SOLVING MATHEMATICAL WORD PROBLEMS IN SECONDARY SCHOOLS: A CASE OF TINDERET SUB-COUNTY, NANDI COUNTY KENYA

BY

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DECLARATION

DECLARATION BY THE CANDIDATE

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ABSTRACT

Mathematical word problems are concepts taught at the end of every topic to allow students apply the content that was taught. The study focused on investigating the student's difficulties in solving mathematical word problems. Its aim was to determine the factors that led to difficulties a learner encountered in the process of solving mathematical word problems. The study objectives were to determine the effects of students' comprehension skills, interpretation of operational terms and student writing of mathematical expressions in solving mathematics word problems. The study adopted was guided by constructivist's theory of learning and quantitative research design. The target population was form three mathematics students and teachers. Stratified random sampling techniques were employed to select nine public secondary schools; one boys' school, one girls' school and eight mixed secondary schools from a population of thirty-three public secondary schools. Simple random sampling was used in picking folded yes/no papers to select one hundred and thirty-five (135) form three students and ten (10) mathematics teachers were purposively sampled. A pilot study was conducted to test the reliability of the data collection instruments. Questionnaires, achievement test items were used to collect data. The data collected was coded and analyzed using the SPSS version 20. The study revealed that students had difficulties in comprehending mathematical word problems, interpreting operational terms used in the word problems and writing mathematical expressions from word problems. From these findings, it was concluded that the poor comprehension of word problems, misinterpretation of operational terms and inability to write mathematical expressions led to student difficulties in solving word problems in mathematics. The study made the following recommendations that the teachers should find ways of ways of improving comprehension skills of the students and a special room for teaching resources in mathematics should be set aside to enrich the course.

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LIST OF ABBREVIATIONS AND ACRONYMS

ANOVA	Analysis of Variance
D.E.O	District Education Officer
D.O.S	Director of Studies
ELLS	English Language Learners
HOD	Head of Department
KCPE	Kenya Certificate of Primary Education
KCSE	Kenya Certificate of Secondary Education
KICD	Kenya Institute of Curriculum Development
KNEC	Kenya National Examination Council
MAT A	Mathematics Alternative A
MAT B	Mathematics Alternative B
MOEST	Ministry of Education Science and Technology
MWP	Mathematical Word Problem
NACOSTI	National Commission for Science, Technology and Innovation
RME	Realistic Mathematics Education
SMASSE	Strengthening Mathematics and Science in Secondary Education
SPSS	Statistic packaging for social sciences
TIM	Trends in International Mathematics and Science Study
TSC	Teachers Service Commission
U.S	United States

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CHAPTER ONE

INTRODUCTION

1.1 Overview

This chapter presents the background of the study, statement of the problem and the purpose of the study. The objectives of the study, research questions, hypothesis and justification of the study will also be addressed. Significance, assumptions, scope, limitations together with theoretical framework, conceptual framework, definitions of operational terms and summary of the chapter will be presented.

1.2 Background of the Study

Mathematics is a core subject which is studied by all the candidates sitting the Kenya Certificate of Secondary Education (KCSE) examinations. However, performance by candidates in Mathematics has been low compared to other subjects. Since KCSE mathematics is a standardized test, word problems contribute to mathematics overall percentage. It is observed that learners have difficulties in solving mathematical word problems leading to poor mathematics performance. Researchers in Kenya have come up with many factors said to be contributing to poor performance in mathematics. Research done by (Eric, Gakii, Muthaa, & Reche, 2013) on factors contributing to students' poor performance in mathematics in public secondary schools in Tharaka south involved fourteen (14) public secondary schools with a sample size two hundred and forty eight respondents (248).it found the following factors: students' absenteeism, poor entry mark, poor teaching methods, inadequate teaching and learning resources, over-enrollment and inadequate number of teachers. The research suggested that learners should be guided on how to deal with mathematics questions. It was also suggested that variety of teaching methods need to be used. Teaching methods improved due to introduction of Strengthening Mathematics and Science in

Secondary School Education (SMASSE) which was started in July 1999 on a pilot basis. Phase II of SMASSE project was started in July 2003 and was extended to the entire country in 2004.

In the past, the ministry of education provided money in order to increase the purchase of textbooks, teaching aids and other teaching resources but learners still recorded dismal performance. Technology, innovation along with other factors are pillars that the achievement of Kenya’s Vision 2030 is anchored on. To achieve the vision 2030, more resources were to be devoted to scientific research. The quality of teaching, mathematics, science and technology in schools, polytechnics and universities was to be raised (Vision 2030).

Achievement of vision 2030 will require the ability to solve mathematics problems in real life situations through word problems. In mathematics course books, word problems given at the end of every sub-topic enable students to practice the learnt skills in real life situations. Therefore, quality mathematics instruction incorporates techniques that are designed to demonstrate to children the relevance of mathematics to their daily lives, the world around them and their future careers. Langenes (2011) points out that standardized tests in mathematics consists of word problems that students must interpret before they are able to arrive at answers. However, a considerable number of students in secondary schools have inadequate understanding of mathematical concepts and skills in solving word problems (KNEC 2007).

A study by Leiss, plath and Schwippert, (2018) on Language and Mathematics key factors influencing the comprehension process in reality-based facts, used fifty-five (55) seventh graders using the think aloud method to solve reality-based tasks that were varied in their linguistic and situational complexity level. The study revealed that that learners had difficulties in solving world problems of higher linguistic complexity. Complex terms limit the student's ability to comprehend the problems therefore causes inability to solve MWPs. Mathematical word problems are tasks that are dressed up in a real-world situation requiring the students to interpret and solve them successfully. Boolean (2015) explains that solving mathematical word problems requires both mental representation of skills and reading comprehension skills. Examples of the most common types of word problems are: distance problems, age, work, percentage mixtures and numbers problems and most of these problems were structured in the form of mathematical word problems (MWPs) (Secondary KLB Mathematics).

Anne and Mayer (1987), asserted that solving Mathematical Word Problems (MWP) effectively was assumed to depend not only on students' ability to perform the required mathematical operations, but also on the extent to which they are able to accurately understand the text of the word problem. It was found out that students were more likely to miscomprehend a relational statement when the required arithmetic operation was inconsistent with the statements relational term. If a student has not understood the text, then incorrect mathematical operations will be used leading to wrong answer to the word problem. According to Boolean et al (2013) developing a deeper understanding of the text of the word problem serves a crucial step before the correct mathematical computations could be performed. Therefore, the main challenge for word problem solvers is to understand the problem in the statement given. Stapel (2014) points out that for a student to understand the problem to be solved, the first step to effectively translating and solving the word problem is to read the problem entirely and make sure they know exactly what the problem is asking for, followed by looking for the key words that indicate certain mathematical operations. Many students make mistakes by reading the problem halfway. They then assume to have known what the question requires of them before completing the statement. This leads to interpreting and answering a question incorrectly. Mathematical operations on the other hand are also presented in the form of words which confuses the learners on the mathematical operations to be used. This is because learners may not have understood the key words.

Sepeng (2013), in his research ‘Use of Unrealistic Contexts and Meaning in word problem solving’ collected data using tests. A few learners from grade nine (9) were selected and the main finding of the study was learners demonstrated tendencies to exclude real world knowledge and realistic considerations from their solution process. This explains that even though the word problem has been entirely read, it is shown that children do not consider real-life factors and constraints when giving answers to word problems. An example would be when a student gives a negative answer for the area of a rectangle. This is an impossible answer in context, therefore incorrect. Comprehension skills make it possible for students to convert words into mathematical operations.

The Netherlands currently places great emphasis on the teaching of word problem solving in contemporary mathematics education. Boonen, koning, Jolles and Schoot (2016), in their investigation on word problem in contemporary mathematics education used eighty (80) sixth grade students who were classified as successful and less successful word problem solvers based on standardized mathematical test. The results of their study showed that even successful word problem solvers had low performance on semantically complex word problems despite adequate performance on semantically less complex word problems. They concluded that reading comprehension skills should be a prominent role during word problem solving instruction. Teaching of mathematics in the Netherlands takes place within the context of a domain-specific instructional approach, called Realistic Mathematics Education (RME), where the process of mathematical word problem solving plays an important role.

Boolean (2015) first classified students as successful or less successful mathematical word problem solvers with the help of a mathematics test that is part of the RME curriculum. This test can be considered a method-specific mathematics test of students' word problem solving ability, which builds upon the currently used instructional Mathematical Word thus reflecting the skills students learn in Realistic Mathematics Education so as to be able to solve word problems. Results from the research revealed interesting situations that students classified as successful word problem solvers in an RME curriculum were unsuccessful in solving semantically complex word problems. The fact that successful problem solvers were able to solve inconsistent word problems with a lower semantic complexity, suggests that this poor performance on semantically complex word problems is not due to shortcomings in their mental representation skills. Rather, it seems that successful problem solvers particularly have difficulties to effectively handle semantic-linguistic complexities in word problems.

Research done by Moschkovich (2002) shows that success in solving word problems requires a learner to gain familiarity with the vocabulary of mathematics. Most leaner's difficulties with mathematics may be more likely due to the complexity of the wording associated with written materials rather than the nature of mathematical tasks being passed or explained. Many teachers encourage learners to have mental representations of word problems. A study done in Nigeria on investigation of ‘The Causes of Poor Performance in Mathematics Among Public Senior Secondary School Students’ found that inappropriate spending by the government, inadequate qualified teachers, students’ negative attitude towards mathematics, anxiety and fear of mathematics, poor teaching methods, inadequate teaching materials and overpopulated schools contributed to poor performance in mathematics (Tata, Abba, & Sadiq, 2014). Mushlihah and Sugeng (2018) in Indonesia collected data from one hundred and forty-seven fifteen-year-old students using a test on types and factors of mistakes in a problem-solving test. Data was analyzed using theory Neman and the results indicated to reading errors of 4.35%, comprehension errors of 17.39% transformation errors of 34.79%, process skills errors of 23.91% and encoding errors of 19.57%, therefore concluded that a student is not able to absorb information well, not understanding the transformation of the problem, not following the material thoroughly and comprehension of mathematical word concepts.

Kavkler and al (2014), explains that the importance of mathematical literacy in this technological age is recognized universally for it is a tool for developing a rational personality. Achieving the Kenya vision 2030 is dependent on improvement of mathematics and sciences. Despite this significance, students still perform poorly in mathematics. A research done in Kiambaa division on factors contributing to poor performance in mathematics in KCSE revealed that teachers had positive attitude towards mathematics however the students had negative attitude towards learning mathematics (Martha, 2015). It can be concluded that mathematics is still performed poorly due to various factors affecting the subject. Data from KNEC (2015) statistics shows that there are fluctuations in mathematics performance, both Mathematics Alternative A (MAT A) and Mathematics Alternative B (MAT B). The research showed that there had been decline in performance in MAT B from 2011 to 2015 though it is a form of simplified mathematics. Analysis done by KNEC also shows that performance in MAT A had been fluctuating. There was improvement in 2011, 2012 and 2015 but a drop in 2013 and 2015 and also in 2016. The table below shows a summary of KCSE mathematics performance in 2014 and 2015.

Table 1.1 Mean Percentages in 2014 and 2015 KCSE Mathematics Examination

Year	2015	2015	2015	2014	2014	2014
Gender	All	Female	Male	All	Female	Male
MAT A	26.88	24.27	29.16	24.02	21.26	26.40
MAT B	8.29	7.84	8.81	12.38	11.85	13.06

Source: (KNEC 2015)

From table 1.1 above, it can be seen that mathematics score is still poor countrywide with a mean mark of below 30% for boys and below 25% for girls. It is very unfortunate that the alternative B mathematics introduced has been recording very poor grades as compared to MAT A which is against the expectations of the curriculum planners. This is an indication that still there are challenges in mathematics. Tinderet Sub County has also been performing poorly in mathematics in the same way as reflected in the table 1.1.

The table 1.2 shows a summary of mathematics mean score in Tinderet Sub County from 2012 to 2017.

Table 1.2 Mathematics Mean Score in 2012 to 2017 KCSE Examinations

Year	2012	2013	2014	2015	2016	2017
Mean	2.5968	2.3760	2.6857	2.5568	2.4372	2.4852

Source: (MOE Tinderet Sub County)

Table 1.2 shows mathematics performance in Tinderet sub country since 2012 to date. From the table, it is observed mathematics scores in Tinderet Sub County are very low and there has been no improvement. The sub county mean score ranged in the same domain for the past five years. A learner may not perform well in mathematics not necessarily because of weak mathematics ability but due to challenges in understanding the steps involved in solving mathematics word problems tests. This made the researcher to ascertain the distribution of mathematics word problems in the national examination. This is supported by the table below which indicates the number and percentage of mathematics word problem questions in KCSE mathematics (MAT A) examinations.

Table 1.3 Number and Percentage of Mathematics Word Problems Questions

YEAR	PAPER 1		PAPER 2	
	No. of Questions	Percentage	No. of Questions	Percentage
2013	15	62.5	14	58.3
2014	17	70.8	13	54.2
2015	17	70.8	14	58.3
2016	14	58.3	15	62.5
2017	13	54.2	16	66.67
2018	13	54.2	12	50.0

Source: (KCSE Mathematics papers, 2013 -2018)

Table 1.3 shows how mathematics word problems were distributed in the past KCSE mathematics examinations. It can be observed that MWPs take a higher percentage in KCSE examinations and therefore solving mathematics word problems could be a contributing factor towards poor performance in mathematics. This provoked the scholar to conduct a study on solving mathematics word problems. Since solving mathematics word problems involves a series of steps, the researcher will determine the stage that is challenging in the process of solving the word problem.

1.3 Statement of the Problem

Performance in mathematics has been low compared to other subjects. According to Njagi (2015) language challenges such as poor mastery of mathematics symbols, use of terms that have different meanings, language barrier that leads to poor communication and language-based factors in solving mathematical word problems have contributed to dismal performance. It indicates that language factors contribute to poor performance in solving word problems.

According to Krick-morale (2006) word problems in mathematics often pose a challenge because they require students to read and comprehend the text of the problem, synthesize ±the question and finally create and solve the numerical equation implying that learners' inability to solve word problems is due to poor solving strategies. Griffin (2009) points out that solving of word problems involves combining one's knowledge of sentence structure, mathematical relation, basic numerical skills and mathematical strategies used to solve the problem. Mathematics performance in secondary schools has continually remained dismal for a long time. Strategies put in place by the government of Kenya and school management, have failed to improve performance over a period of time. Reports from MOE Tinderet sub county shows that they have stagnated at a mean less than 3.0 a deviation of ± 0.2 over a period six years. From KCSE mathematics papers, it is observed that mathematics word problems take a higher percentage in KCSE and therefore inability to solve mathematics word problems could be a contributing factor towards poor performance in mathematics. The study was expected to assess the steps and difficulties encountered in solving mathematics word problems. The problems to be addressed in this research is continuous low performance of mathematics in KCSE in Tinderet Sub County

1.4 Purpose of the Study

The purpose of the study was to determine the difficulties students encounter in the process of solving mathematical word problems in Tinderet sub county schools, Nandi County.

1.5 Objectives of the Study

The specific objectives of the study were to:

i. Determine the influence of students' comprehension skills on solving mathematical word problems.
ii. Establish the influence of interpreting operational terms used on the students' ability to solve mathematics word problems.
iii. Determine the influence of writing of mathematical expressions on the students' ability to solve mathematics word problems.

