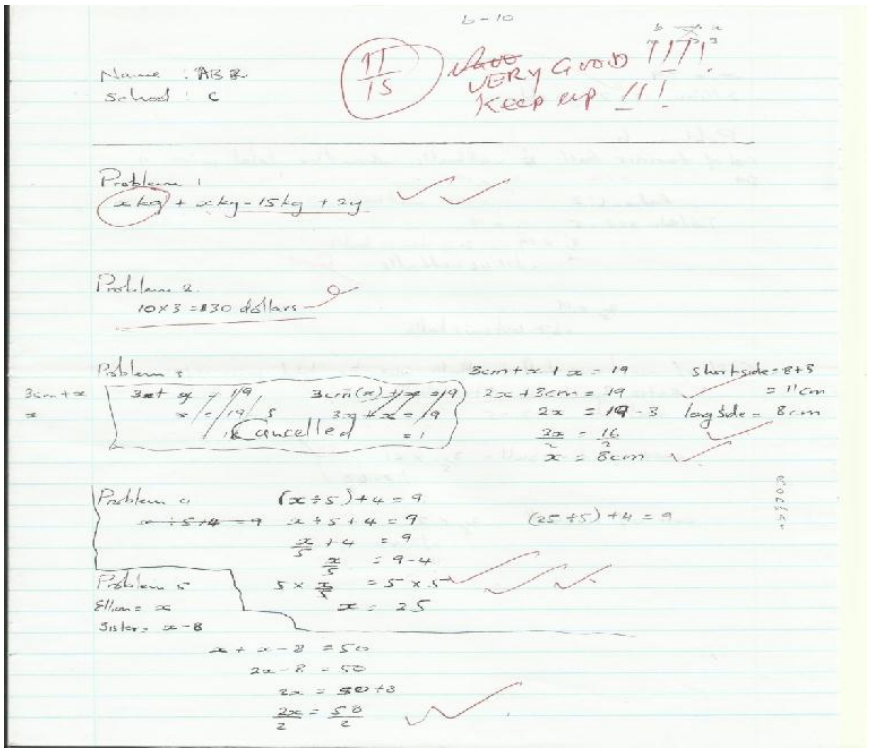

Figure 8: Algebraic word problem exercise result of learner AB from school C

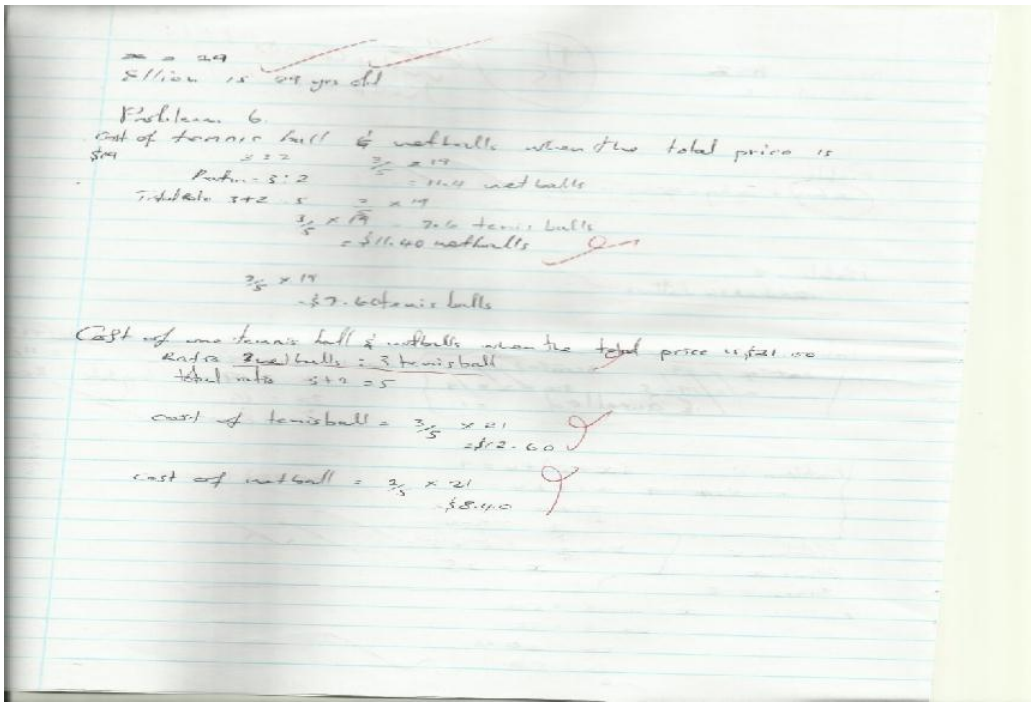

Figure 9: algebraic word problem exercise result of learner AB2 from school C

Learner AB from school C was the best overall in the all three sample school. This

result demonstrated that learner AB2 understood the question 1, 3, 4 and 5, and knew what strategies to apply in these problems to solve it effectively. He only failed to solve question 2 and question 6 correct.

In general, the researcher observed that these questions 2, 3 and 4 were familiar to the learners and the problems used simple text language. Although, learners like AB2 and AA4, did extremely poor they however managed to answer question 2 of the exercise. See the results below in Figure 10 and Figure 11.

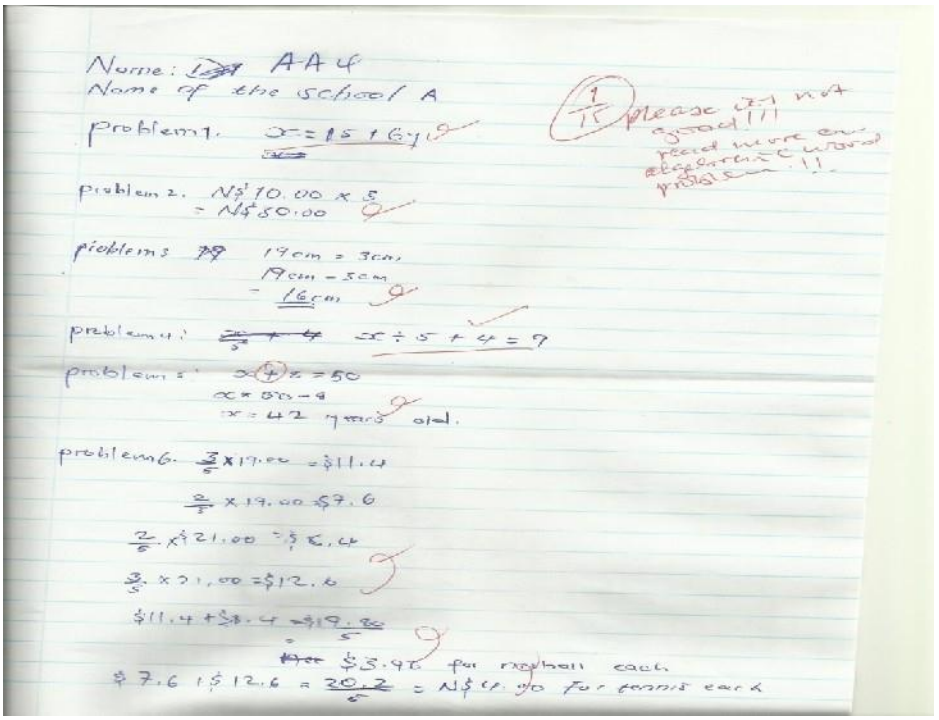

Figure 10: algebraic word problem exercise result of learner AA4 from school A

Learner AA4 from school A only scores one mark from the exercise that was given to them to solve. The result demonstrated that leaner AA4 have little exposure to algebraic word problem. She applied wrong strategy to solve the problem, this showed that she did not understand what to do in most the questions. For instance

learner AA4 understood the question but failed to choose correct strategies to solve the problem effectively.