1.6 Research Questions

In order to achieve the objectives, the study was guided by the following research questions.

i. What is the influence of students' comprehension skills on ability in solving mathematical word problems?
ii. What is influence of interpreting operational terms used on student's ability to solve word problems?
iii. What is the influence of writing mathematical expressions on the student's ability to solve mathematics word problems?

1.7 Justification of the Study

Much research has been done on difficulties in solving mathematical word problems and performance in mathematics. Unfortunately, there is insufficient data documented in the country on solving word problems. Special interest was given to Nandi County, specifically Tinderet Sub County. In this technological age, it is very important to understand the effects of failing to solve mathematical word problems, yet they are used to solve daily encounters in today's business world and also in predicting the economy of a country. Enormous efforts by mathematics teachers, learners, school managements and strategies that have been laid by the government of Kenya in order to improve performance in mathematics have not borne fruits, since the country still records poor grades. The study therefore sought to establish difficulties students encounter when solving mathematical word problems.

1.8 Significance of the Study

The findings of this study will be of significant importance in Tinderet sub county schools and the country at large. The findings will enlighten Head of Departments (HODs) and mathematics teachers on the difficulties encountered by learners when solving word problems and thus find ways to improve performance in Mathematics. It will also enlighten the Ministry of Education on areas of difficulty in order to allocate funds to provide the necessary facilities to be used in teaching learners how to solve word problems.

The findings will help the Kenya Institute of Curriculum Development (KICD) to realize the areas of difficulty in solving word problems in order to place more emphasis in the Mathematics curriculum. Further, it will enlighten school management on the importance of students' language of communication when solving word problems.

Understanding the difficulties encountered when solving word problems is important to the students because it will make them realize areas of difficulty and the possible strategies to be laid. Hence, enable them to improve in the given areas which leads to improved performance.

1.9 Assumptions of the Study

The study assumed that the selected sample was willing to volunteer and respond honestly to the research tools. It was taken that the respondents were using the same mathematics curriculum.

1.10 Scope of the Study

The study focused on the students' difficulties when solving mathematical word problems in Tinderet Sub County, Nandi County. It examined the extent to which comprehension of mathematical word problems, interpreting operational terms and writing of expressions from word problems and how they affect the student's ability to solve mathematical word problems. The study targeted form three students because they are exposed to more mathematical content. Form four students were busy revising for their final examinations. It also examined the strategies adopted to improve performance in mathematical word problems. The study was conducted in Tinderet sub-county, Nandi County within the months of July and September, 2018 because Tinderet was among the poorly performed sub counties in Nandi County. The data was collected using questionnaires and a mathematics word problem test.

1.11 Limitations of the Study

Tinderet sub-county has a poor topography and therefore accessing some schools proved difficult. The accuracy of the expected response depends on the students understanding of the questions while others might not complete answering the questions.

Learners in forms three were targeted as respondents because they had sufficient mathematics content since the form fours were busy revising for KCSE examinations. Data collection was done during the rainy season and therefore it was difficult to visit some schools due to inaccessibility and poor roads. For this reason, the researcher was forced to walk on foot to those schools forcing adjustment on time allocated to visit the schools. For that reason, Tinderet Sub County is educationally marked as hardship zone.

1.12 Theoretical Framework

This study was guided by constructivist's theory of learning. The theory is based on the idea that humans process the information they receive rather than merely responding to stimuli. Constructivism is a theory of learning that has roots in both philosophy and psychology. The essential core of constructivism is that learners actively construct their own knowledge and meaning from their experiences (Catherine, 1996). Thus, constructivism acknowledges the learner's active role in the personal creation of knowledge, the importance of experience (both individual and social) in this knowledge creation process and the realization that the knowledge created will vary in its degree of validity as an accurate representation of reality.

Bruner (1990) and Piaget (1972) are considered the chief theorists among the cognitive constructivists, while Vygotsky (1978) is the major theorist among the social constructivist. Piaget focused on the development of mathematical and logical concepts while Bruner focused on science and mathematics learning. Learning is an active process in which learners construct new ideas or used upon their current/ past knowledge.

Piaget proposed that learning is a dynamic process comprising successive stages of adaptation to reality during which learners actively construct knowledge by creating and testing their own. The basic principle underlying Piaget's theory is the principle of equilibrium; all cognitive development progresses towards increasing complex and stable levels of organization. Equilibrium takes place through a process of adaptation that is; assimilation of new information to existing cognitive structures and the accommodation of that information through the formation of new cognitive structures. This is applicable in Mathematical word problem for example learners who already have the cognitive structures necessary to solve certain mathematical problem. They will need to modify their existing structures to accommodate the newly acquired information to solve the new type of problem. Thus, learners adapt and develop by assimilating new information into existing cognitive structure.

According to Bruner, learning is an active process in which learners construct new ideas or concepts based upon their current or past knowledge. The learner selects and transforms information, constructs hypothesis and makes decisions relying on a cognitive structure. From constructivists' perspective, knowledge cannot be transferred from one individual to the other but instead, the child is seen as an active participant in the acquisition of new knowledge. The child is responsible for the construction of his knowledge through the interaction of new ideas.

According to Bruner as far as instruction is concerned, the instructor should try and encourage students to discover principles by themselves. This is applicable in mathematical word problems where students and their teacher engage in an actual discussion. The concept of inverse proportion is more understood when the learner through construction discovers that when the number of people increase, the time taken to complete a piece of work decreases. Bruner (1961) asserts that the purpose of education is not to impart knowledge but instead, to facilitate a child's thinking and problem-solving skills which can be transferred to a range of situations.

In constructivist guided instruction is applicable to this study because, when a teacher poses a word problem as the last content to be learnt in a given topic, learners are not shown how to solve the word problem but they are given time to decide on the steps to follow by constructing their own knowledge using past known information. It involves intellectual experience where learners construct knowledge. Word problems are presented to the learners in order to construct mathematical ideas and solve the problems by explaining the steps so as to provide their understanding. Construction of mathematical ideas from real life experiences are also done by applying what they had already been taught. How the words in a mathematics word problem can be converted into the solution were looked at. When a learner understands how to solve word problem, the understanding is not transferable. In order to solve the word problem, the learner must write the required mathematical expression. The process of writing mathematical expression involves intellectual construction of meaning from the word problem.

1.13 Conceptual Framework

Conceptual frame work as illustrated in Figure 1.1 shows a number of factors influencing the process of solving mathematical word problems. The variables investigated in the study include: comprehension skills, interpreting operational terms, arithmetic expressions and the strategies adopted. There are other factors that influence the process of solving mathematical word problems. These include: language of instruction which can be controlled by using vocabulary instruction to improve learners' mastery of mathematics vocabularies, classroom culture which can be controlled by setting new ways of learners' behavior in mathematics lessons like working in groups.

Independent variables (students' difficulties) Dependent variable (mathematical word problem)

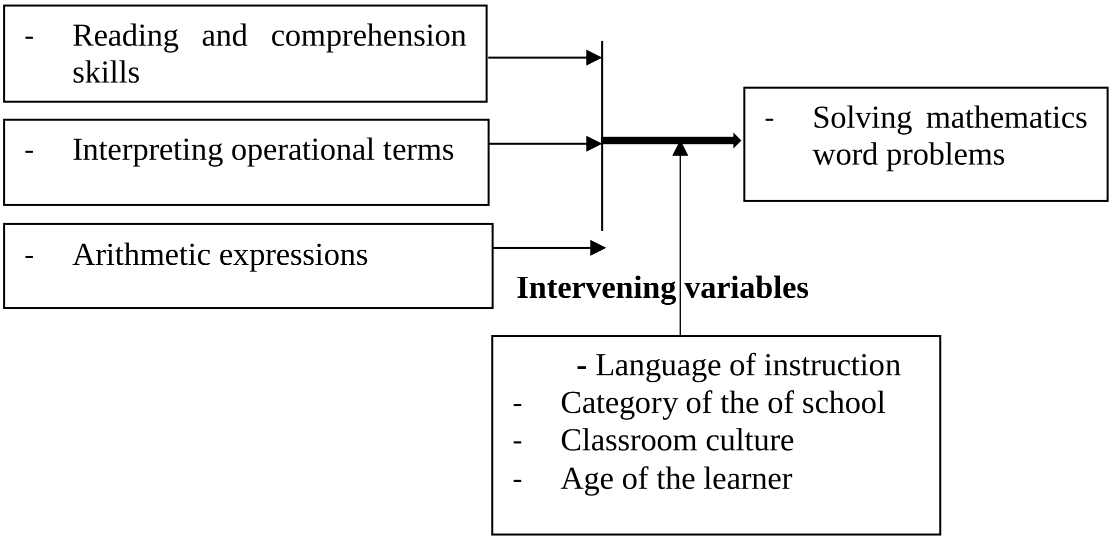

Figure 1.1 Conceptual Framework Showing how Students' Difficulties Affect Solving of Mathematical Word Problems

The figure above illustrates that student's comprehension skills, ability to interpret operational terms in a word problem and ability to write correct mathematical expressions leads to solving mathematical word problems and hence improved mathematics performance. The language of instruction in the level of the student, the category of the school and the classroom culture in terms of priory to word problems and peer learning competition also leads to solving of mathematical word problems.

1.14 Definition of Operational Terms

Mathematical vocabulary- Refers to words that label mathematical concepts for example dividend, hexagon (Sanders, 2007).

Mathematical Word Problem- is mathematical Problem written in words that requires resolutions and for which the individual sees no apparent or obvious means or path to obtaining the solution.

Mathematical word- Refers to words which have different meaning when used in common day English language as compared to when they are used in mathematics.

Mathematics-it is a science of numbers and operations of expressions in real life situations.

Performance- Refers to student's achievement in mathematics as indicated by his/her scores in a mathematics examination.

School Category- this is a classification of schools in terms of the extent to which they select students during form one placement.

Student language difficulties-these are situations where learners need great mental effort beyond his/her ability in order to explain mathematical and English terms used in mathematics word problems.

Student- one who is receiving instructions on mathematical word problems.

1.15 Chapter Summary

This chapter provides Background of the study which shows that standardized tests consists of word problems. It is found that students have limited understanding on the word problems due to poor comprehension skills. The word problems are dressed up in real world situations requiring students to interpret. The objective of the study was to determine the students' difficulties when solving mathematical word problems since solving involves a series of steps. The study was justifying that with improving technology solving mathematical word problems promotes solution of problems in real life in various categories of life. The study will be of significant importance to HODs, KICD and students because it will enable them to lay strategies appropriate strategies. The study was conducted within the months of July and September in Tinderet Sub County. Form three students were targeted and it was assumed that the same Mathematics curriculum was used. The study was guided by constructivist's theory of learning and the proponent was Jerome Bruner (1966).

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter contains a review of related scholarly work. The study mainly focuses on learners' difficulties in solving Mathematical word problems with reference to the steps involved: reading comprehension skills and its effects on solving mathematical word problems, Mathematical vocabulary, writing mathematical expressions from word problems and strategies that can be adopted to improve performance in mathematics word problems.

Learners in Kenya are evaluated using summative evaluation, where performance is measured using Kenya Certificate of Primary Education (KCPE) and Kenya Certificate of Secondary Education (KCSE) examinations. In these examinations, learners' performance is categorized as poor, good or excellent. Performance in Mathematics has been dismal since time immemorial in Kenya. This performance can be attributed to factors such as poor teaching methods, inadequate instructional materials or negative attitude by the learners. Although these factors have been researched on and the Ministry of Education Science and Technology (MOEST) has tried to improve on them, learners perform poorly in the KCSE.

2.2 Comprehension Skills on Solving Mathematical Word Problems

Comprehension skills provide the ability to recognize words and understand their meaning in context. In order to comprehend the text, a learner must be aware of their thoughts as they read. Learners will have difficulty in comprehending the information if they cannot recognize the expressions quickly and understand their meanings. Knowing definitions of word problems is dependent on understanding the word problem itself, however, people from different cultures or backgrounds will often understand word problems in different ways. Ability to read Mathematical texts does not necessarily lead to successful strategy in solving word problems. Caldwell and Goldin (1979) assert that reading and comprehension difficulties arise when children cannot imagine the context in which a word problem is set or their approach is altered by the context in which the word problem is given. There are various word problems given according to the concepts taught. Every mathematics topic has its own problem in which the learnt concepts in the topic are applied in order to solve them.

Voyer (2011), conducted a study in Canada on performance in mathematical problem solving as a function of comprehension. The study findings revealed that pupils with weaker arithmetic skills construct had different representations based on the information presented in the problem. The study recommended that learners must be taught how to recognize the problem and how to translate word problems into statements that mean something to them. Prathana, Sumiwon, and Siridej (2014), carried out an analysis of Elementary School students' difficulties in Mathematical problem solving in Thailand. The study used test items for the learners and interviews for teachers to collect data. From the study, it was established that learners had difficulties in understanding the keywords appearing in problems, thus cannot interpret them in mathematical sentences. The study also revealed that learners were unable to figure out the necessary information required to solve the problem because they were impatient and do not like reading long mathematical problems. MWPs differs in how they presented because some are written in one sentence while others are in form of a paragraph depending on the complexity of the problem.

Gokhan, Hayriye and Ahmet (2015), in their study evaluation of students' mathematical problem-solving skills in relation to their reading levels. Using a sample of six third grade students with different reading levels, the study carried out a correlation between levels of students' reading and skills in solving Mathematical problems in Turkey. The study employed Ekwall reading inventory (data collection through reading of texts). The results showed that problem solving skills vary according to learners reading levels. Jamal and Carol (2001), in their study investigated the importance of language in student test performance on mathematics word problems. Tests containing original and revised items were administered to 1,174 eighth grade students. It was found that students who were English language learners scored lower on the mathematics test than proficient speakers of English. Scores on the linguistically modified version were slightly higher

Yushau and Hafidz (2015), in their study on Mathematics Performance and its Relation to English Language Proficiency Level of Bilingual Arab University Students in Saudi Arabia, indicates that many universities in the Arab world are becoming English medium universities. The findings show the students' proficiency level in English are a factor affecting their performance in mathematics. The findings could also be similar in Kenya because their learners are bilingual. Yashau and Omar (2015), investigated the relationship between language proficiency and mathematics performance among bilingual Arab university students. The findings indicated that mathematics performance is significantly related to the English proficiency level of students. The study also showed that percentages of students who are top performers are proficient in English than those who are weak. Participants were native Arabic speaking male students with an average age of 18 years.

Rambely, Ahmad and Jaaman (2008), conducted a study on the relationship between English proficiency level and Mathematics achievement in Malaysia. The study used a sample of 118 students. The study found out that good mastery of English was needed to nurture and understand mathematics subject in order to achieve excellent results. On the other hand, low English proficiency resulted in students experiencing a challenge learning mathematics and that led to lower grades in mathematics course. Piia, Kaisa and Jari-Eric (2008), involved 225 respondents aged 9-10 in grade4, investigated the interplay between mathematical word problem skills and reading comprehension. The results showed that performance on mathematics word problems was strongly related to performance in reading comprehension, indicating that technical reading abilities increases the ability to solve word problems. Clarkson (1992), in his study on Language and Mathematics, a comparison of bilingual and monolingual students of mathematics in the New Papua, New Guinea established that out that students' reading ability as well as carrying out computations are important factors for success in Mathematics. The research showed that performance in solving Mathematics word problems are strongly related to performance in reading comprehension. Students who were competent in both languages scored significantly higher compared to colleagues who had low competence in their languages.