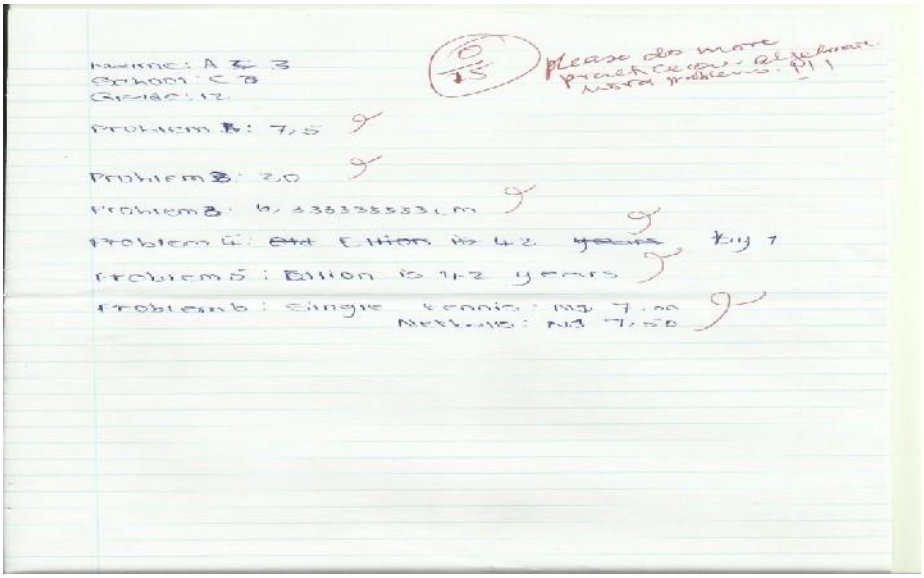

Figure 11: algebraic word problem exercise result of learner AC3 from school C

The learner AC3 from Figure 11 was the only learner who scored zero in the algebraic word problem exercise. The researcher observed that learner AC3 from school C was challenged by language factors and text difficulty during the exercise. Hence this affected her to not understand all questions in the exercise and failed to solve all the algebraic word problem exercise correct.

Overall, almost 90% of participants scored below 50% in the algebraic word problem exercise and only 11% met the pass mark of 50% and above from all the three schools. This shows that solving algebraic word problems is still difficult to Grade 12 learners in these three schools whereby 66. 7% of learners scored below 30% in the algebraic word problem exercise.

4.7. Effect of mathematical language toward solving algebraic word problems

According to the Namibian constitution's first amendment (1998) Article 3 "the official language shall be English". However, it is also important to state that the constitution do not prohibit the use of any other language as a medium of instruction in all government schools or in private schools, subject to compliance with such requirements as may be imposed by law, to ensure proficiency in the official language, or for pedagogic reasons.

It is for this reason that the researcher did not restrict participants to use English only in their discussion but allowed learners to use any language which they study as a subject at school and which they understand easily and use it in this study. It is in this regard that languages such as Rukwangali, Gciriku and Sambyu were allowed to be used in the focus group discussions. This arrangement was also not a problem for the researcher since the researcher can write and s peak all the three languages mentioned. This was done to enable learners to express their views and opinion clearer with regard to the learning strategies of algebraic word problems.

During the observations the researcher observed that learners from all the three schools lacked the relevant vocabulary, a factor which had a negative effect on the results of the algebraic word problem exercises; especially question 6 in which almost all learners from the three schools had no idea that it was a simultaneous equation (see Figure 7, 8, 9 and 10 some of the result of the learners). As stated above, this challenge seems to have been caused by lack of exposure of these learners to the simultaneous words concepts. Other concepts that were observed to have challenged learners in the algebraic word problem exercise include the following: "*of the normal*

price; longer than; divide a number by; younger than".

Some learners who seemed to have understood the questions started well with correct strategies but failed to set up appropriate strategies to solve the problems because they misinterpreted the problems. For example Learner AC5 said that "The English that was used in the formulation of the questions of algebra problems is somehow tricky in a way. Since I have to understand the question for me to answer the question, it was difficult to solve the problem given the fact that English was very challenging". However the questions in which the learners did better in the algebraic word problems exercise were question 2, 3 and 4. As noted above the researcher observed that these types of questions were familiar to the learners and the questions used simple language. On the other hand question 1, 5 and 6 were difficulty to many learners in solving them correct. The researcher identified that the texts used in the questions were not familiar to the learners in all the three sample schools.

During the focus group discussion, it was observed that all learners from the three schools stated that English is used as medium of instruction during their mathematics lessons. According to these learners the use of English as medium of instruction in the mathematics lessons helped them a lot to communicate in English during mathematics lessons. So it must have been easy for participants to understand and answer the questions but this was not the case in practice.

4.8. Strategies used to solve algebraic word problems

The researcher observed the types of strategies that Grade 12 learners from the three schools used to solve algebraic word problems. During the study the researcher gave

participants an exercise with algebraic word problems to work on while the researcher observed them as they were solving the problems. After the participants completed the exercise the researcher involved the same participants in the focus group discussion for an hour.

During the analysis of the learners' solution to the algebraic word problems, the researcher identified eight emerging themes for strategies used by learners to answers the algebraic word problems, namely *identifying key words, underlining key words, re-reading the words, visualising problems, guessing and checking, mapping out steps or procedures, looking for patterns and counting techniques.*

Table 1: Lists of strategies used by learners to solve the problems.

Strategies used	**Names of learners**
Identifying key words	AA2,AA3,AA4, AA5,AB6,AB4,AC5,AC3,AC4,AB3
Visualising the questions	AA2,AA3,AA4,AB6,AB4,AC3,AC5
Looking for patterns in the problems	AA5,AC2,AC3,AB3, AC1
Counting techniques	AA2,AB2
Guess and checking the answers	AB2,AC5,AA5,AC3
Choose operation	AC2,AA1,AB5,AC3,AB3,AC4
Rereading the problems	AA1,AC3,AB3,AC4,AC2,AB4,AA5

The above Table 4 shows that most learners from the three sampled schools used underlining key words and identifying of key words before setting up the equations. Some learners like AA2, AA3, AA4, AA5, AB6, AB4, AC5, AC3 and AC4 used

strategies of rereading the words first and visualising the questions before they attempted to solve the problem especially in questions 1, 2, 3 and 4.

Learner AA5 however use strategy of looking for patterns in the problems, he jotted down the main points. 'Counting techniques' was observed by learner AA2, but she used a calculator to solve the problems. 'Guess and check answers strategy' was observed by learners AB2, AC5 and AA5 while learners AC3, AB3 and AC4 used several strategies like identifying key words, choose operation, visualised the problems and rereading the problems.