Fluentes (1998), stated that fluent technical reading ability increases solving word problems skills. Even after controlling the level of technical reading, performance in Mathematics word problems still relates to reading comprehension which suggested that these skills require overall reasoning abilities. At the stage of reading a given word problem, difficulties arise when children are not able to decode the words used in a word problem, comprehend a sentence, understand specific vocabularies and lack confidence or the ability to concentrate when reading. Often, real world problems come in the form of word problems. Mathematics outside the classroom learning rarely deals with simple algorithms. Without the ability to read and comprehend Mathematical Word Problems, (MWP) learners will have difficulties in answering word problems.

Research by Monroe and Panchyshyn (2005) shows that the biggest problem in solving MWP is language and the main concern is that many word problems do not use the same language that children use in everyday life; therefore, children are struggling with language, not necessarily real Mathematics computations. With emphasis on learner centered method of instruction, the standards in Mathematics are now more focused on obtaining conceptual skills rather than teaching a general methodology. This will prepare learners for careers because they can explain how to logically arrive at conclusions. Becker and Vanderwood (2009), on their research on evaluation of the relationship between literacy and mathematics skills showed that reading comprehension in fourth and fifth grade students in California was the best predictor of applied mathematics performance. It indicates that comprehension skills when paired with Mathematics computation skills leads to mathematics performance, while another study looked at reading ability and its impact on Mathematics scores of tenth grade students. (Larwin, 2010) In his research done in U S A on the impact of student reading ability found that the higher the reading ability of the student, the more likely the student will have high Mathematics scores. This indicates that those students scoring low grades in mathematics have a lower reading ability. A similar study performed in Ireland by Ririordain and O'Donoghue (2009) found that students who could speak English but with lower proficiency, scored significantly lower on word-based Mathematics tests, than students who are proficient in English. The reading of informational texts can assist in teaching Mathematics concepts. The informational texts create a connection between mathematics and the real world. With real world examples, teachers can build several concepts when compared to the limitations of a simple equation.

Cognitive load theory holds that performance on complex cognitive tasks depend on whether the amount of information presented to the user equals or exceeds the availability of working memory. Kalyuga et al (2003) assert that when working memory is exceeded, the probability of errors increases. This implies that if students must apply cognitive resources to comprehension text, less working memory resources will be available for MWP because the steps in solving them includes: reading and comprehension, which require identification of terms used and their meaning in context, forming a representation of the problem mathematically, identifying the appropriate mathematical operation, performing the computation and checking the answer in cases of English learners. The need to allocate cognitive resources in understanding the problem presented in non-primary language will force the learner to comprehend the problem in the first language, which would reduce the resources available for Mathematics problem solving and thus increase the probability of errors.

In Kenya, the language of communication at a tender age is mother tongue while the language of instruction is acquired in the process of learning. English language is introduced at primary level before the learner is able to master all the vocabularies in the first two languages, thus posing a major challenge to learners. (Hegarty, Mayer &Green, 1992) observed that many students from Kindergarten through adulthood have difficulties in solving arithmetic word problems that contain relational statements that is; sentences that expresses numerical relations between two variables.

From the research done by Hegarty, Mayer and Monk (1995) on word problems containing relational statements, it is evident that the comprehension process plays an important role in solving arithmetic word problems. This is because learners cannot comprehend problems which have the phrases “less than’ or ‘more than’ as arithmetic operations. Chi et al (1988) and Smith (1991) pointed out expert-novice differences. It is revealed that novices are more likely to focus on computing a quantitative answer to a story problem for example in Biology whereas experts are likely to initially rely on a qualitative understanding of the problem before seeking a solution in quantitative terms .The direct translation approach makes minimal demands on working memory and it does not depend on extensive knowledge of the types of problems. However, this leads to incorrect answers.

Stanovich (2001) and Naglietric (2001), showed that students with low reading ability are generally low academic achievers. Due to the skills needed in reading comprehension and success in real life Mathematics problems, it is possible that reading comprehension will be a factor in conceptual Mathematics. Engaging learners in mathematics through reading and discussing mathematical ideas is an important means of developing these practices and skills needed to succeed in these tasks.

Research done by Carole, Niall and Paul (2010), focused on the relationship of English proficiency and mathematics performance in a sample of high school students, 47% included English language learners. Results indicated that mathematics performance for the ELLs increased with English-reading proficiency in a nonlinear manner. In 2009, 87% of children of immigrants were born in the United States and 11% of those children enrolled in U.S. public schools and needed to acquire English proficiency to succeed academically. Low levels of English proficiency were probably linked to the fact that these children usually resided in homes where adults spoke no English. The increasing number of English ELLS led to low Mathematics performance.

Brown et al (2011), Henry, Baltes, and Nistor (2015) asserted that Mathematics assessments in the United States required English proficiency for all test takers, implying that students with low Mathematics achievement are weak in English. There are many subjects which are included in the school curriculum yet there is greater pressure for children to succeed in Mathematics than for example in History and Geography even though these other subjects also form part of the curriculum. Mathematics is allocated the highest number of lessons per week, second to English and in a way, given special consideration. For many mathematics is seen in terms of the arithmetic skills which are used at home or in offices, workshops and some regard Mathematics as the basis of scientific development and modern technology. It can also be used to present information in many ways not only by means of figures, but also by using diagrams, tables, graphs and geometrical drawings so that it cannot only explain the outcome of an event which has already occurred but also used to predict the outcome of one which is yet to take place.

Dawe (1983) carried out a study on bilingualism and mathematical reasoning in English as a Second Language of Italians and Jamaicans, a case study of children aged 11-13 growing up in England. The study established that first language competence is an important factor in a child’s ability to reason in Mathematics than in English as a second language. The study further showed that bilingual students who performed poorly in Mathematics tended to have low levels of competence in their native languages. He explained that, this occurred because students had learned their second language (i.e. English) without proper foundation of the first language competence. They had not acquired proficiency which is a necessary foundation for academic learning.

A study by Njagi (2015) on language issues in Mathematics achievement in Tharaka-Nithi county-Kenya, found out that solving mathematical problems modified into mathematical expressions had a positive effect on improving students' achievement in Mathematics. Achievement tests were administered to provide the needed data. It was therefore concluded that a learner may not perform well in mathematics not because of weak mathematical ability but due to challenges in understanding the language involved.

The language of communication in Kenya is English, although at a child's early stage of life their native language is used. In pre-school the child is introduced to Kiswahili Language and later English which becomes the medium of communication throughout the education system. Instruction of Mathematics is done in English; a third language which learners acquire last; therefore, Kenyan children are bilingual. Teachers and learners experience some problems in teaching and learning Mathematics due to these changes from their native languages to Kiswahili and English.

According to Abedi and Herman (2010), the problem of teaching science and mathematics in English language was faced by most countries around the world due to globalization and migration from underdeveloped states whose mother tongue was not English language, to developed countries who's medium of instruction is English. The trends in international Mathematics and Science study (TIM), (2008); administering assessments written in English to students currently learning English complicates the learning experience for those students because of their weak English proficiency skills.

According to the curriculum, Mathematics is studied in order to develop the power of logical thinking accuracy, Opton, (1987). Bernardo (2002), conducted a study to determine whether Filipino-English bilingual students understanding and solving word problems claimed students were able to understand and solve problems in their first language whether the first was English or Filipino. The language used in thinking is always likely to be the first language. Thus, knowledge communicated in the second or third language for that matter English in Kenya, might need to be translated into another language to allow thinking and then will be translated back to enable feedback. This implies that errors and misunderstandings might arise at any stage of translation. This argument is supported by (Algarni, Biresi & Porter, 2012) by explaining that cognitive load is much higher when using the second language because the brain must work to translate the language while simultaneously trying to understand the new information. From this information, it is well indicated that bilingual students are much affected by MWP.

2.3 Interpreting Operational Terms Used and Solving Word Problems

Adams (2003) defines mathematical vocabularies as technical terms, non-technical terms, symbols and words with multiple meanings. These operational terms (vocabularies) pose challenges to learners' comprehension on tasks involving word problems. Pimm (1981) points out that most learners' difficulties in Mathematics word problems may be due to complexity of wording associated with written materials.

Sepeng and Madzorera (2014), in their study: Sources of Difficulty in Comprehending and Solving Mathematical Word Problems in South Africa assert that mathematical language influences learners' comprehension when solving mathematical word problems. The study employed mixed research design. The data was collected using test items and questionnaires with structured and open-ended questions. Analysis of data revealed that learners struggled with defining algebraic terms used in the word problems.

Mathematics is a skill subject similar in many ways to learning a foreign language. Learning will not take place unless the subject is practiced. Reys, Sydam and Lindquist (1995) asserted that learning Mathematics must have meaning. In order to achieve this, emphasis on understanding the Mathematics concepts rather that memorization must be done. Anghileri (1995) asserted that when a word problem is to be solved, problems arise when attempting to provide a meaningful understanding to mathematical terms which have different meanings in everyday language, for example, the terms: difference, product, similar, face volume and table which have multiple meanings. Learners experiences are interfered with when words borrowed from everyday language are used in Mathematics where they are supposed to attach different meanings depending on the context in which these words are used (Kotsopoulus, 2007). The same is mentioned by (Rubenstein, 2007) that Mathematical vocabulary can be difficult to learn and remember because of how the words are used in everyday English which often contrasts with how the words are used in Mathematics. He went ahead to give us some of the ways in which Mathematics language can be difficult for students. He explains that some words are used in everyday English and in Mathematics but have different meanings in each context. For example, right angle and right answer. He also points out that some mathematical words are only found in a mathematical context for example; quotient, isosceles and hypotenuse. Some mathematical words also have more than one meaning for example, distance round a circle versus to round off a number. He also found out that some mathematical words are homophones to everyday English words for example, sum versus some and also pi verses pie. Some mathematical concepts are verbalized in more than one way for example one-quarter infractions.

These terms and definitions to the learners are a problem because the Kenya National Examination Council (KNEC) is testing manipulation skills and not testing mastery of definitions of terms and their meanings. Most Mathematics textbooks currently in use introduce vocabularies before the concepts are learnt, which cannot allow deep understanding because they force the learners to memorize the definitions. In many cases, giving learners opportunities to experiment with the concepts through word problems in real life and allowing them to develop their own meanings before teaching the actual terminologies can increase comprehension. Wanjiru & O-connor, (2015) assert that learners need to know the meaning of mathematical vocabulary, whether written or spoken in order to understand and communicate mathematics ideas. Faith and Boniface (2018), in their study done in Meru County, Kenya on influence of mathematical English on performance, used a sample size of one thousand and eighty standard eight pupils. Simple random sampling was employed and data was collected using mathematics test questionnaire. The study established that vocabulary, lexical ambiguity and syntactical features were critical components in primary school mathematics a learner should understand. It further recommended that teachers should guide learners on how to interpret mathematical vocabulary and comprehend mathematical language. Steps in learning Mathematics tend to be teacher centered when it comes to word problems. Learners should be given an opportunity to verbalize their mathematical ideas and solve word problems in order to make the lesson to be learner centered.

Research done by Schoenberger and Lliming (2001) found that improving mathematical operational terms helps students to solve multi-step problems and word problems. They also found that if students knew their vocabulary and how to communicate the mathematics effectively, their problem-solving skills were improved. Questions that had language complexity were altered by changing the vocabulary and grammar while holding the overall count. A comparison was done on students' improvement from MAT A to MAT B; it was found out that performance was poorer for word problems written in more complex language as compared to the same problems in easier texts. According to Abedi (2010), linguistic modification of test items results in significant difference in Mathematics performance. Scores on the linguistically modified version were slightly higher. The difficult part in solving word problems is understanding of the problem but it cannot be understood if the terms or words used in it are difficult to understand. Misunderstanding certain words make the problem difficult because inappropriate mathematical operations will be used.

Bums (2007) compared learning of Mathematics with learning of a second language. According to her, Mathematics is described as a language and the process of learning it is the same as that of learning a second language. It is clear that learning of Mathematics as a second language is not independent but has to do with learning a foreign language which is the medium of instruction. Sharma (2006) pg. 66 also supports the above argument and also compares Mathematics to a kind of language where communication takes place through symbols; it has its letters, vocabularies and grammar. In solving Mathematics word problems, learners cannot be successful if they do not know the meanings of certain words of Mathematics.

According to Amen (2006), understanding mathematical terms influences comprehension of lessons and various tests especially in solving word problems. This shows that capabilities to solve word problems depend on the understanding of mathematical vocabularies. Mcconell (2008) on Impact of Vocabulary Instruction for the Understanding of Mathematical concepts by students, asserted that when students are directly instructed to use the language of Mathematics in many ways, they develop better understanding of mathematical concepts and solving word problems becomes easier.

Taking time to write words related to the given problems and discussing their meanings in the contexts of the word problems, students will have more opportunities to know what to do with the problems (Solomon, 2009). Mathematics is not a natural language as no one uses it as a first language. The functions of mathematical language are to help one express mathematical ideas and meanings in its activities. Itan and Ginsburg (2001), assert that apart from teaching learner’s technical vocabulary independently, teachers must encourage them to learn definitions of technical terms within particular mathematical contexts. They further argue that when learners practice that, they are advantaged when solving word problems because they can select suitable strategies.

Dresher (1934) in a study that investigated the effect of using specific vocabulary in teaching junior high school mathematics learners, concluded that the teaching of specific vocabularies before administering tests on word problems was effective. The study found out that learners who had received special instruction on specific vocabulary performed better on word problems than those who were subjected to normal teaching. In Kenya, there is no special instruction on specific vocabulary and therefore it could be another cause for failure in Mathematics.

2.4 Writing Mathematical Expressions in Solving Mathematical Word Problems

A learner must be able to perform Mathematics operations. In order to be successful in conceptual Mathematics, number sense skill is also emphasized. According to research done by Witzel, Ferguson and Mink (2012), it is seen that basic principles of number sense in early elementary and pre-grades are the strongest predictors of success in Mathematics. However, number sense and basic operations do not necessary imply that there is success in conceptual Mathematics but it is only introductory work that is needed for success to be achieved.

In conceptual Mathematics, the most important part is to break down the problem. Learners have to read the problem and understand what is being asked which the metacognitive process is. They must find numbers in the word problem that are helpful to them. They need to determine whether the problem asks them to add, subtract, multiply, divide or a combination of all the four basic operations. The words given in the problem must also be converted into mathematical expressions or equations. Learners need to move beyond rules and express real-life experiences mathematically.

Expressing concepts mathematically is difficult if students do not know or have not been taught definitions, rules and mathematical algorithms. Learners can perform tasks that involve arithmetic operations very well but when they are given word problems, many of them give up and show the need for help. According to Carey (1991), children appear to find it hard to form Mathematical expressions for some word problem structure than others. These difficulties can result in children not being able to perform a correct calculation. It has also been shown that children do not consider real-life factors and constraints when giving answers to word problems which can result in giving an answer that is impossible in the context, like negative length and therefore is incorrect.

Koji and Mukaka (2016) In their research an investigation into challenges faced by secondary school teachers and pupils in algebraic linear equations used a sample size of eighty (80) grade 11 pupils and fifteen (15) mathematics teachers. A descriptive survey method was employed and the findings were indicating that pupils lack prerequisite knowledge, conceptual, procedural and strategic knowledge skills required for solving linear equations. From the findings, pupils need to be exposed to formulating equations from situations which they are familiar.

Wyndham and Saijo (1997), Cooper (2000), Bardillion (2004), found out that ability to solve worded problems depends on how they translate phrases into mathematical symbols. This is also supported by Yeo (2009), that some students have slow progress in solving the problem due to their inability to translate the problem into mathematical form.

2.5 Strategies Adopted to Improve Performance in Word Problems

From the information gathered, it can be concluded that solving mathematical word problems is related to comprehension of the word problem, understanding the mathematical terms used and writing correct mathematical expressions from the word problems. Prathana (2013) did analysis of elementary school difficulties in Mathematical Problem Solving and concluded that, mathematical problem-solving diagnostic tests for teachers should be created and developed in order to improve students' mathematical problem-solving skills.

Perveen (2010) on The Effects of Problem-Solving Approach on Academic Achievement of Students in Mathematics at the Secondary Level used a sample of forty-eight girls. He found out that the experimental group outscored the control group significantly on the post-test. Another research by (Wright, 2014) on Factors Affecting Students' Performance in Algebraic Word Problem Solutions employed a mixed-methods design and a sample size of 163 students in the south eastern United States. The translation phase of the solution process presented the students with the most significant difficulty because, the natural language of the problem statement was changed into mathematical symbolism and equations. The findings suggested that additional cognitive tasks and abilities were required to obtain successful solutions to arithmetic word problems. A similar research, (Al & Paul, 2016) on students' difficulties in Mathematizing Word Problems in Algebra, which used a sample of 51 Indonesian students found out that formulating a mathematical model evidenced by errors in formulating equations, schemas or diagrams is the main difficulty. Evans atteh (2014), on The Problem-Solving Strategy of Solving Mathematical problems, used a sample of thirty-five (35) students and problem-solving strategy of teaching and learning was employed. The findings showed that the problem strategy of teaching and learning employed during the intervention process improved the students' academic performance. It also promoted student participation in the teaching and learning process and environment. Another research done in Malaysia (Nasarudin, Lilia, & Ehandi, 2014) on A Thinking Strategy and Visual Representation Approach in Mathematical word problem solving, used 96 students as the experimental group and 97 received the conventional approach. The study found that the Vstops approach had a positive impact on achievement, conceptual knowledge, and metacognitive awareness, awareness of problem-solving strategies and students' attitudes towards mathematical word problem solving.

Wiest (2004), used individual student's interests on student problem-solving performance. The results showed that there was no significant increase in student achievement when the personalization treatment was used regardless of student reading ability or word problem. The research was done in Nevada using forty-two (42) fourth grade students and the quantitative research design was used. Research done in Africa also indicates that there have been learner difficulties in word problems. There are many researches that have been done in Nigeria. Anyichie (2012) Points out that the effect of gender on mathematical word problem achievement was insignificant but significant interaction effect was observed between gender and learning strategy. Male were found to perform significantly better than the female in the experimental group. The research employed non-randomized control group pre-test post-test experimental design and a sample size of 131 students of about16 years old. Esan (2015), On the research; Impact of a Cooperative Problem-Solving Strategy on the Learning Outcomes in Algebraic Word Problems used a sample size of two hundred and forty (240) junior secondary school students in Ilesa township of Osun state Nigeria. He found out that the overall achievement of students exposed to cooperative problem-solving strategy was better than those exposed to the conventional method.

A study by Adani, Eskay and Onu (2012)on the efects of self-instruction strategy on the achievement in algebra of students with learning difficulty in the research used a sample of 40 students and the quasi-experimental design was employed mathematics.

It showed that self-instruction was effective in improving the achievement in algebra of students with learning difficulty in mathematics. Osoro (2014), in his research on word problem strategy for Latino English Language learners at risk for mathematics disabilities suggested that focus on comprehension strategies may help facilitate mathematics skills development for English language learners at risk for mathematics disabilities.

Koj and Angel (2016), carried out a study in Zambia on investigation into challenges faced by secondary school teachers and pupils in algebraic linear equations. The study used descriptive survey method on a sample size of 80 grade II pupils and 15 teachers of Mathematics. It was discovered that pupils need to be exposed to formulating equations from situations which are similar and that teachers should get regular refresher courses to keep them up-dated with new developments in the teaching and learning of mathematics.

According to Benson and Miheso (2015) Wanjiru, Marguerite and Sophia (2015), the study: Effects of Mathematical Vocabulary Instruction on Students' Achievement in Secondary Schools Mathematics, found out that the Frayer model when integrated with technology provided better opportunities for learners to understand the interaction with mathematics content. The study purposively selected two secondary schools in Muranga County Kenya. A sample size of fifty-four (54) was used and a non –equivalent control group, pre-test post-test quasi-experimental design employed. The experimental group was exposed to mathematical vocabulary instruction using the graphical organizer based on the Frayer model with ICT integration instructional approach. The control group was taught mathematical vocabulary by the definition only method for the same period of time. Data was analyzed using analysis of variance (ANOVA), independent t-test and paired t-test and it was concluded that a well-developed and executed mathematical vocabulary instruction can effectively improve students' achievement in mathematics.

2.6 Summary

This chapter provides information on the researches done by scholars and academicians on students' difficulties in solving mathematical word problems. From the literature review, mathematics is the back bone of technology in most countries of the world and especially in the Kenyan education system. The literature presented suggests that the following factors affect performance in mathematics: unavailability of resources, shortage of mathematics teachers in schools, learners' absenteeism and methods of teaching mathematics. It was established that comprehension skills were a factor in solving word problems. Comprehension was still poor, this study sought to fill this knowledge gap by establishing difficulties that learners encounter in solving mathematical word problems. This study paid particular attention on comprehension skills, interpreting operational terms in a word problem, arithmetic expressions and language of instruction in the process of solving word problems.

CHAPTER THREE

RESEARCH, DESIGN AND METHODOLOGY

3.1 Introduction

This chapter provides the description of the process and the methods that were used to carry out the study. This chapter covers: the location, research design, target population, sampling procedure, sample size, study variables, research instruments, validity and reliability of the instruments, data collection and processing and ethical considerations.

3.2 Study Area

The study area was Tinderet Sub County in Nandi County. The region is located in latitude $0^{o}18'$N and $35^{o}12'$E. It consists of three political wards namely: Tinderet/Meteitei, Soba/Songhor and Chemelil/Chemase wards and also comprises of 15 locations. It also has two constituencies namely; Tinderet and Nandi-Hills of which it covers 379.7km^2.

Tinderet Sub County in Nandi County is covered by wooded highlands which are part of the dissected piles of lava forming an extension of the Kenya Highlands. In the wooded south east corner at the top corner of Meteitei valley, rocks jut out to a height of 2500 meters. The land has steep slopes especially on the parts of Meteitei, Kabirer and Tinderet areas to the south-west. Fifteen kilometers to the East of Nandi-hills – Chemelil - Kisumu road the terrain is highly rugged. The Sub County has rapid falls, one of which is used to harness hydro-electric power in Diguna. Tinderet Sub County also has a long rain season between March and June and the short rains come in October and November. Rain intensity is measured as millimeter in height which is the height of the rain water column collected over a standard area. Standard rain gauge to collect the rain water is used and the rainfall volume is 1,200ml and 2000ml annually with temperatures of between 15°C and 25°C.These climatic conditions are ideal for tea, coffee and sugar cane farming in the sub county which led to the establishment of two tea factories and two coffee co-operative societies. The existence of these factories has made Tinderet Sub County cosmopolitan, therefore data collected from the sub county will be a representation of Kenya at large.

In terms of infrastructure and development, Tinderet Sub County has one tarmac road under construction joining Nandi-hills –Kericho road at Kopere, two marrum roads and several earth roads. The most common means of transport are motor cycles and donkeys but during the rainy seasons, donkeys have proved to be more reliable

The sub county is still developing in terms of education facilities. There are two youth polytechnics, thirty-three secondary schools; one Extra County, two county and thirty sub county secondary schools one hundred and twenty-one primary schools and one hundred and fifty-two Early Childhood Development (ECD) centers (Ministry of Education 2019). Apart from being cosmopolitan, the study area was selected because it has been recording poor grades in mathematics for the past five years.

3.3 Study Design

According to Mugenda and Mugenda (2003), research design is a framework of methods and techniques chosen by a researcher to combine various components on research in a reasonably logical manner so that the research problem is efficiently handled. It provides insight about how a research can be conducted using particular methodology.

There are three types of research designs: Quantitative, Qualitative and mixed research design. Qualitative research collects qualitative data and more often, the data collected are inform of words rather than numbers. Data is collected by direct observation, participant observation and through interview. Quantitative research gathers information from existing and potential customers using sampling methods and sending out online surveys, online polls and questionnaires. In Mixed research, data is collected by use of questionnaires, interviews surveys and direct observation (Timos, 2016).

This study adopted quantitative research design to assess the student’s difficulties when solving mathematical word problems because of the methods of data collection employed. There are two methods to conduct quantitative research. These are; primary quantitative and secondary quantitative research. Primary quantitative research focuses on collecting data directly rather than depending on data collected from previously done research, while secondary research involves using already existing data. The researcher therefore adopted primary quantitative research. The research technique has multiple types: survey, correlational causal-comparative and experimental research (Zikmud, 2003). Causal-comparative research was used because the researcher can draw conclusions about cause-effect between two or more variables where one variable is dependent on the other independent variable. It also allows sampling methods to be used in collecting data (Mugenda & Mugenda, 2003).

3.4 Target Population

Mugenda and Mugenda (2003) defined it as that population to which a researcher wanted to generalize the results of the study. The target population was all form three students in Tinderet sub-county because they have sufficient information required for the study. Form fours were not used because they were busy preparing for their final examinations. The study also targeted mathematics teachers. According to the ministry of education, there are thirty-three (33) secondary schools in the sub county.

3.5 Sampling Procedure of the Study

Sampling is the process of selecting the sample to be used in research (Mugenda, 2003). A sample is a smaller group obtained from the accessible population. There are various techniques of selecting a sample classified in two categories; probability sampling and non-probability sampling. Probability sampling is used to select a reasonable number of subjects that represent the target population. They include; simple random, systematic, stratified and cluster. Non probability is also known as biased sampling which includes; purposive, maximum variation versus homogenous, snowball, quota and convenient or accidental sampling. Stratified random sampling was used to take care of categories of schools in terms of gender; boys', girls' and mixed schools. Tinderet Sub County has 1 extra county school and this was purposively sampled to represent this level in the sub county. Since there are two county schools, one of them was purposively sampled based on sex to participate in the study hence 1 boy and 1 girls' school were stratified according to zones and finally simple random sampling was then used to select the 8 sub county schools from the 6 zones. Students were selected from the sampled schools using simple random sampling by writing yes/no papers which were folded and students were allowed to pick. Form three teachers of mathematics were purposively sampled but in cases where the teachers were unavailable, any other mathematics teacher was picked. According to Cohen and Manion (2007), simple random sampling allows generalization to the larger population with a margin of error. It also allows the use of inferential statistics.

3.6 Sample Size of the Study

Kothari (2004) states that sample size of 30% of the target population is sufficient to form a study. The target population is less than 10,000, therefore, the required sample size will be smaller. A sample is a smaller group obtained from accessible population and will be derived as in the table below.

3.6.1 Population Frame

Table 3.1 Target Population and Sample Size

Type of School	Total Population	Girls	Boys	Target	Sample Size
Mixed	1002	686	316	301	91
Girls	154	154	0	46	14
Boys	339	0	339	102	30
Total	**1495**	**840**	**655**	**449**	**135**

3.7 Study Variables (dependent and independent variables)

A variable is a measurable characteristic that assumes different values among the respondents.

3.7.1 Dependent Variable

Dependent Variable is a variable that is as a result of another variable. In this study the dependent variable was solving mathematical word problems.

3.7.2 Independent Variables

Independent variables include: comprehension skills, interpreting operational terms and Mathematics arithmetic expressions.

3.8 Data Collection Instruments

These are the testing devices for measuring a given phenomenon. The study employed two sets of questionnaires: a set for form three students and another for mathematics teachers. Achievement test was also administered to the students.

3.8.1 Questionnaire

It is a list of research questions given to respondents and is designed to extract specific information from the population. It is developed to address a specific objective, research question or hypothesis of the study because it collects the appropriate data, makes the data comparable, minimizes bias in formulating and asking questions and finally makes questions engaging and varied.

3.8.1 (a) Students Questionnaire

Two Students questionnaires were developed in order to collect information in two parts. Part A was used to gather the general information about the learners. Part B comprised 26 items answering the research questions guiding the study. The research questions targeted learner comprehension skills, interpreting operational terms, writing mathematics expressions and strategies adopted to improve solving mathematics word problems the items enabled collection of more information from the respondents. They chose responses from Likert scale of strongly agree (SA) agree (A) not sure (NS) disagree (D) and strongly disagree (SD) which were used to measure attitude, perception and behavior of the learners towards mathematics word problems.

3.8.1 (b) Mathematics Teachers Questionnaire

Mathematics teachers' questionnaire was developed to collect information supplementing what was obtained from the learners because subject teachers have more information about their learners' progress. The questionnaire consisted of two parts designed in a way that part A was used to obtain the general information about mathematics teachers while part B comprised 16 items answering the research questions guiding the study the respondents chose responses from Likert scale of strongly agree (SA) agree (A) not sure (NS) disagree (D) and strongly disagree (SD). The questionnaire was designed in a way that specific items answered specific research questions in the order of research objectives.

3.8.2 Mathematical Word Problem Test

It is a specific task that respondents were asked to perform. It is developed to address issues which are very specific. The test item consisted of seven questions in the order of increasing complexity. Learners were asked to define underlined words in the test according to mathematics, write their understanding of the question, write a mathematical expression and finally solve the problem given. The test item was used to establish comprehension skills, understanding mathematical terms and also to determine whether learners could form a mathematical expression and solve mathematics word problems. Data from the test was used to confirm the information collected using questionnaires.

3.9 Pilot Study

Piloting was done in order to refine the instruments. The process was necessary so as to estimate the time allocation, determine the difficulty level of items in the instruments and language used, to enhance validity and reliability of the items. After sampling, the schools not in the sample were sampled for the second time by writing the names in piece of papers then one school was picked to be used for piloting. The researcher sought permission from the school sampled for piloting in order to collect data. Students participating in piloting were sampled using simple random sampling. The research tools were administered twice after an interval of one week. It was discovered that some items were not clear and necessary amendments were done. The instruments showed consistent results and were considered to be reliable. This was determined by the percentage score on MWP test and the questionnaires. Data collected was used to amend the instruments appropriately.

3.10 Validity and Reliability of Research Instruments

Mugenda & Mugenda (2003) explains that for reliability and validity to exist in the data, the data collection techniques must yield information that is relevant and correct. Therefore, validity and reliability of data collected must be maximized by ensuring correctness and relevance of data collected. They are fundamental elements in the evaluation of a measurement instrument.

3.10.1 Validity

Mugenda and Mugenda (2003) defines validity as the degree to which an instrument measures what is intended to measure. Validity of an instrument is demonstrated when that instrument performs its designed function. The instruments were validated using consolidating experts (lecturers) opinions from the school of education at the University of Eldoret who are conversant with the study area. They assessed the face, content and construct validity to establish whether the instruments represented the variables under study. Establishing validity involves examining the logical relationships that should exist between assessment measures. The tools were developed according to their comments.

3.10.2 Reliability

This is a measure of the degree to which a research instrument yields consistent results or data after repeated trials (Mugenda & Mugenda, 2003). The reliability of data collection instruments was determined using respondents not included in the sample. The study concurs as stated by Mugenda and Mugenda (2003) and adopts the test-retest reliability and the following steps were followed: the developed questionnaires and test items were administered to one school not in the sample; a sample to be used was selected using simple random sampling; The test and the questionnaire were administered and responses manually scored; the same was administered to the same school after one week, keeping all the initial conditions constant; the scores were also scored manually; computation of correlation coefficient between the first and the second result was done; correlation coefficient ≥ 0.75 imply a strong relationship; a comparison between the responses obtained was made using Pearson product moment correlation coefficient. The calculated value was 0.76 for the learner's test item. Therefore, the instruments were considered to be reliable.