The researcher found out that 'choose operations strategy' helped these five learners (AC2, AB5, AB2, AA1 and AC4) to set up appropriate equations in numerical form. They also demonstrated in their works that they used correct set up procedure to get the solutions to the problems. 'Identifying key words strategy' was identified in both focus group discussion and algebraic word problem solve exercise mostly in question 4. Most learners were able to set up the equation for question 4 correctly, only few learners who were challenged by text difficulties did not set the equation correctly instead of writing $\frac{x}{5} + 4 = 9$ they wrote $\frac{5}{x} + 4 = 9$

During the focus group discussions the researcher asked participants to share their opinion on strategies that they used to get answers during the exercise. Themes such as: *"set up procedure, identifying key words, visualising words, guess and check, and look for patterns"* emerged during the discussions and analysis.

The other strategy that came out from the focus group discussions from these three schools was ‘re-reading questions several times’ until they understood what the question required of them and wrote short notes before constructing the equation or expression. Some of the participants like AA1, AB3, AC2, AC1, AA5 and AB4 said for them they read the question three times before attempting to solve the problems. The strategies of re-reading a question and identify key words then underline the key words before setting to solve the equations were also identified as one of the strategies learners AB4 and AC2 said they used. Few participants also indicated that they used ‘guess and check strategy’ during the exercise like learner AC3.

In conclusion, the researcher merged the findings from the observation and focus group discussion and discovered that those learners who understood the problems were able to use correct strategies to solve the problems effectively. Another insight which the researcher gained from the analyses was that visualising the word problem really seemed to help learners to comprehend and solve problems. For example, one question in which learners were asked to solve during the algebraic word problem exercise was: *Divide a number by 5 and add 4 to the result. The answer is 9. Write the equations that can match these statements and solve the equation* (see Figure 8 and 10). This proved to be difficult problem for most of the learners. There was a lot of discussion about what the problem was asking them to find and how to solve it. But learners who were able to understand the concepts in the problem helped them to visualise the problems and were able to choose correct operation signs to work out the problem to get the correct solutions.

4.5. The challenges experienced by learners in solving algebraic word problems

This study revealed how difficult the algebraic word problems were to the sampled learners especially the Grade 12 learners in the Kavango East Education region. Many Grade 12 learners from the three sampled schools scored high marks (more than 50 %) in the August 2015 examination but in the algebraic word problem exercise 80% of the sampled learners failed below 20 %.

The study used an algebraic word problem exercise and focus group discussion to gather the data. So during the data analysis the researcher identified common themes that emerged from the three sampled schools. namely: *choose operation, text difficulty, using inappropriate strategies, unfamiliar context in problems and background knowledge* were identified as challenging factors that hindered learners from the three schools from solving the algebraic word problems effectively.

Many learners managed to identify the key words but failed to put these key words together to make meaning in many questions. Many learners like AB2, AB4, AB5, AA2, AA4, AC3 and AC1 set up incorrect equations but when the researcher tried to follow through their work, surprisingly these learners again failed to solve their incorrect set up equations. It was clear to the researcher that learners are not only challenged by word problems but also by the lack of the skills of solving algebraic problems.

The researcher also observed that many learners hardly understood the concepts used in the algebraic word problems especially concepts like *"of the normal price; longer than; divide a number by; and younger than"*. The researcher identified that the

unfamiliar concepts used in the algebraic word problems hindered learners not to use appropriate strategies and set up correct equations. The other causes that the researcher identified that these types of questions used in the algebraic word problems are not often asked in the Grade 12 mathematics examination for ordinary level (core), but words like *sum, add, subtract, difference, divide, product and multiplication* are often used in the examinations.

Question 6 was not easy to many learners from all the sampled schools. Only learner AA5 used backward strategy to work out answer question 6. He was the only one who got the solution correct. This strategy helped this particular learner to trace back the answers to give him the same problem. Ninety-five percent of learners did not know what to do with question 6 and had no idea as to where or to how to start. Some learners did not even attempt to solve it. As stated above many learners did not realise that it was a simultaneous equation.

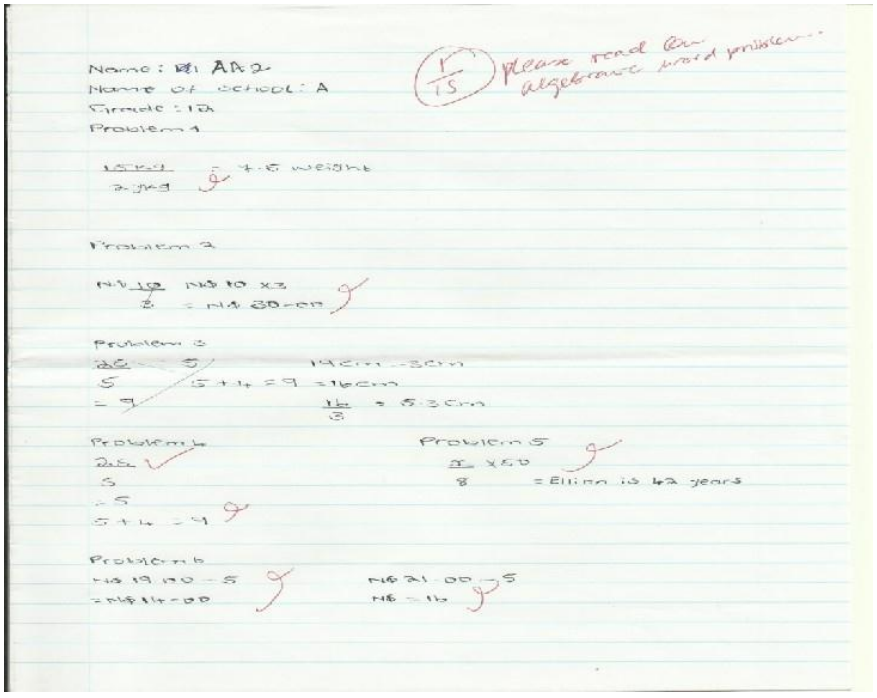

Figure 12: algebraic result of learner AA2 of school A

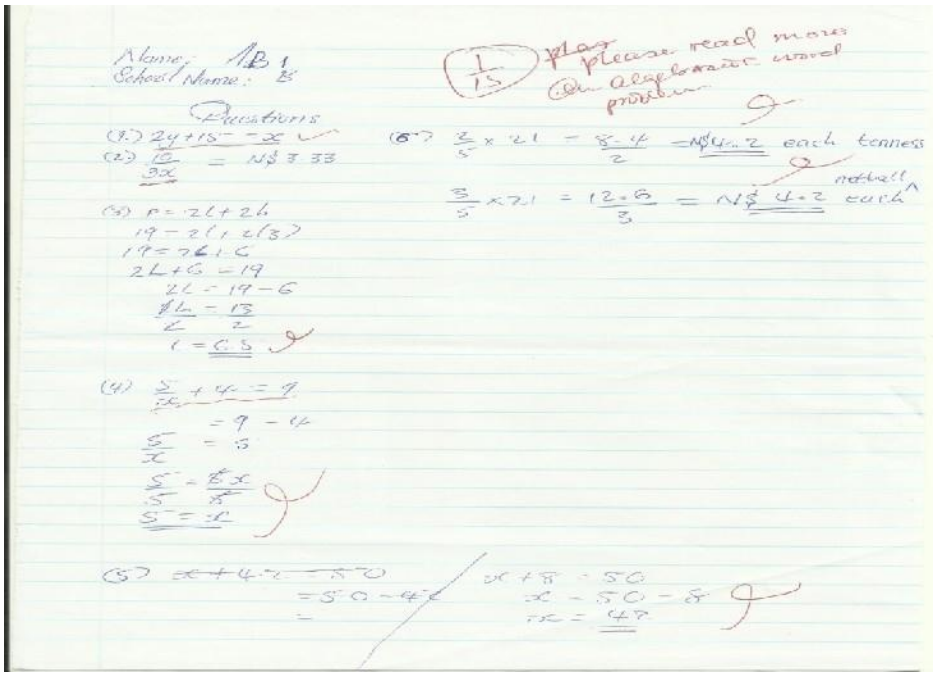

Figure 13: algebraic word problem exercise result of learner AB from school B

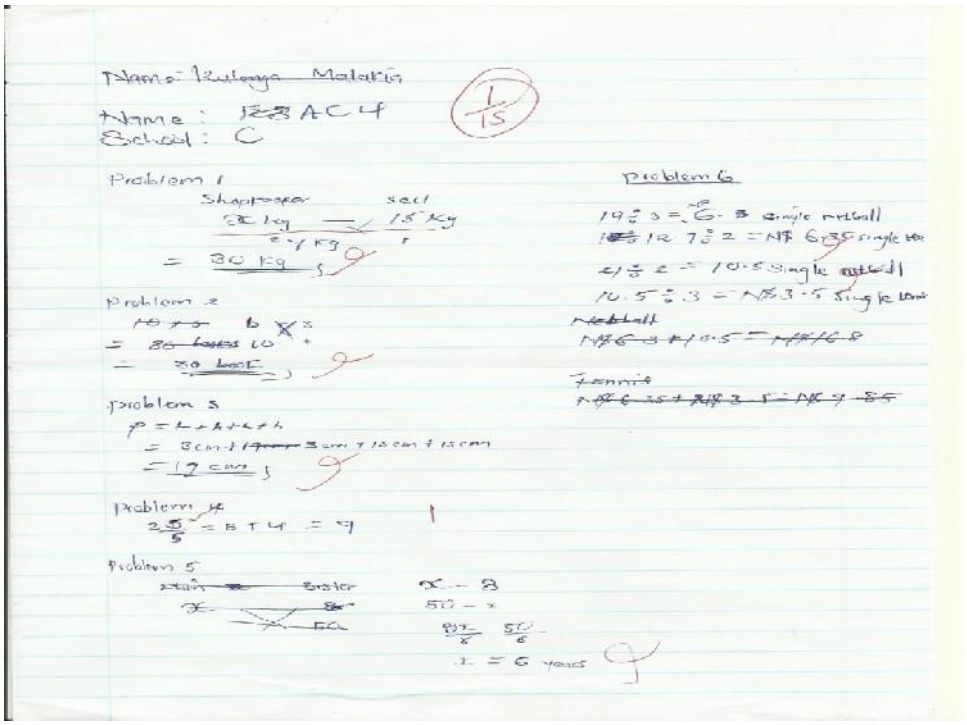

Figure 14: algebraic word problem exercise result of learner AC4 from school C

Figure 11, 12 and 13 are some of the samples of the participants who failed to answer question 6 correct. This indicated that learners from the three sampled schools had

limited skill of these types of skills, although this skill is in the syllabus and also in the prescribed textbooks that they use in Grade 12 ordinary level (core).

During focus group discussions, learner AB2 said reading and understanding the problem texts was not challenging but determining the strategies to find the answer was very challenging. While learner AB6 said that the problem was the strategies to set up the equations and also to understand the questions properly. She further said that the concepts used in the texts (e.g. "*of the normal price, longer than divide a number by, younger than"*) were unfamiliar suggesting that she did not know the meaning at all. Learner AB1 said that solving algebraic word problems was not a problem for him but the challenge he faced was that he misinterpreted signs in the setting up the equations and expressions. The negative sign (-) and positive sign (+) were mostly misinterpreted in the numerical translation of the problems. The process of grouping like terms in equations confused him such that instead of taking negative he used positive sign. See the result of learner AB1 as shown below in Figure 15.

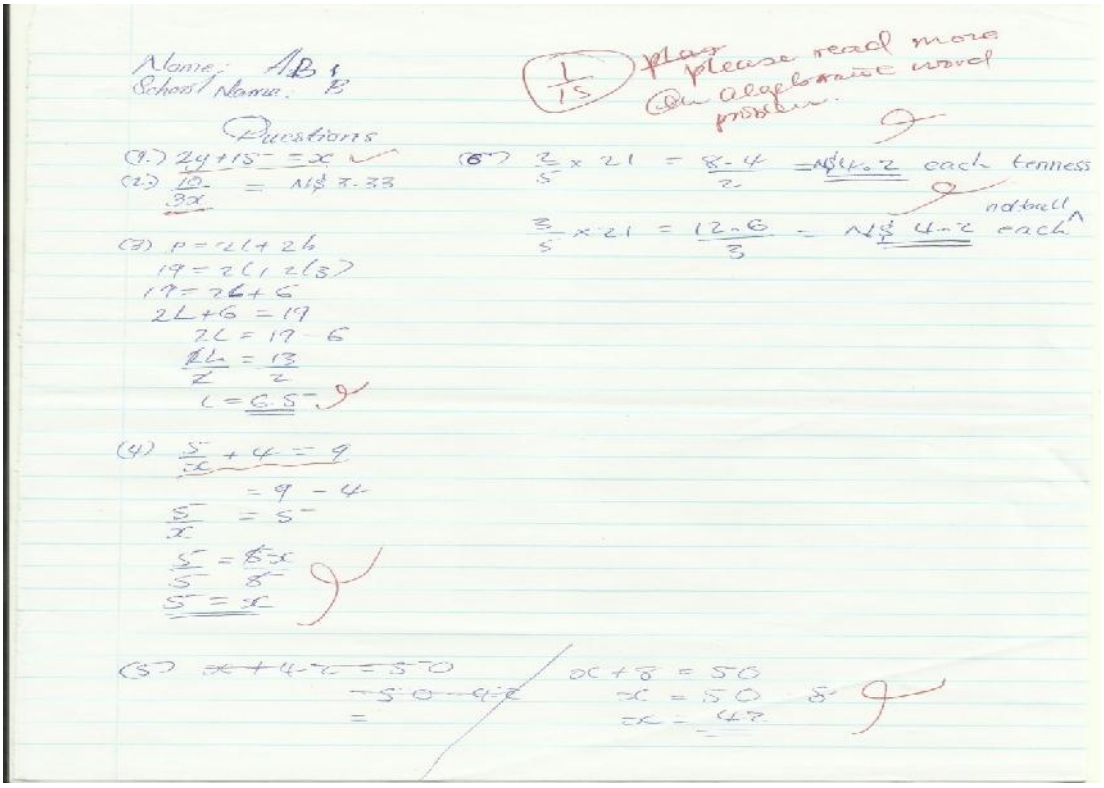

Figure 15: sample of algebraic word problem exercise result

The other difficulty the Grade 12 learners faced was the strategy of setting up the equations or expressions. Many participants said they were confused with concepts used in the problems more especially with terms like *'longer than', 'off the normal price', 'divide a number by', 'younger than' and 'sell of'*. For example when the algebraic word problems has a term 'Longer than' learners did not realise that they have to add a number to the equation before solving it. Regarding the word 'off the normal price', learners did not realised that this concept implies subtraction. However the word 'divide a number by' was understood by few participants although they failed to set up the correct equation. Thirteen (13) sampled learners said that the concepts used in the mathematical word problems were unfamiliar to them and in most cases they do not always see them in the examination question papers. They further said they were more comfortable to solve algebra in numerical format than

in word format. The reason for such inability is the fact that solving such problems demands mathematical computations along with other kinds of knowledge including linguistic knowledge, which are required in order to understand the problems.