3.11 Administration of Data Collection Instruments

Before administration of the research instruments, the researcher sought permission from university of Eldoret and also from Tinderet sub-county education office to administer research instruments within Tinderet Sub County. The research authorization letter acquired from the university was sent to the National Commission for Science, Technology and Innovation (NACOSTI) in order to acquire a research permit.

The sampled schools were visited and permission sought from the administration to sample students and administer data collection tools. Clear instructions were given to the participants on how to answer the questionnaires and test items. Once the collection exercise was over, all research instruments were checked for completeness before coding and analyzing the data.

3.12 Data Analysis and Presentation

The questionnaires were checked for completeness after collection. Completed questionnaires were numbered from one to one hundred and twenty-one. SPSS window was prepared and all variables were entered in the variable view. The values were assigned according to the specific variable and the type of measurement was specified. After entering all the variables, data view was created by clicking data view. Information in the questionnaires were entered in the data view window starting with the questionnaire labeled one to the last. The data was then analyzed by clicking analyzed by clicking analyze and the method of presenting the results was selected and presented.

Data from the mathematical word problem test scripts were also checked for completeness and numbered from one to one hundred and twenty-one and SPSS programme version 20 was also used to analyze the data using descriptive statistics and presented inform of tables, pie charts and bar graphs. The structured likert scale questionnaires from the sampled schools were analyzed using descriptive statistics and presented inform of tables, pie charts and bar graphs. Multiple regression model was also used to test for the relationship between the independent variables and dependent variable. The regression model that was estimated is specified as follows:

$$\mathbf{Y=\beta_0 +\beta_1 X_1 +\beta_2 X_2 +\beta_3 X_3 +\varepsilon}$$

Where; **Y** – Solving mathematical word problems

$\mathbf{X_1}$**-** Learners' reading and comprehension skills

$\mathbf{X_2}$ – interpreting operational terms

$\mathbf{X_3}$- Learners' writing of mathematics expressions

$\boldsymbol{\beta_1}$, $\boldsymbol{\beta_2}$, $\boldsymbol{\beta_3}$ represents coefficients of variables

$\boldsymbol{\varepsilon}$- Error term

Data was interpreted in relation to research questions in form of tables and discussions.

3.13 Ethical Considerations

Research authorization letter acquired from University of Eldoret indicating authorization to carry out the study was used to get a research license, which was acquired by applying to NACOSTI. Both the permit and the license were used to seek permission from the Ministry of Education, the D.E.Os, Tinderet Sub County. The sampled schools were visited with the permit. The purpose of the research was explained to the principals and other respondents. All the ethical issues of confidentiality, integrity, honesty, anonymity and respondent's rights while acquiring the required information were adhered to. The respondents participated after their voluntary consent was sought by preparing a consent letter as an indication of informed consent by the respondent. They were also assured that the information from the study would be used for the purpose of the study only. Schools were coded to secure their identity

3.14 Research Field Experience

Data collection was done in the month of July and this is a period in which Nandi County experiences the long rainy season. Most of the schools sampled were not along the tarmac and therefore means of transport was a challenge. The most commonly used means of transport was motor cycles. At some point the researcher was forced to travel on foot because most of the roads were impassable. The administrators of all the sampled schools, mathematics teachers and learners were welcoming. However, it was discovered that learners fear attempting questions related to mathematics. On assurance that there would be no ranking, the learners availed themselves. Research assistants were used in the first collection of data but the researcher discovered that there was no supervision and therefore decided to collect the data personally. Most schools had busy schedule hence, data collection was limited to break time. The researcher decided to use games time because of convenience; it had longer time allocation. Otherwise, the data collection process was exciting.

3.15 Summary

The area of study was Tinderet Sub County in Nandi County. The study targeted secondary schools. From the information in this section, it was noted that the topography of the Sub County is rugged leading to poor transport and communication which hindered smooth collection of data. Questionnaires, interview-schedules and test items were used to collect the required information from learners and teachers. The study targeted form three learners and mathematics teachers from various schools. Stratified sampling and simple random sampling were employed in order to categorize schools into boys', girls' and mixed schools. Piloting of the research instruments was done to minimize confusions during the process of data collection. The data collected was coded, analyzed and interpreted in form of tables, discussions and inferential statistics and then presented.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION INTERPRETATION AND DISCUSSION OF THE FINDINGS

4.1 Introduction

This chapter deals with analysis and interpretation of findings from the study. It analyses learners' difficulties when solving Mathematical word problems in public secondary schools. The data was collected from secondary schools in Tinderet sub county, Nandi County, Kenya in which 10 mathematics teachers and 135 form three students were sampled. The data collected was processed using Statistical Package for Social Science (SPSS) version 20 and analysis done using descriptive statistics presented in form of frequency tables and percentages and discussions. Further, inferential statistics such as multiple regression and analysis of variance (ANOVA) were used. The presentations, analysis and discussion of data were grouped into four main sections according to the order of the research objectives.

4.2 Questionnaire Response Rate

Two sets of samples consisting of 10 mathematics teachers and 135 form three students were picked using purposive, stratified and simple random sampling methods respectively. Data was collected from 10 mathematics teachers and 135 form three learners making a total of 145 respondents. Nine teacher's questionnaires were filled translating to 90% response rate and 121 student's questionnaires translating to 78.4% response rate as shown in table 4.1

Table 4.1 Questionnaire Response Rate

Respondents	Sample	Response	Response Rate (%)
Mathematics Teachers	10	9	90
Learners	135	121	78.4
Total	**145**	**130**	**100**

According to the information in table 4.1, the overall instrument response rate was 78.4% and 90% for students and teachers respectively, which was above 70% that Mugenda & Mugenda (2003) recommends as adequate for a study. The high response rate achieved could be attributed to the willingness of the respondents to the study ‘difficulties encountered by students when solving mathematics word problems.

4.3 Demographic Information

4.3.1 Learners’ Demographic Information

Table 4.2 Gender Distribution of Learners

Gender	Frequency	Percent
Male	75	62
Female	48	38
Total	**121**	**100**

According to table 4.2, boys who participated in the year 2018 study were more than girls represented by 62%. This is because the boys’ school target population was higher than the girls due to higher population of boys in the boys’ school than in the girls’ school.

The researcher also sought to find the ages of the learners and table 4.3 illustrates the findings.

Table 4.3 Distribution of Learner by Age

Age	Frequency	Percent
16-17 years	52	43.0
18-19 years	54	44.6
Above nineteen	15	12.4
Total	**121**	**100**

According to table 4.3, most of the learners were within the secondary school age bracket and therefore was not considered as a factor influencing solving of Mathematics word problems because the frequency of learners of age 20 and above was a small percentage. Learners were asked to state the nature of the school they attended so as to be used to determine whether it affected solving of mathematics word problems but the findings show that the nature of the school did not affect.

4.3.2 Teachers Demographic Information

Table 4.4 Gender Distribution of the Teachers

Gender	Frequency	Percentage
Male	8	88.9
Total	**9**	**100.0**

From table 4.4, most mathematics teachers are male and this can influence mathematics performance of the girls. The study also wanted to establish whether mathematics teachers were qualified as shown in table 4.5.

Table 4.5 Teachers' Highest Academic Qualification

Highest Qualification	Frequency	Percentage
Bachelor of Education	7	77.8
Diploma in Education	1	11.1
Certificate (KCSE)	1	11.1
Total	**9**	**100.0**

Minimum qualification for teachers as per the teacher's service commission (TSC) is Diploma in Education Secondary option with a mean grade of C+ and also C+ in the two teaching subjects. There were no teachers with masters and doctorate degrees. From Table 4.5, majority of the teachers were qualified and were represented by 88.9%, while the 11.1% were those continuing with their training. This indicates that most mathematics teachers were qualified and were likely to have variety of teaching techniques therefore, learner difficulties in solving mathematics word problems were not contributed by teachers' qualifications.

Table 4.6 Teachers' Work Experience

Work Experience	Frequency	Percentage
1 – 5 years	7	77.8
6-10 years	2	22.2
11-15 years	0	0
16-20 years	0	0
Above 20 years	0	0
Total	**9**	**100.0**

From table 4.6 above, majority of the teachers fall in the category of below 5 years. There were no teachers falling in the categories 6-10, 11-15 and 16-20 years. This implies that a majority of the teachers were fresh from college and therefore might not have acquired much experience. This could be one of the causes of the difficulties in solving mathematics word problems because experience in content delivery in terms of pace and mastery affects learners' understanding.

4.4 The Findings For Specific Research Questions and Objectives

The objectives of the study were: to determine the effect of learners' comprehension, to establish the influence of interpreting operational terms in a word problem, to determine the effects of writing mathematical expressions on students and to establish strategies adopted to improve students' performance in solving mathematical word problems.

4.4.1 Effects of Learners Comprehension Skills in Solving Mathematical Word Problems

The first research objective sought to determine the effects of students' comprehension skills in solving mathematical word problems. In order to find students attitude towards comprehension of word problems, seven questions were asked. The first item asked whether the learners read through a word problem to the end. The findings are shown in table 4.7 and 4.8.

Table 4.7 Comprehension Skills and Solving Mathematics Word Problem

Statements on comprehension skills	SD		D		NS		A		SA	
	F	%	F	%	F	%	F	%	F	%
I read through the word problem to the end before interpreting	9	7.4	10	8.3	7	5.8	48	39.7	47	38.8
We often do word problems in class	16	13.2	15	12.4	9	7.4	56	46.3	25	20.7
Mathematics teacher gives us time to read through the word problems in class	12	9.9	20	16.5	8	6.6	48	39.7	33	27.3
I have difficulties in comprehending word problems	21	17.4	9	7.4	4	3.3	57	47.1	30	24.8
I dislike word problems	42	34.7	40	33.1	9	7.4	13	10.7	17	14.0
I do not read word problems in an examination	61	50.4	36	29.8	8	6.6	9	7.4	7	5.8

Table 4.7 shows various responses on how students perceive the word problems. The items presented were used to determine whether students attempted word problems in terms of reading and interpreting what the question requires of them. The responses on whether students read through mathematical word problems shows that who agreed took a fairly larger percentage of 75.8%, indicating that most of the learners

read mathematical word problems to the end. The items were also used to determine whether the learners were given time to read through and solve the problems in class and whether they read word problems in an examination.67% agreed that they were given time and also did the word problems in class. This indicates that learners were involved in reading and solving word problems.

Table 4.8 Teachers View on Students Comprehension Skills and Solving Mathematics Word Problem

Statements on comprehension skills	SD		D		NS		A		SA	
	F	%	F	%	F	%	F	%	F	%
Learners have difficulties in reading and comprehending word problems	0	0	0	0	2	22.2	3	33.3	4	44.4
Learners find solutions to a word problem before identifying the problem in question	0	0	2	22.2	1	11.1	3	33.3	3	33.33
Learners interpret words in the problem wrongly	0	0	2	22.2	0	0	4	44.4	3	33.3

Table 4.8 shows the teachers views on how learners interprets the word problems. The results show that teachers agree that learners have difficulties in comprehending the word problems that is cannot interpret the statement given correctly and also work out the word problem without identifying what is required of them.

Caldwell and Goldin (1979), explained that comprehension difficulties arise when children cannot imagine the context in which a word problem is set or their approach is altered by the context in which the word problem is given. This was seen from test item one, where learners were not able to comprehend and solve a given word problem. All the learners in the study were not able to solve the problem due to poor comprehension skills, they misunderstood the terms. This was supported by the teachers' responses on how learners interpret word problems in table 4.8.

From table 4.8, a majority of the teachers (77.7%) agreed that learners understood word problems wrongly which made them unable to solve the problems correctly. Students would solve the problem if they had translated the problem into personal and meaningful vocabulary. This was pointed out by Hollunder (1990) that solving word problems can be enhanced when the reader attempts to increase his/her comprehension through translating the language of the text into personal and meaningful vocabulary at their comprehension level. The study also attempted to find out whether the learners were given time to solve problems in class and the results were as shown in table 4.7. The findings also showed that learners who did word problems more often in class were represented by 57.9%.

Apart from working out the problems, the learners were also allowed to read the word problems. There was a fair distribution on learner involvement in reading through word problems in class. However, a larger percentage agreed that their mathematics teachers gave them time in class. This was represented by 61.1%, indicating that there is student involvement. Results obtained showed that learners have difficulties in comprehending word problems as seen in table 4.7. The information is supported by the teachers' views as shown in the Table 4.8. A majority of the teachers indicated that learners have difficulties in comprehending word problems. This shows that students' difficulties in comprehending word problems affects their ability to solve such problems leading to poor performance. The findings agree with (Clarkson, 1992) that students reading ability is an important factor to success in mathematics. The research also showed that performance in mathematics word problems are strongly related to performance in comprehension. This is also supported by Fluentes (1998), that fluent technical reading ability increases solving word problems skills.

The study also sought to find whether students interpret the statements given correctly before writing mathematics expressions. Table 4.8 shows that those who agreed and strongly agreed took a slightly higher percentage (77.7%) than those who disagreed. The results above are supported by figure 4.1

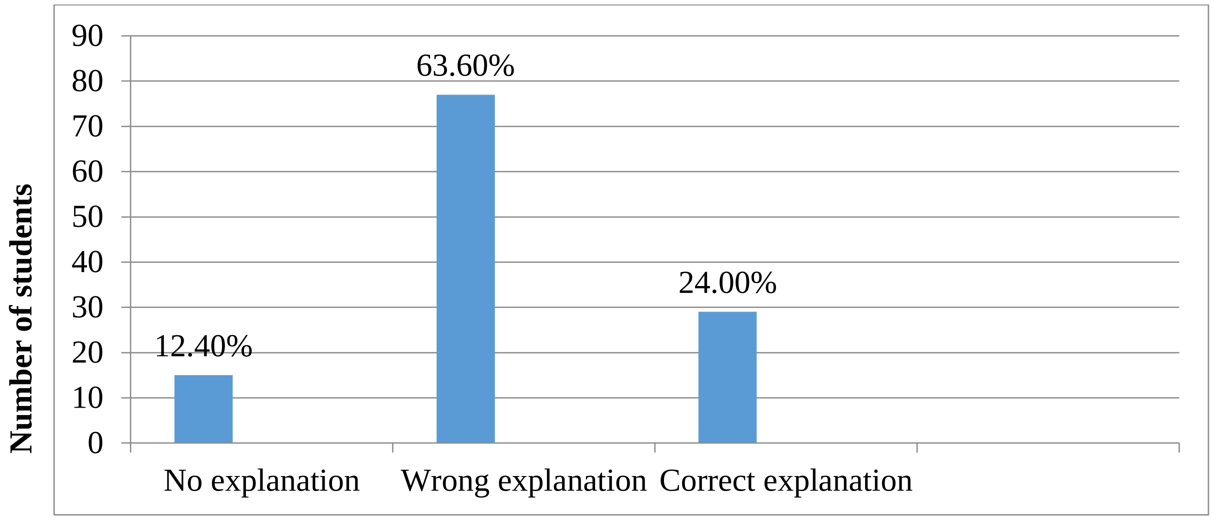

Figure 4.1 Students' Word Problem Explanation

Figure 4.1 was used to show learners representation on interpretation of word problems. A majority of the learners explained the word problem given although most of them gave wrong interpretation. This indicates that students attempted to solve word problems but there were difficulties in finding solutions arising from comprehension of mathematical words employed. Parantham et al (2013) supports the above information that students have difficulties in understanding keywords appearing in problems, thus cannot interpret them in a mathematical sentence. Making a wrong or failing to give an interpretation on the understanding of the word problem leads to wrong solutions.

The attitude towards the word problems was also tested and this was summarized in table 4.7. Those who disagreed that they disliked word problems were eighty-two students representing 67.8 %. This showed that most of the students have a positive view towards word problems indicating inexistence of attitudinal challenge that could have led to poor comprehension. The research determined further whether the students read word problems in examinations and their responses also indicated that learners have a positive attitude towards word problems. Ninety-seven students disagreed that they don’t read word problems in an examination representing 80.2 %. This confirms the positive view of the learners towards mathematics word problems (MWPs). The findings indicated that majority of the learners read through word problems in an exam and therefore reading is not an issue but comprehension is a challenge in the application of mathematics solving skills in word problems.

4.4.2. How Interpreting of Operational Terms Influence Students Ability to Solve Mathematical Word Problems

The second objective sought to establish the influence of interpreting operational terms used on students’ ability to solve word problems. The research question was “what is the influence of interpreting operational terms used on student’s ability to solve mathematical word problems?” Mathematics is a language just like other languages since it has its terms that have different meanings from those in English. It also has terms that are not used in the English like logarithm and hypothenuse.

Table 4.9 Students View on Influence of Operational Terms and Solving Word Problems

Statements on students view on operational terms in word problems	SD		D		NS		A		SA	
	F	%	F	%	F	%	F	%	F	%
It is difficult to assimilate familiar words into correct mathematical concepts	7	5.8	6	5.0	14	11.6	51	42.1	43	35.1
The terms used in word problems are difficult therefore I cannot construct meaning of the word problem	18	14.9	24	19.8	9	7.4	42	34.7	28	23.1
Some mathematical vocabularies do not exist in the English vocabulary	43	35.5	31	25.6	15	12.4	22	18.2	10	8.3
Some English words have different meanings in mathematics	27	22.3	21	17.4	13	10.7	37	30.6	23	19.0
Teacher defines mathematical terms in class before answering a question	14	11.6	11	9.1	4	3.3	38	31.4	54	44.6
Mathematics teacher gives us time to define every term in a word problem before solving	23	19.0	19	15.7	5	4.1	41	33.9	33	27.3
Words and their relevant mathematical meaning are provided in class inform of charts	59	48.8	34	28.1	7	5.8	13	10.7	8	6.6

Table 4.9 represents information on how operational terms are interpreted in class in the process of solving mathematics word problems. The items presented were used to collect information from the learners on interpreting operational terms in the word problem, assimilating familiar words into correct mathematical concepts and whether they recognize that some English words means differently in mathematics. In order to find the influence mathematics language has on solving word problems, the first item

asked whether it was difficult to change familiar words to represent mathematics concepts.

From the findings, 77.2% learners agreed that it is difficult to assimilate familiar words into correct mathematics concepts. This indicates that most learners did not understand English terms used when mathematics content is delivered. It agrees with Anghileri (1995) who points out that problems arise when attempting to provide a meaningful context to mathematical terms having different meanings in everyday language. The choice of words in mathematics remains the same which means there will be perpetual poor comprehension hence deficiency in problem solving. Findings also indicates that terms used are difficult causing a challenge to learners' comprehension skills of the word problems in essence making it difficult to compute a complex arithmetic word problem. It is also noted that most learners were aware that the meaning of vocabularies in mathematics can be found in the English dictionary, implying that mathematical vocabulary does not influence solving of word problems correctly but rather the specific mathematical expressions it represents.

Apart from finding meaning of mathematical terms from the dictionary, the research also sought to find whether the learners were conversant with English terms having different meanings in mathematics. Findings indicates that most learners do understand that there are English terms that mean differently in mathematics but they were not used to English words that meant differently in mathematics. It agrees with (Rubenstein. 2007) that mathematical vocabulary can be difficult to learn and remember because of how the words are used in everyday English which often, contrast with how the words are used in mathematical language. Learners showed that when dealing with word problems they take the literal meaning of terms rather than translating the words mathematically. This could be one of the causes of poor understanding that could lead to inability to solve word problems. Terms used in mathematics need to be explained mathematically for the learners to understand.

Table 4.10 Teachers View on Operational Terms Solving Word Problems

Statements on teachers' view on operational terms in word problems	**SD**		**D**		**NS**		**A**		**SA**	
	F	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
Definitions on new terms in every topic are given to the learner	1	11.1	1	11.1	2	22.2	3	33.3	2	22.2
Mathematical vocabularies and their definitions are available either in class in form of charts	3	33.3	4	44.4	1	11.1	1	11.1	0	0
Before finding solutions, definition of terms is always done by students	2	22.2	3	33.3	1	11.1	2	22.2	1	11.1

Table 4.10 presents information from the teachers' point of view on interpreting operational terms. Findings indicates 55.6% of the teachers disagreed that definitions are by the students. Responses from the students view on who does definition of operational terms were; 76% agreed that definition of terms were done by the teachers while 61.2% agreed that definitions were done by the students. We can conclude that definitions of terms were more of teacher centered. Therefore, students could not master the terms which were to be applied in word problems. This means lack of leaner involvement (heuristic learning) limits comprehension of mathematical sums hence poor problem solving of word problems. Mcconell (2008) asserts that when students are directly instructed to use the language of mathematics in many ways, they

develop better understanding of mathematical concepts and solving word problems becomes easy.

Further, the study sought to establish from the students whether they were given time to define operational terms in a mathematics word problem. Findings indicates that a majority of the learners define terms in class represented by 60.2%. This shows that learners were involved in definition and application of mathematical terms before solving a problem. Even though the learners were involved in defining terms, there is still a challenge as explained by Sepeng and Madzorera (2014) that learners struggled with defining algebraic terms used in the word problems. Their way of defining terms is presented in figures 4.2 and 4.3 respectively.

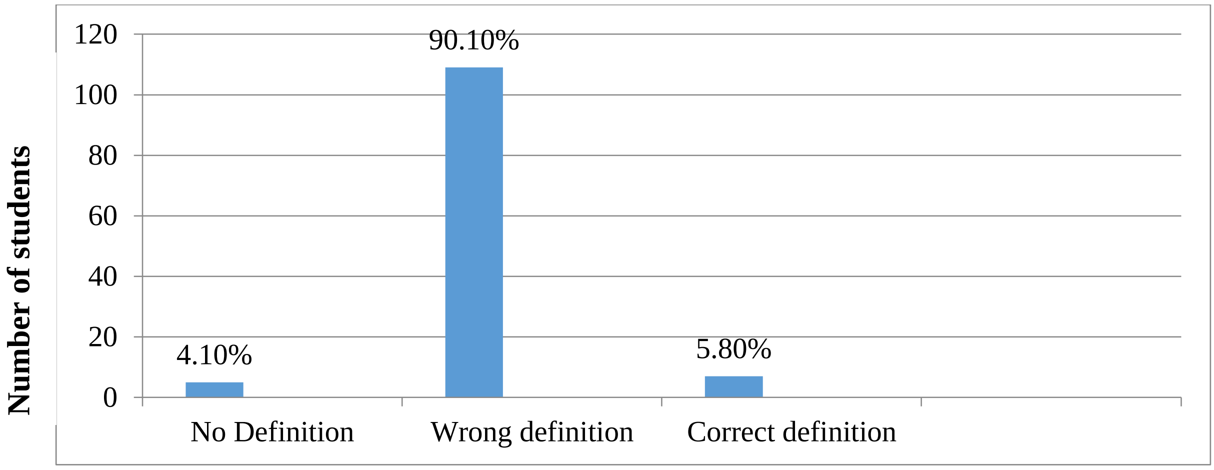

Figure 4.2 Students' Definition of Sum

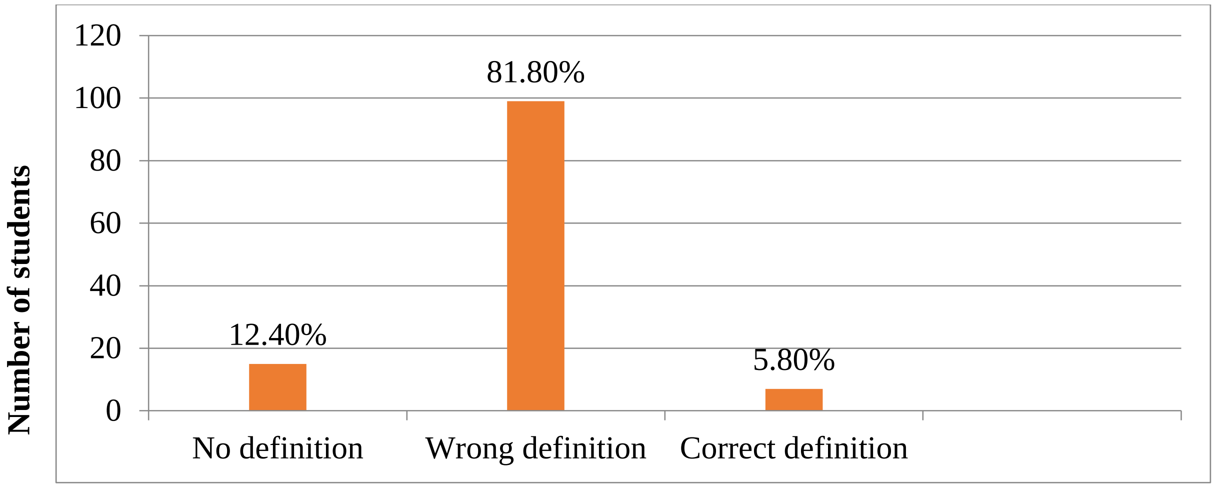

Figure 4.3 Students’ Definition of Product

Definition of terms was also tested in the word problem test to support the information obtained from the questionnaires. The data was supported by Figure 4.2 and 4.3 showing the distribution of how learners defined the terms sum and product respectively. It is observed that a majority of the learners attempted to define the terms but most of them gave a wrong definition sum and product which were represented by 90.10% and 81.80% respectively. From the above, learners tried to define terms but they failed to give correct definitions. It is deduced that the teacher’s strategy of not defining operational terms at the learner’s pace, negatively affected their comprehension skill and thus problem solving.

4.4.3 Effects of Writing of Mathematical Expressions on Students Ability to Solve Mathematical Word Problems

The third research objective sought to determine the influence of writing mathematical expressions on the students’ ability to solve mathematics word problems. The research question was “what are the effects of writing mathematical expressions to a student when solving word problems?” Solving a mathematics word problem cannot be done without writing a mathematical expression which represents the given word problem mathematically. The process of writing mathematical expressions is a very important step in solving mathematical word problems because it involves synthesizing the statements given which requires changing of words into mathematics symbols.

According to the learner, terms used in mathematics were difficult to understand. The study sought to find out the effects of leaners' ways of writing mathematical expressions in solving word problems. Results on the fact that identifying mathematical operations in a word problem were difficult, are shown in Table 4.11.

Table 4.11 Responses on Effects of Writing Mathematical Expressions on Students Ability to Solve Word Problems

Statements on the effects of writing mathematical expressions on students' ability	SD		D		NS		A		SA	
	F	%	F	%	F	%	F	%	F	%
Identifying a mathematical operation in a word problem is very difficult	16	13.2	18	14.9	5	4.1	51	42.1	31	25.6
Writing a mathematical expression from a word problem is challenging	9	7.4	9	7.4	6	5.0	54	44.6	43	35.5
Order of operation in a word problem is confusing	7	5.8	9	7.4	6	5.0	56	46.3	43	35.5
Our teacher gives us time to identify mathematical operations in a word problem	13	10.7	13	10.7	8	6.7	50	41.3	37	30.6
Words and their relevant mathematics symbols are provided in class in form of charts	62	51.2	34	28.1	5	4.1	9	7.4	11	9.1
We do group discussions to come up with mathematical expressions	21	17.4	15	12.4	3	2.5	31	25.6	51	42.1

Table 4.11 summarizes the responses on writing of mathematics expressions on whether learners were able to write mathematics expressions, identify mathematical operations in a word problem or had group discussion s for mathematics word problems. From the data, the responses were fairly distributed. However, more students pointed out that identifying mathematical operations in a word problem was difficult. This was represented by 67.7 %, indicating that most of the students were not able to identify the operation to be used when solving word problems therefore could not form correct mathematical expressions worth solving. This could be one of the reasons as to why most learners were not able to solve word problems. The information above was supported by the teachers view in Table 4.12.

Table 4.12 Teachers View on the effects of Writing of Mathematical Expression on the Students to Solve Mathematical Word Problems

Statements on effects of writing of mathematical expressions on student's ability	SD		D		NS		A		SA	
	F	%	F	%	F	%	F	%	F	%
It is difficult for a learner to identify mathematical operation in a word problem	0	0	1	11.1	1	11.1	5	55.5	2	22.2
It is very difficult for a learner to write a mathematical expression	0	0	1	11.1	1	11.1	4	44.4	3	33.3
Most learners do not carry out order of operation correctly	0	0	2	22.2	1	11.1	3	33.3	3	33.3
Mathematical words and their relevant mathematical symbols are provided in class in form of charts	2	22.2	2	22.2	0	0	4	44.4	1	11.1
Students are involved in writing mathematical expressions in groups	1	11.1	2	22.2	1	11.1	4	44.4	1	11.1

According to table 4.12, a majority of the teachers agreed that it was difficult for a learner to identify mathematical operations in a word problem and this was represented by 77.8%. This implied that a larger percentage of the learners were not able to identify mathematical operations in a given word problem.

The study further sought to find whether writing mathematics expressions from a word problem was challenging to learners. It was realized that there was a slightly higher distribution for those who agreed that is 80.1% of the students have challenges in writing mathematical expressions. This could be the cause of learners' inability to solve word problems which is precisely caused by inability to comprehend the prerequisite applicable mathematical expressions as viewed by (Yeo, 2009). Some students have slow progress in solving the word problems due to inability to translate problem into mathematical form. The teachers view on writing mathematical expressions indicate that almost all the teachers agreed that it is very difficult for a learner to write a mathematical expression. The above observations are supported by the results on wring mathematical expressions in the questions on the achievement test as shown in the figures below. There were three categories of word problems leading to three categories of mathematical expressions from the word problems. The first mathematical expression involved a sum. Students' performance is represented in Figure 4.4

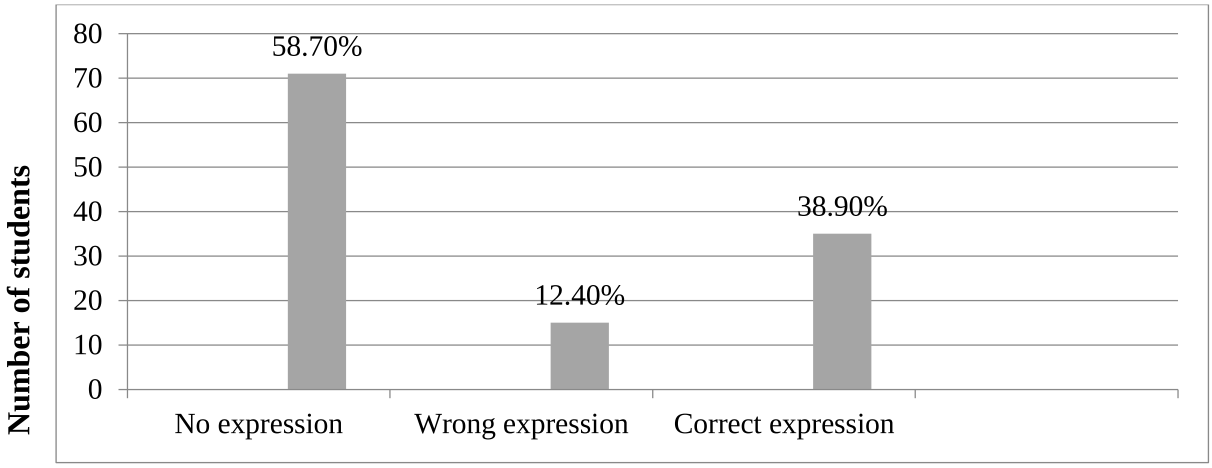

Figure 4.4 Students' Expressions for Sum

Figure 4.4 shows the distribution of how the students performed in the mathematics word problem test in the question involving sum. A majority of the students were not able to write an expression because they could not deduce what was required of them so as to put it into mathematical expressions. Only 38.9% of the students were able to write correct mathematical expression that involved addition meaning not more than 38.9% will solve the problem correctly. Students' distribution on solving the problem is presented below.