Four of the sampled learners from school C used incorrect signs in setting up equations and expressions during the algebraic word problem exercise. Thus, these affected them and led to their poor performance. The researcher discovered that the concepts and all the questions were not clear and understandable to Grade 12 learners of school C. The researcher found that, the use of unfamiliar concepts and location in the problems confused participants. Many participants did not understand the main ideas in the texts, so they failed to set up the equation/problems in numerical form correctly.

4.6. Learners' perspective of classroom practices for learning algebraic word problems in general.

This study discussed the learners' perspective with regard to learning algebraic word problems. During the study, 70 percentages of participants said the algebraic word problem solving exercise was very difficult to them. But participants acknowledged that, if they found someone who could explain to them the meaning of concepts used in the texts they could do better. According to Learner AA5 for example, the only way could know how to work out these types of questions was to make sure that he practiced every time on algebra topic. On the other hand, learner AB3 said practicing mathematical word problem exercises every time, help him to know how to solve algebraic word problems, because he will be exposed to algebraic concepts and he will also learn the skills of setting up equations and expressions and the skills of

solving the equations (Sajadi., et al, 2013).

Learner AC1 also acknowledged that learning to solve algebraic word problems better requires, "the teachers to give learners more works so that we can do it on our own when we find the answers wrong or right as opposed to the teachers getting involved in working it out to guide and correct the mistakes of learners so that learners can see where they went wrong". In addition, learner AA2 said the way to make word problems fun is for teachers to use some of the questions using contextualised questions. Learner AB6 said "The way teachers can help me in mathematics with word problems is to work out with me more and more until I get it or put us to working in groups I think it can help me a lot". In the same vein learner AB5 said that "the teachers must also give us a lot of work on this, at first they must teach us how to solve these types of questions, and later on they must give us more exercises on this type of problems. The more work they give us to work out the better we will get used to it and the more it will benefit us in the future". On the other hand learners AA1, AC6 and AC5 preferred to learn how to solve algebraic word problems with classmates or friends because they can use simple language and can explain in the language that they understand better. They thought it can help them also to know concepts and strategies to solve the algebraic word problems.

In general, the three senior secondary schools in Kavango East focus on teaching and learning skills for solving symbolic equations but solving word problems is usually regarded as harder and introduced later as an application of these skills or sometimes none of these skills were taught to the Grade 12 learners of the three schools (Miranda, 2009). This was proven in the research study when Grade 12 learners were

given algebraic word problem exercise to solve and many of these Grade 12 learners failed to work out these problems. The researcher identified that the finding is also evident in the lack of strong relationships between learners' understanding of algebraic notation and their most sophisticated algebraic strategy. For this weak relationship to be addressed, teaching of algebra should therefore be focusing on the structure of problems (Seifi, *et al*, 2012).

CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Introduction

The purpose of this study was to investigate the types of strategies used by Grade 12 ordinary level mathematics (core) learners when solving algebraic word problems in Kavango East Region. This research also tried to determine what difficulties Grade 12 learners experience when solving algebraic word problems and the possible causes of such difficulties so that recommendations for improvements could be made. The findings demonstrated that it is primarily the structure of problems that makes algebraic word problems difficult, not the algebraic symbolism.

5.2. Summary

The study used observations and focus group discussions as methods for data collection. During the study, the researcher gave participants some algebraic word problems to solve and observed them while they were solving the problems. After the participants completed the exercise the researcher marked the tasks before involved the same participants in the focus group discussions. This was done in order for the researcher to have a deeper understanding of the Grade 12 learners' word problem solving abilities and the problems that they experienced when solving algebraic word problems.

The marks that the Grade 12 learners' obtained in the algebraic word problem exercises were presented in bar graphs (see figure 4, 5, and 6). The study found that almost 90% of participants scored below 50% in the algebraic word problem exercise

and only 11 percentages obtained the pass mark of 50% and above from these three school. While in the August 2015 examination the results showed that 70% of participants scored above 50% and only 4 participants scored below 50%. Overall most learners scored below 30 % in the algebraic word problem exercises. This showed that solving algebraic word problems is still difficult to Grade 12 learners in these three schools in the Kavango East region. Therefore, the researcher felt that, the poor understanding of algebra might compromise the Grade 12 learners' comprehension of Mathematical concepts and thus might inhibit their academic performance in Mathematics.

The study revealed that the possible causes of Grade 12 learners' difficulties were the language factors. Language factors were divided into four areas: *text difficulties, unfamiliar contexts, using of inappropriate strategies and lack of solving skills*. The first most-cited cause of the Grade 12 learners' difficulties was the text of the word problems. Text difficulties are words used in problems from the textbook or other curricular materials that the students had to solve. A second aspect of text difficulty was that the problems the learners needed to solve in the study were complex and frequently involved more than one step. This made the problems harder for the learners to understand and solve.

The researcher also established that lack of mathematical solving skills and understanding of algebraic word concepts were also major causes of the difficulties that learners faced. Many learners who set up wrong numerical equations also failed to solve these problems. The strategies of solving algebraic equations and expressions in general seem to be lacking in these participants from all three schools.

Other findings of this study showed that word problems become easier for learners when they are embedded in familiar contexts. A study by Seifi *et al* (2012) showed that algebraic word problems become easier to learners when familiar contexts were used in the problems. The researcher agreed that familiar contexts used in the algebraic word problems helped learners to pay more attention to the problems and were able to apply appropriate strategies to work out the problems.

The researcher argued that familiar contexts strongly influenced learners' problem solving performances in a positive way. This is consistent with the results of the present study. In many research studies it was noticed that familiar contexts enhanced word problem solving by increasing the meaningfulness of contexts and motivating learners to solve the problems (Ku & Sullivan 2002; Magruder, 2012; Seifi et al, 2012,). Therefore, exposing learners to algebraic word problems at an early stage can help learners to understand the concepts better. Participants confirmed in the focus group discussions that text difficulties in the context of the problems, caused problems for them. Numerous learners noted that the algebraic word problems texts used in this study in most algebraic problem cases were not "real world" to them and not relative to their learning experiences.

Another finding from focus group discussion is that the effective learning strategies used by the learners fell into four categories: making change in the phrasing of the problem context, identifying key words in the problem texts, concept clarification and building an experience. It has been shown during the study that learners who used this strategy of making changes in the phrasing of the problem context had a remarkable impact on solving word problems successfully especially question 6

(Vicente *et al*, 2007). Therefore making changes in the phrasing of the problem context is a learning strategy Grade 12 learners can use to solve not only algebraic word problem but for any word problems.

Identifying key words is another learning strategy of reading the word problems and identifying key words from the algebraic word problem and putting these key words together to set up an expression or equation. For example "*Ellion thinks of a number. He subtracts three from the number, doubles the answer and gets an answer of 12. Find the number Ellion was thinking of"*. For the learners to solve this he or she needs to use identifying key words from the problem before she or he attempts to solve it.