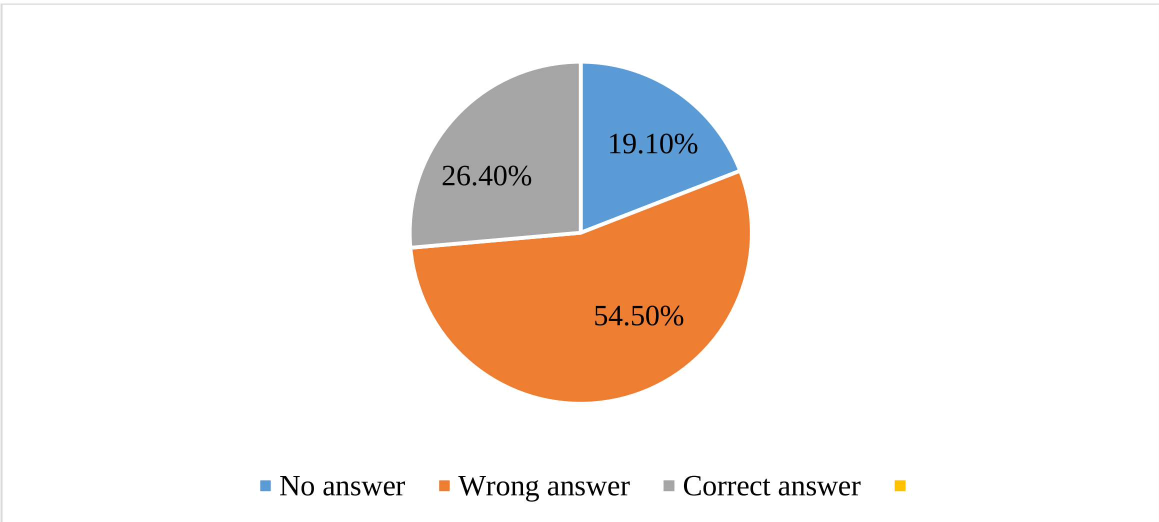

Figure 4.5 Percentage Distribution on Answers for Worded Problems Involving Sum

Figure 4.5 shows the distribution of how the learners solved the word problem involving addition. 19.1% did not write the expression and thus were not able to solve the word problem. 54.5% and 26.4% represented those whose answers were incorrect and correct respectively. This shows that finding a correct answer is dependent on writing correct mathematical expression although, 12.5% could not be accounted for, but this could be attributed to wrong order of operation. Another category of mathematics expression involved multiplication. Students' performance in writing the expressions are presented in the figure below.

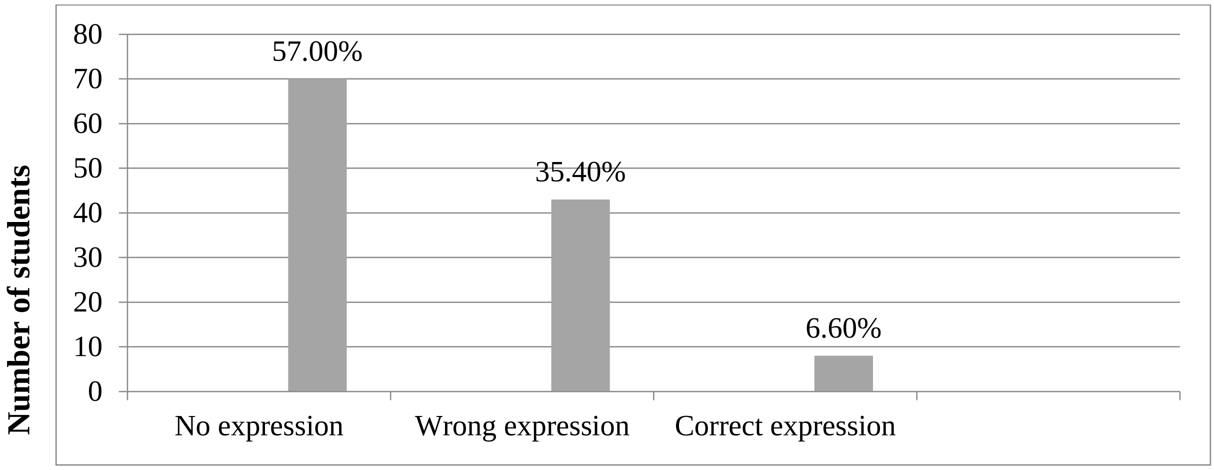

Figure 4.6 Students Expressions Involving Product

Figure 4.6 shows the distribution of how the students wrote mathematical expression involving multiplication in the mathematics word problem test. A majority of the learners were not able to write mathematical expressions involving product, followed by those who wrote wrong expressions. Very few learners were able to write correct mathematical expressions. It was observed that writing expressions involving addition was fairly done compared to writing expressions involving multiplication. Finding answers on the word problem involving product is illustrated in Figure 4.7.

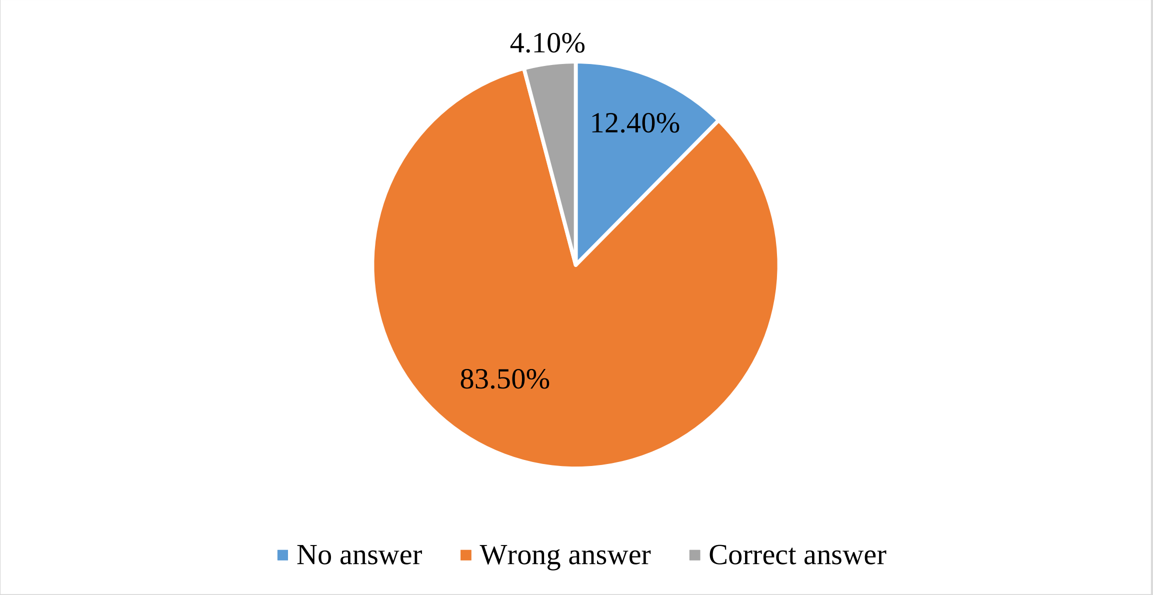

Figure 4.7 Students Distribution on Answers Involving Product

The figure illustrates the answers given by students on word problems involving multiplication. A majority of the learners gave wrong answers followed by those who could not solve the word problem and the least were those who gave correct answers. Writing mathematical expressions involving product was more challenging as compared to expressions involving sums which made the leaners unable to solve problems involving product as evident above. This was due to poor comprehension hence inability to solve the word problem. The last category was represented by word problems with compound statements as shown in Figure 4.9

Findings from the study indicate that the order of operation in a word problem confused the learners. From table 4.11 a larger percentage of learners agreed that the order of operation in word a problem was confusing. Those who agreed were 81.8% which is an indication that order of operation contributed to confusion resulting to slow understanding of order of operation leading to inability to solve the mathematical word problems. A majority of the teachers strongly agreed and also agreed that most learners do not carry out order of operation correctly. 66.6 % of the represented teachers confirmed that most learners do not carry out order of operation correctly, therefore, contributes to inability to solve mathematical word problems.

The students were asked whether they were given time to identify mathematical operations in a word problem. Results from the study shows that a number of students agreed that teachers gave them time to identify mathematical expressions in a word problem.41.3% agreed and 30.6 % strongly agreed that they are given time to identify mathematics operations in a word problem. This indicates that learners participate in identifying mathematical operations in word problems. For this reason, it is realized that word problem lesson is student centered therefore student participation is not a factor to inability to identifying mathematical operations.

The study sought to find whether words and their relevant mathematics symbols are provided in class in form of charts. Findings indicate that a majority of the learners asserted that words and their relevant mathematics symbols were not provided in class in form of charts. The findings also indicate that79.3% of the learners disagreed, showing that mastery of words and their relevant mathematical symbols is poor due to lack of exposure to the terms and therefore causing a challenge in writing mathematical expressions leading to inability to solve the word problems. Findings also shows that some of the teachers provide mathematical words and their relevant mathematical symbols while others do not. 55.5% claim to provide mathematical words and their relevant mathematical symbols in class only during the lesson on the board but not inform of charts. This is supported by the majority of the students who claimed that charts were not provided. it indicates that a majority of the learners were not provided with mathematical words and their relevant mathematical symbols which could be a contributing factor to inability to solve mathematical word problems correctly as supported by (Bardillon, 2016) that ability to solve worded problems depends on how the students translate phrases into mathematical symbols.

It was also imperative to the study to find out whether learners were involved in writing mathematical expressions. A majority of the learners strongly agreed that they carried out group discussions to come up with mathematical expressions. This was represented by 42.1% while 16.8% agreed, an indication that most of the lessons on word problems were learner centered, making learners internalize the steps better than teacher centered lessons. Group discussions may not be an interventional strategy to comprehension of mathematical word expressions because they already exist yet the challenge persists. From the above information, learners should be able to write correct mathematical expressions because they are involved through group discussions but that was not the case in the achievement test. Most of the learners could not write correct mathematical expressions. The figure below illustrates the total percentage scored by the learners on the mathematics word problem test.

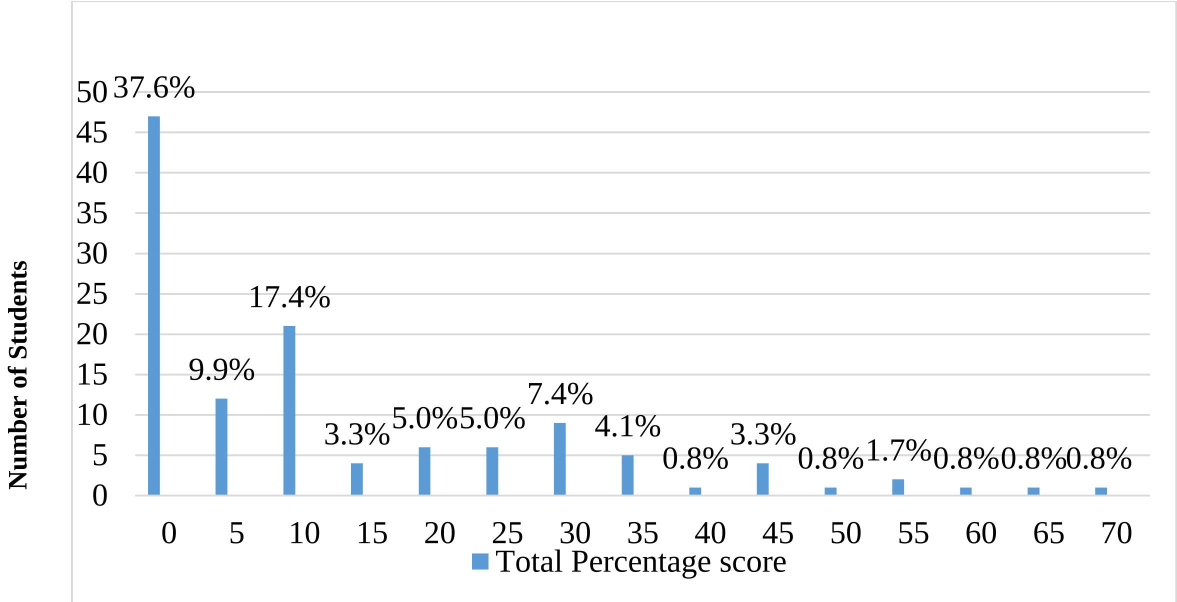

Figure 4.8 Total Percentages Scored by Learners in Word Problem Test

Figure 4.8 shows the overall percentage scored by the students in the mathematical word problem test. From the figure, students performed poorly in mathematics word problem test as indicated by 37.6% scoring zero. This is an indication that there were challenges in solving mathematical word problems.

The findings show that a majority of the students were not able to interpret a mathematical word problem correctly. Some were not able to explain their understanding as it was seen that they did not give any explanation in the mathematics test. From the data, 12.4% did not provide an explanation for the interpretation, while 63.6% had wrong explanation implying that the interpretation was done wrongly. It can therefore be deduced that students have poor comprehension skills in MWPs. Findings also show that students were not able to correctly define mathematical terms given. A majority of the learners attempted definitions for sum as compared to definitions for product.

Most learners were not able to define the terms correctly implying that the terms used were not understood and therefore caused wrong interpretation for the word problem. The findings also indicated a majority of the learners were not able to write correct mathematical expressions involving sum. However, 28.9% of the students were able to write a correct expression. Findings also show that even though 58.7% of the learners did not write an expression, they were able to give answers for the word problems. A few of the learners were not able to find an answer for the problem given. Students who were able to write correct expressions were 28.9% but those who got the correct answer were 26.4%. The difference represents learners who were not able to apply correct order of operation. Leaners who got wrong answers were 54.5%

representing learners who wrote a wrong expression and those who did not have a mathematical expression but carried out some calculations in the problem.

Comparing mathematical expressions involving sum and product, it is seen that a majority of the students were not able to write an expression but a greater number of students were able to write correct expression involving sum represented by 28.9%, while those who were able to write correct expressions involving the product were 6.6%. Students were able to handle word problems involving sum better than word problems involving product. Those who got correct answers for the word problem involving product were 4.1%. The difference between percentage of correct expressions and correct answers on word problems involving product was 2.5%. The difference was due to inability to follow correct steps in the order of operation.