Concept clarification as a learning strategy makes the concepts in the text clearer and easier to grasp. This strategy provides learners with visual understanding of the problems. The findings proved that if there was a reading difficulty, the learner tended to rush through the word problem without giving any thought to what the problem required of the learners. Building an experience is also a learning strategy; learners are given a lot of experience (exercises) in reading word problems and translating their meaning into numbers and symbols and vice versa.

5.3. Conclusion

In this study, the researcher analysed algebraic word problem-solving strategies used by Grade 12 learners in the three sampled schools in Kavango East Educational Region in September 2015. During the study the researcher looked at learners' abilities

to use problem-solving strategies and challenges these Grade 12 learners face when solving the algebraic word problems.

This study summarized the overview perspective of Grade 12 learners' abilities in Kavango East Region on how they solve the algebraic word problem. During the study learners were given algebraic word problems exercises and later they were engaged in the focus group discussions. These tasks were meant to force learners to think in a particular way, to generate ideas on how to tackle the task by themselves, thereby helping them to approach mathematics from a different perspective (Fulop, 2015).

The focus group discussion encouraged learners to produce their own lists of strategies, to think about their own strategies used during the exercise and how they have applied them accordingly against a variety of problems. At the same time learners had an opportunity to experience a range of emotions associated with the problem-solving process for instance learners were asked to reflect on their experiences as they went through the algebraic word problems.

The findings of this study showed that it is possible to teach problem-solving strategies within the limits of a mathematics classroom so that the learners learn about strategies without losing out on conceptual or procedural understanding of concepts. During the algebraic word problem exercise the researcher identified strategies used by Grade 12 learners to answer the questions. The results of the algebraic word problems analysis showed that learners used the strategies like *identifying key words, underlining key words, reading and re-reading the words, visualising problems, guessing and checking, step procedures, looking for patterns*

and counting techniques.

The result of this study might have been expected, partly because the opportunity for learners to use other strategies was limited and partly because several of the tasks in the exercise might have led the learners to focus on various standard procedures. Learners who used the strategies like identifying key words, underlining key words and visualising problems showed an understanding of a critical aspect of strategies, namely that the same strategy can be used in different contexts or in the same context but in tasks with different characters. However many learners showed in the focus group discussions that they had little knowledge about types of strategies they could use in solving algebraic word problems. The reason for this might be that mathematics teachers did not expose these learners to a variety of strategies for solving word problems. On the other hand communication in English might have been a barrier to the learners who were not able to give their views clearly during the focus group discussions. Hence the researcher argued that it is of great importance to actively teach about problem-solving strategies if one wants Grade 12 learners to develop the ability to use them in solving mathematical problems effectively.

Algebraic word problem concepts were the most difficult ones especially *unfamiliar contexts, using of inappropriate strategies and lack of solving skills*. These were the most difficult ones which the Grade12 learners faced during this study. These were observed in the algebraic word problem exercise and confirmed in the focus group discussion. Therefore the results in this paper demonstrated how ineffective teaching of problem-solving strategies influence and change the focus of learners' learning abilities from solving algebraic word problems.

The researcher is of the opinion that the three senior secondary schools in Kavango East region might focus on teaching and learning skills for solving symbolic equations but solving word problems was not given more attention or none of these skills were taught to the Grade 12 learners in the three sampled schools. This was identified in the study when Grade 12 learners were given algebraic word problems to solve and many Grade 12 learners failed to work out these problems.

Finally, the study made some recommendations to various stakeholders in education. Mathematics teachers were recommended to give more algebraic word problems to the learners to allow them to practice in order to help learners to become more efficient in solving such problems. On the other hand, further Researches were recommended to be carried in the four areas: the teacher training, primary schools, junior secondary schools, and senior secondary schools Mathematics curriculum to identify gaps that exist in learning of algebraic word problem solving skills in all four areas.

5.4. Recommendations

This study recommends the following to the various stakeholders in the teaching and learning of Mathematics in Grade 12 in order to enhance effective learning strategies of algebraic word problems:

5.4.1. Teachers

a.) Mathematics teachers should give more algebraic word problems to the learners to allow them to practice in order to help them to become more efficient in solving such problems (Seifi, et al. 2012). Therefore, Mathematics lessons should allow

learners to explore word problems solving skills and discover new mathematical concepts related to word problems on their own. Learner centred teaching should be used as a learning strategy in the mathematics classrooms. Therefore, having a lot of experience with word problems will enable learners to see terms used in a variety of situations with a different usage. This is a benefit to learners because in a mathematical text, certain vocabulary will be used differently than in everyday language.

b.) In order for teachers to reinforce skills in mathematical word problem solving, the researcher suggests that teachers should carefully design and choose appropriate examples and activities that are to be used in the classroom practices, because unfamiliar contents and language complexities in the problem context, makes learners to be unable to recognize the problem. This was identified in the algebraic word problem exercises. Hence, teachers should also design teaching and learning aids from the local materials that are familiar to their learners that could foster effective learning strategies of solving algebraic word problems skills in the Mathematics classrooms.

c.) Teachers should also utilised different strategies such as "seeking for similar model", "designing a specific form for the problem" and "making changes in the phrasing of the problem" for their learners so that the learners learn how to recognize the problem and then how to design a method for solving it.

5.4.2. Ministry of Education (Advisory Service)

a) The advisory services of the Ministry of Education should try to work hand in hand with the teachers to ensure that they receive continuous support. Teachers should be given some professional development in the area of algebraic word problems and other topics of mathematical word problems.

b) The Ministry of Education should also avail the teaching and learning materials to schools like mathematics textbooks, chalkboard charts etc. The teaching aids should be accessible to all teachers so that they will be able to make use of them .The advisory services for teachers should also organise workshops where teachers can meet and talk about different issues affecting the teaching and learning word problems in Mathematics more especially algebraic word problems.

c) Curriculum developers from the Ministry of Education should increase the learning objectives for algebraic word problems in the Mathematics curriculum to enhance the development of strategies for solving algebraic word problems through the teaching and learning of Mathematics over an extended amount of time.

5.4.3. Further research

a) The researcher is certain that in Namibia, more studies of this nature need to be done in order to enhance the teaching and learning of algebraic word problem effectively. Attention should also be paid to questions of how best researchers can offer their professional support to teachers of mathematics in Namibia, in order for them to realize the need to attend to learners' processes of making meaning of mathematical

(algebraic) structures. Such teaching and learning skills in mathematics should try to maximize opportunities for both in-service and pre-service mathematics teachers. This will both ensure the provision of learning opportunities and help in creating new means of inducting new mathematics teachers into the teaching profession.

b) Research should be carried in the four areas: the teacher training, primary schools, junior secondary schools, and senior secondary schools Mathematics curriculum to identify gaps that exist in learning of algebraic word problem solving skills in all four areas. Once the gaps are identified the researcher believes that can harmonise the development of learning strategies of algebraic word problems through the teaching and learning of Mathematics in the country. This was a small-scale study that was carried in the Kavango East Educational Region but this study needs to be extended to other parts of the country.

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APPENDICES

Appendix 1: Algebraic Word Problems Exercise

Name of Learner:

Name of School:

Grade 12:

Duration of the exercise: 30 Minutes

Total marks: 15

INSTRUCTIONS

1. Write your name in the spaces provided above.
2. Write your answers in dark blue or black pen.
3. Answer all questions.
4. Write your answers and working on the space provided.
5. All working must be clearly shown.
6. Marks will be given for working which shows that you know how to solve a
7. problem even if you get the answer wrong.
9. The number of marks is given in brackets [ ] at the end of each question.
10. The total number of marks for this paper is 15.

Problem 1. A shopkeeper has x kilograms of tea in stock. He sells 15 kilograms and then receives a new shipment weighing 2y kilograms. Write expression that will represent the weight of the tea he has now. [1]

Problem 2. At a local bookstore, books that normally cost b dollars are on sale for 10 dollars off the normal price. How many dollars does it cost to buy 3 books on sale? [1]

Problem 3. One side of a rectangle is 3 cm longer than the other side. The perimeter of the rectangle is 19 cm. find the lengths of the two sides. [3]

Problem 4. Divide a number by 5 and add 4 to the result. The answer is 9. Write the equations that can match these statements and hence solve the equation. [3]

Problem 5. Ellion is x years old. His sister is 8 years younger than Ellion. If their total ages are 50, calculate how old Ellion is? [3]

Problem 6. At the local sports store, all tennis balls are sold at one price and netballs are sold at another price. If three netballs and two tennis balls are sold for $19.00, while two netballs and three tennis balls are sold for $21.00, what is the cost of a single tennis ball and netball? [4]

Memo

$\frac{x-15}{}+2y$ √

(b- 10)3 or 3(b – 10)

=3b - 30 √

$\frac{x+3}{}+x=19$

2x = 19 – 3 √

2x = 16

x = 8

sides are 8 cm and 11 cm √√

$\frac{x}{5}+4=9$

$\frac{x}{5}$ *5 +4*5 = 9*5

x+ 20 = 45 √

x =45 – 20

x = 25 √√

Ellion Sister

x x-8

Total ages is 50

x+ x- 8 = 50 √

2x = 50 +8

2x = 58 divide both side by 2

x= 29 Ellion is 29 year old. √√

Let netball be x and let tennis ball be y

Set two equations:

3(x) + 2(y) =19 eq1 √

2(x) + 3(y) = 21 eq2

Solve the two equations simultaneously

Elimination method

[3x +2y =19]2

[2x +3y = 21]-3

6x +4y =38

-6x – 9y =-63 sum up the two equations

-5y = -25 divide by -5

y= 5 √

sub y= 5 in eq 1

3x+ 2(5) =19

3x =19 -10

3x =9 divide by 3

x= 3 √

a single tennis ball is N$ 5.00 and single netball is N$ 3.00 √

TOTAL MARKS: 15

Appendix 2: Interview Guide

Good Afternoon, my name is Ellion Sikukumwa a student from the University of Namibia. Thank you very much for your time and for agreeing to participate in a focus group discussion on the algebraic word problems solving strategies. This focus group is part of a larger needs assessment process that I am conducting to learn about the learning strategies that you (Grade 12 learners) use to solve algebraic word problems and the difficulties that you face when solving algebraic word problems. I specifically want to understand and find out how teachers might customize their teaching approach to better enhance learners' skills of solving algebraic word problems.

Section A: Biographic data of the interviewee

Interviewer: I will be asking you some questions about learning mathematics, specifically algebraic word problems. With your permission, I would like to record the interview. Before I can begin the interview, I must ask you to sign a consent form that I gave you earlier with the information letter. If you have any questions regarding the study, please feel free to ask me.

Record the following information on the voice recorder.

Name of interviewees: ……

……

……...

……..

……..

…….

Name of School ……

Region……

Date……..

How many mathematics periods do you have per week? .....

What languages do you often communicate during maths periods……

How does/do that language/s help to learn maths better? .....

……

……

Focus Group Discussion Questions

The following questions seek your opinions with regard to learning algebraic word problem. I pledge total confidentiality to all responses. Please note that your response to the interview protocol is not compulsory. Except for the researcher **no** individual, such as colleagues, Principal, Education Officer, or the Regional Director will have access to the responses. When the data processed, the interview record and observation checklists will be destroyed.

Interview Questions

1. Describe any difficulties that you have encountered when working with algebraic word problems. *Example, Ellion thinks of a number. He subtracts three from the number, doubles the answer and then gets an answer of 12. Find the number Ellion was thinking of.*
2. What do you think are the causes of difficulty you faced when you solve the algebraic word problem exercise?

3. How do you feel about solving algebraic word problems?
4. Is mathematics important to your field of study?

Interviewer: I am now going to ask you a couple of questions that are similar.

5. What specific strategies did you use when you solving algebraic word problems exercise?
6. Where did you learn such strategies?
7. What do you consider to be your best method for solving algebraic word problems

Appendix 4: Permission letter to Kavango East Education Director

Mr. Ellion Sikukumwa

P.O Box 1162 Rundu, Namibia

Cell: 0812367478 / 0818141438,

10 May 2015

The Director: Kavango East Education Region

Re: Seek permission to carry out a study in the Kavango East Education Region

I' m Ellion Sikukumwa hereby seek permission to carry out the research study in your Education Region. The study will be conducted for the thesis in partial fulfilment for the Masters of Education Degree of the University of Namibia which must be completed this year 2015. The main objective of the study is to investigate the types of strategies used by grade 12 ordinary level mathematics learners of Kavango East region when solving algebraic word problems. The following senior secondary schools were selected as sample schools: Maria Mwengere; Dr. Romanus Kampungu and Elia Neromba Secondary School.

The study is significant to mathematics teachers to improve their own teaching practices, teaching approaches, as well as setting of assessment tasks that support teaching and learning mathematical word problems. I pledge total confidentiality to all responses, and the final results will be made available to the public. I have enclosed the permission letter from the permanent secretary in the Ministry of Education. The

study will be conducted during the weeks of September 2015.

I trust that my request will receive your favourable consideration.

Sincerely

E. Sikukumwa

_____

UNAM M.Ed Student (Mathematic Teacher, Rundu S.S)

Appendix 5: Principal's memo

The Permission memo by the school Principals.

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

Signature:…….

Mr (s) ……. Principal of …….

Appendix 6: Information letter for participation in research project

I am writing to ask your permission to participate in the University of Namibia research project. The title of the project is **investigating the types of strategies used by Grade 12 ordinary level mathematics learners in solving algebraic word problems.** This project will be conducted at school were you are studying in the afternoon for two days. The researcher is conducting this study to learn about the learning strategies that you grade 12 learners use to solve algebraic word problems and difficulties that you are facing in solving word problems. The researcher want to understand and find out how teachers might customize their teaching approach to better fits ways of learning mathematical word problems.

The project is expected to be an enjoyable experience and will require less than 60 minutes of time out of class. However, the decision about participation is yours. During the project you will be given algebraic word problem exercise that you will answer in less than 30 minutes. Also will be asked to discuss your opinion regarding on the exercise you have done and the researcher will audio record your conversation others.

All your result from this exercise will be considered confidential and individual's results will not be shared with school staff or your friends. Only Grade **12** who themselves agree to participate, will be involved in the study. Also, you may withdraw your permission at any time during the study without penalty by indicating this decision to the researcher. There are no known or anticipated risks to participation in

this study. I would like to assure you that this study has been reviewed and approved by the Research Ethics Review Committee at University of Namibia. In addition, it has the support of the principal of your school and the director of Education of Kavango East region. However, the final decision about the participation is yours.

I would appreciate it if you would permit yourself to participate in this project, as we believe it will contribute to furthering our knowledge of. Please complete the attached permission form, whether or not you give permission to participate, and return it**.** If you have any questions about the study, or if you would like additional information to assist you in reaching a decision, please feel free to contact me (**Sikukumwa Ellion)** at **ellion.siku@gmail.com** **or you can call me on 0812367478** or my faculty supervisor (**Dr. Mirinda)** at **hmirinda@unam.na** **or 065 2323000.** Thank you in advance for your interest and support of this project.

Sincerely,

Signature:

Mr. Sikukumwa Ellion (Department of mathematics, Science and Sports)

Student number: 200421603

Appendix 7: Observation checklist

Researcher observation check-list	
Questions	Strategies used to answer each questions
1. A shopkeeper has x kilograms of tea in stock. He sells 15 kilograms and then receives a new shipment weighing 2y kilograms. Write expression that will represent the weight of the tea he has now. [1]	
2. At a local bookstore, books that normally cost b dollars are on sale for 10 dollars off the normal price. How many dollars does it cost to buy 3 books on sale? [1]	
3. One side of a rectangle is 3 cm longer than the other side. The perimeter of the rectangle is 19 cm. find the lengths of the two sides. [3]	
4. Divide a number by 5 and add 4 to the result. The answer is 9. Write the equations that can match these statements and hence solve the equation. [3]	
5. Ellion is x years old. His sister is 8 years younger than Ellion. If their total ages are 50, calculate how old Ellion is? [3]	
6. At the local sports store, all tennis balls are sold at one price and netballs are sold at another price. If three netballs and two tennis balls are sold for $19.00, while two netballs and three tennis balls are sold for $21.00, what is the cost of a single tennis ball and netball? [4]	

Appendix 8: Pre-designed categories of strategies (Focus Group Discussion)

Pre-designed categories of strategies (Focus Group Discussion)	
Strategies	
Identify key words	
Draw pictures	
Reword/ reread	
Step procedures	
Make table/list	
Visualised the problems	
Work backward	
Choose operation	
Guess and check	
Counting techniques	
Inverse operation	
Looking for patterns	
Personal experiences	
Work a simpler problem	
Unable to answer questions	
Causes 0f learners challenges	

Appendix 9: Pre- Causes of learners' difficulty (Focus Group Discussion)

Pre -Causes of learners difficulty (Focus Group Discussion)	
Text difficulty	
Language factors	
School curriculum	
Teacher training	
Background knowledge	
Previous teachers	
Standardised test	

Appendix 10: CONSENT FORM FOR RESEARCH PARTICIPANTS

Name of Researcher: Sikukumwa Ellion

Title of study: Investigating the Types of Strategies used by Grade 12 Ordinary Level Mathematics Learners in Solving Algebraic Word Problems

Please read and complete this form carefully. If you are willing to participate in this study, ring the appropriate responses and sign and date the declaration at the end. If you do not understand anything and would like more information, please ask me.

I …….(full name) agree to take part in the research study entitled, Investigating the types of Strategies used by Grade 12 Ordinary Level Mathematics Learners in Solving Algebra Word Problems.

The research was satisfactorily explained to me both verbally and in written form by the researcher.	YES / NO
I understand that my participation is voluntary and I will not be forced to take part in this research study.	
I also understand that I may withdraw from this study at any time without any penalty. <u>This will not affect my future care or treatment.</u>	YES / NO
I understand that all information about me will be treated in strict confidence and that my name will not be written on publishable documents arising from this study.	YES / NO
I understand that any audiotape material of me will be used solely for	YES / NO

research purposes and will be destroyed sometime after the completion of this research.

Further, I agree that the researcher will be discussing the progress of this research study with the supervisor and co-supervisor of the University of Namibia YES / NO

By signing here under, I voluntarily give my consent to be involved in this research study and have been given a copy of an information letter for my own information.

Signature of Participant: ……

Date: ……

Appendix 11: Information Letter and Consent Form for Parents or Guardians

Date :

Dear Parent(s) or Guardian(s):

I am writing to ask your permission for your child to participate in the University of Namibia research project. The title of the project is **investigating the types of strategies used by Grade 12 ordinary level mathematics learners in solving algebraic word problems.** This project will be conducted at school were your child is studying in the afternoon for two days. The researcher is conducting this study to learn about the learning strategies that grade 12 learners use to solve algebraic word problems and difficulties that they are facing in solving word problems. The researcher want to understand and find out how teachers might customize their teaching approach to better fits ways of learning mathematical word problems.

The project in which your child has been invited to participate is expected to be an enjoyable experience and will require less than 60 minutes of time out of class. However, the decision about participation is yours. Children will meet with the researcher and the researcher will provide them with algebraic word problem exercise that the children will answer in less than 30 minutes. The children will also be asked to discuss their opinion regarding on the exercise they have done and the researcher will audio record their conversation.

All children's performances will be considered confidential and individual children's results will not be shared with school staff. Only children in Grade **12** who have

parental permission, and who themselves agree to participate, will be involved in the study. Also, children or parents may withdraw their permission at any time during the study without penalty by indicating this decision to the researcher. There are no known or anticipated risks to participation in this study. I would like to assure you that this study has been reviewed and approved by the Research Ethics Review Committee at University of Namibia. In addition, it has the support of the principal at your child's school and the director of Education of Kavango East region. However, the final decision about the participation is yours.

I would appreciate it if you would permit your child to participate in this project, as we believe it will contribute to furthering our knowledge of. Please complete the attached permission form, whether or not you give permission for your child to participate, and return it to the school**.** If you have any questions about the study, or if you would like additional information to assist you in reaching a decision, please feel free to contact me (**Sikukumwa Ellion)** at **ellion.siku@gmail.com** **or you can call me on 0812367478** or my faculty supervisor (**Dr. Mirinda)** at **hmirinda@unam.na** **or 065 230 006.** Thank you in advance for your interest and support of this project.

Sincerely,

Signature:

Mr. Sikukumwa Ellion (Department of mathematics, Science and Sports)

Student number: 200421603

Appendix 12: Consent Form – Parents/ guardians

I have read the information letter concerning the research project entitled (investigating the types of strategies used by Grade 12 ordinary level mathematics learners in solving algebraic word problems) conducted by Sikukumwa Ellion of the Department of Mathematics, Science and Sports at University of Namibia. I have had the opportunity to ask questions and receive any additional details I wanted about the study.

I acknowledge that all information gathered on this project will be used for research purposes only and will be considered confidential. I am aware that permission may be withdrawn at any time without penalty by advising the researchers.

I realize that this project has been reviewed by and approved by the Research Ethics Review Board at University of Namibia, and that I may contact this office if I have any comments or concerns about my son or daughter's involvement in the study. If I have any questions about the study I can feel free to call the researcher **(Sikukumwa Ellion, 0812367478, ellion.siku@gmail.com).**

☐ Yes – I would like my child to participate in this study

☐ No – I would not like my child to participate in this study.

Child's Name **(please print)** _____

Child's Birth Date _____ Gender of Child ____ Male ____ Female

Parent or Guardian Signature _____Date _____

Researcher's Signature _____ Date _____