From figure 4.8, a majority of the students scored zero (37.6%), the score was contributed by inability to comprehend the word problems. Poor understanding of the terms used and inability to write correct mathematical expressions led to inability to solve word problems correctly. It can be seen that the distribution of scores is almost positively skewed, the scores obtained by students were from word problems involving sum from simple mathematical statements. Otherwise, the inability to get high scores was contributed by learners’ inability to solve some word problems involving products and relational statements. From figure 4.8, it can be concluded students are facing great difficulties in comprehension skills which lead to inability to solve some word problems involving products and relational statements. It can also be concluded students are facing great difficulties in comprehension skills which leads to poor interpretation of the word problems; inability to understand mathematical terms used and difficulties in writing correct mathematical expressions. All contributes to students' inability to solve mathematical word problems correctly, hence poor performance in mathematics.

Njoji and Mukaka (2016), reveals the same information that pupils lack pre-requisite knowledge, conceptual, procedural and strategic knowledge skills required for solving linear equations. In the constructivist theory, learners construct their own knowledge from past learned experiences. Word problems are solved using the learned experiences in mathematics content introduced at the beginning of every topic. Steps in solving word problems requires comprehension and understanding of mathematical terms already learned but it is revealed that leaners are not able to apply those concepts. The study supports the theory that if students were able to construct meaning in MWP by applying what was already taught, there would be no difficulties in solving MWPs.

4.4.4 Strategies Adopted to Improve Performance in Solving Mathematical Word Problems

Strategies that could be put in place in order to improve solving of mathematical word problems were presented to the learners in form of questions. The first question asked the respondents whether they explain mathematical terms before solving any mathematical problem. The table below shows the responses obtained.

Table 4.13 Students' Responses on Strategies Adopted to Improve Performance in Solving Mathematical Word Problems

Statements on strategies adopted to improve performance in word problems	SD		D		NS		A		SA	
	F	%	F	%	F	%	F	%	F	%
We explain mathematical terms before solving any mathematical problem	9	7.4	10	8.3	9	7.4	53	43.8	40	33.1
We formulate our own word problems and solve them in class	29	24.0	28	23.1	8	6.6	38	31.4	18	14.9
We use concrete objects and models in order to solve problems	43	35.5	34	28.1	8	6.6	24	19.8	12	9.9
We experiment word problems in class using demonstration	47	40.5	24	19.8	9	7.4	20	16.5	19	15.7
Resources like models are available in school	47	38.8	25	20.7	13	10.7	23	19.0	13	10.7
We have mathematics room where mathematics models and charts are kept	73	60.3	33	27.3	9	7.4	2	1.7	4	3.3

Table 4.13 shows a summary of students' responses on strategies adopted to improve performance in mathematics word problems. Items were used to draw information form the teachers and learners on the approaches adopted in order to improve solving of mathematics word problems. According to Table 4.13, 76.9% of the responses agreed that they explained mathematical terms before solving any mathematical word problem. This is an indication that learners are involved in defining mathematical terms before solving a problem. It is seen that teaching methods in mathematics word problems should be learner centered. From the table above, a majority of the learners agreed that they formulated their own word problems and solved them in class.

Table 4.14 Teachers' View on Strategies Adopted to Improve Performance in Word Problems

Statements on strategies adopted to improve performance in word problems	SD		D		NS		A		SA	
	F	%	F	%	F	%	F	%	F	%
Learners formulate their own word problems and solve them	2	22.2	2	22.2	1	11.1	3	33.3	1	11.1
Concrete objects and models are always used when solving word problems	1	11.1	3	33.3	2	22.2	3	33.3	0	0.0
Simulation guided by a teacher is done in class when a problem is not understood	0	0.0	3	33.3	3	33.3	0	0.0	3	33.3
Mathematics resources and models are available in school	1	11.1	3	33.3	0	0.0	4	44.4	1	11.1
The school has a mathematics laboratory/room where a student can practice word problem solving	7	77.7	1	11.1	1	11.1	0	0.0	0	0.0

Table 4.14 shows teachers' responses on strategies adopted to improve solving of mathematics word problems. Findings shows a fair distribution in teachers' views on learners' ability to formulate their own word problems and solve them. The study further asked the respondents whether concrete objects and models were used to solve word problems. Findings shows that 63.6% of the learners disagreed on the use of concrete objects and models to solve word problems. This was an indication that in the process of solving word problems, models and concrete objects are rarely used. As evident, leaners exposure to real objects is minimal hence reducing comprehension capability and as a result affects mathematical problem solving. A majority of the teachers also indicated that concrete objects and models were not used when solving MWP.

Apart from using models in solving word problems, demonstrations could be performed to enable learners understand word problems. The study sought to find whether demonstrations were done in class and respondents agreed in both tables (4.13 and 4.14). From the findings 60.3% of the learners disagreed that they experimented word problems in class using demonstration. It is an indication that demonstrations on word problems were not performed. This strategy of practical teaching which lacks in the table above affects internalization of mathematical word expressions. It reduces leaners prowess in solving mathematical word problems. From the findings, models and concrete objects were not used in order to solve word problems.

The study sought to find whether models were available in school and majority of the learners disagreed that objects and models were available representing 59.5 %. This implies that a majority of the schools have not acquired mathematics models and relevant objects that could enhance understanding of mathematics problems. This is supported by 12.6% of the learners who were not sure whether models are available in school or not indicating that they have never seen them. Teachers' views on availability of models in various schools showed a fair distribution where 55.5% said that there are resources and models in schools while 44.4% disagreed. This indicates that approximately half of the teachers have models in their schools but majority of them do not use when teaching mathematics. The rest do not have, thus affects content delivery in mathematics leading to poor performance. Finally, the study sought to find whether schools had mathematics rooms where mathematics models and other resources are kept. Findings shows that 87.6% of the learners disagreed that there is a mathematics room where mathematics models and charts are kept. This indicates that there are no mathematics rooms that can be used to store models or mathematics resources. This shows that resources acquired or teaching aids prepared did not have a place to be stored and therefore students could not refer to them. Unavailability of these vital rooms has reduced leaners accessibility to learning resources that could enhance independent learning and research. This has a negative impact on learner's ability to formulate and solve mathematical problems on their own.

Findings also shows that, a majority of the teachers strongly disagreed that their schools have a mathematics room. This is represented by 77.8% which leads to a conclusion that there were no models and charts in most schools and if they were available, to locate where they were kept was difficult. Learners were also asked to comment on how they could improve the process of solving mathematics word problems. The data collected from the open-ended questions were grouped in terms of opinions given and summarized and presented as percentages. Students who explained that they did not comprehend the word problems therefore could find solutions were 21.1% while 20% suggested that if exposed to more practice on word problems, they would improve their performance in mathematics however 16% had no comment. The remaining percentage represented those who had varying opinions which can be adopted to enable them improve the process of solving word problems. The opinions included: availing learning resources or being assisted in every step of solving word problems. Some had given up because they had a view that word problems are difficult. The other reason was that word problems were confusing, challenging and thus suggested that word problems be done in groups.

4.5 Inferential Statistics

4.5.1 Students' Questionnaire

In order to achieve the three objectives, the results from the students' questionnaire were regressed. The study aimed at assessing the composite and relative contributions of the three factors considered in this study to be influencing solving of mathematics word problems. Tables 4.15, 4.16 and 4.17 depict the summary of multiple regression analysis.

Table 4.15 Multiple Regression Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
.426[a]	.182	.161	.81396

Predictors: (Constant) learners' reading and comprehension skills, interpretation of operational terms, learners' writing of mathematical expressions

Dependent variable: solving mathematics word problems

According to Table 4.15, the multiple correlation coefficients R had a value of 0.426. Multiple R is the correlation between the observed values of dependent variable and the value of dependent variable predicted by the multiple regression models. Therefore, the large value of R (0.426) meant there was a positive correlation between the predicted and observed values of the level of solving mathematical word problems. As such, multiple R is a gauge of how well the model predicts the observed data.

The coefficient of determination R^2 which is the proportion of variance in the dependent variable that can be explained by the independent variables was found to be 0.182 implying that 18.2% of variance in the solving mathematical word problems was explained by learners' reading and comprehension skills, mathematical vocabulary and learners' writing related questions. Further, the adjusted R^2 value of 0.161 means that 16.1% of variance in solving mathematical word problems could be accounted for if the model has been derived from the population from which the sample was taken.

Table 4.16 Multiple Regression Model significance (ANOVA)

Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	17.192	3	5.731	8.650	.000[b]
	Residual	77.517	117	.663		
	Total	94.709	120			

df*: Degree of freedom.

Table 4.16 shows the analysis of variance (ANOVA) output. The *F*-ratio in the ANOVA table tests whether the overall regression model is a good fit for the data. That is, the ANOVA shows whether the model, overall, results in a significantly good degree of prediction of the outcome variable. The table shows that the joint independent variables statistically significantly predict the dependent variable, F (3, 117) = 8.650, p <0.05 and that other variables not included in this model may have accounted for the remaining variance. In other words, the regression model was a good fit for the data.

Table 4.17 Summary of Multiple Regression Model Coefficients

Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	Std. Error	Beta		
1	(Constant)	.873	.338		2.585	.011
	Learners' reading and comprehension skills	.178	.087	.183	2.052	.042
	Mathematical vocabulary	.180	.081	.195	2.219	.028
	Learners' writing	.189	.081	.213	2.319	.022

Table 4.17 reveals the relative contribution of the three independent variables to the dependent variable, expressed as beta weights. The regression model capturing the hypothesized relationship was as follows: Y= β_0+ β $_{1\times1}$+$\beta_{2\times2}$+ $\beta_{3\times3}$+ε, where y = Solving mathematical word problems, x_1 = Learners' reading and comprehension skills, x_2 = interpreting operational terms x_3 = Learners' writing of mathematical expressions, while ε is the error term. Assuming the error term ε to be zero and substituting the unstandardized coefficients β values, the estimated multiple regression equation becomes:

$Y = .873 + .178X_1 + .180X_2 + .189X_3$.

According to the regression equation established, taking all factors constant at Zero, the level of performance in mathematics was 0.873. The constant β_0 value of 0.873 shows that if all the investigated predictors were assumed not to have significant influence, solving mathematical word problems would be influenced by a factor of 0.873 by other predictors. The β values indicate the individual contribution of each predictor to the model if the effects of all other predictors are held constant. In other words, the β values show the relationship between solving mathematical word problems and each predictor. Therefore, holding other factors constant, learners' reading and comprehension skills will improve solving mathematical word problems by 0.178 units, while mathematical vocabulary will improve solving mathematical word problems with 0.180 units similarly learners' writing of expressions will improve solving mathematical word problems with 0.189 units.

In order to have a direct evaluation and better understanding of significance of predictors, the standardized β values that do not depend on the units of measurement of variables were used. The standardized β values give the figure of standard deviations that the effect would vary as a result of one standard deviation change in the predictor. Consequently, table 4.17 shows that all the independent variables had a positive impact on solving mathematical word problems. This shows that if more practice by the students on the independent variables, that is, learners' reading and comprehension skills, interpreting operational terms and learners' writing of expressions, could lead to an improvement in solving mathematical word problems. Table 4.17 indicates that learners writing of mathematical expressions had the highest influence in solving mathematics word problems (β_3 = .189; t = 2.319, $p < 0.05$), followed by learners writing of mathematical expressions (β_2= 0.180; t = 2.219, $p < 0.05$) and learners reading and comprehension skills was the least influencer (β_1=.178; t = 2.052, $p < 0.05$)

4.6 Summary

In this chapter, the data was collected through: Questionnaires and mathematics word problem test. This data was presented, analyzed and interpreted in reference to the research objectives using tables, figures and discussions. In terms of mathematics concepts, it was observed that most learners in all school categories have difficulties in comprehension of mathematical word problems, interpreting operational terms and writing of mathematical expressions which had a relative influence on solving mathematical vocabulary. From the mathematics word problem test, it was noted that interpretation of operational terms and writing of mathematical expression were the major factors that affected solving mathematics word problems. From the regression model $Y = .873 + .178X_1 + .180X_2 + .189X_3$, it is concluded that solving mathematics word problems was majorly affected by inability to write mathematical expressions correctly. Discussions, conclusions and recommendations of the findings are presented in the next chapter.

CHAPTER FIVE

SUMMARY OF THE FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The purpose of the study was to determine the students' difficulties when solving mathematical word problems in secondary schools. The study used questionnaires and mathematics test to collect the required data. The results of the study were coded analyzed and presented in chapter four. This chapter discusses the summary of the research findings, recommendations and suggestions for further research.

5.1.1 Summary of the Findings

The study focused on the student's difficulties when solving mathematical word problems. The study was guided by the following objectives: to determine the effects of student's comprehension skills in solving mathematical word problems; establish the influence of mathematical operational terms on the learners' ability to solve word problems and to determine the effects of students' writing of mathematical expressions when solving word problems.

5.1.2 Comprehension Skills and Solving Mathematical Word Problems.

In this study, the research question under investigation was "what are the effects of comprehension skills to students' ability in solving mathematical word problems". The findings indicate that students read through the word problems before they could attempt to solve them. A majority of the students were not able to comprehend word problems, while those who comprehended were unable to express themselves in the language of instruction. This agrees with the research done in Thailand by Pradhan et al (2013) that students were unable to figure out the necessary information required in order to solve the problem because they were hampered by poor comprehension skills. This is reiterated by the teachers as reported by their responses in the questionnaire. Regression model indicates that comprehension skills was not a major contributor to inability to solve MWPs

5.1.3 Interpreting Operational Terms on Students' ability to Solve Word Problems

The research question was "what is the influence of interpreting operational terms used on students' ability to solve word problems?" The findings in this study indicated that students have difficulties in assimilating familiar words into correct mathematics concepts. This implies that the terms used in the mathematical word problems hindered students' comprehension leading to inability to solve them. It was noted that although majority of the students were aware that meanings of mathematics terms could be found in the English dictionary, they did not refer to it, therefore, the understanding of the terms was limited. On the other hand, students who possessed a dictionary could refer to it but could not master the terms because understanding them was not a priority to teachers since they did not make any follow up to check whether the students had mastered terms neither did, they provide their definitions in class. However, findings showed that defining the terms wrongly, did not affect writing of correct mathematical expressions.

It was discovered that learners understood the symbols of the terms but could not explain their meanings. This study is in agreement with Sepeng & Madzorera (2014) which revealed that learners struggled with defining algebraic terms used in word problems, it also concurs with Reys, Sydam & Lindquist (1995) who revealed that mathematical learning have a meaning and this is achieved by emphasizing on understanding the mathematics rather than memorizing. Students' poor understanding of the meanings of terms was illustrated when they gave wrong definitions but they were able to write correct expressions. The findings also showed that definitions of terms were done by the teacher and the learners used the terms only when a word problem is given, thus, definition of terms was not prioritized. From regression model, interpretation of operational terms was a major contributor to inability to solve MWPs.

5.1.4 Writing Mathematics Expression when Solving Mathematical Word Problems.

The research question was; "what are the effects of writing of mathematical expressions on the students' ability to solve word problems?" Findings in this study showed that students were involved in class when writing mathematical expressions from word problems and the process was done either in groups or individually. Learners did not have problems in identifying mathematical operations to be used. However, a majority of the learners indicated that they had difficulties in writing mathematical expressions. This was also seen in the test item where most of them could not write a mathematical expression and if they wrote, the expressions would be wrong.

From mathematics teachers' views, the learners had difficulties in identifying mathematical operations because of poor understanding of the terms used or misinterpretations of the questions given. A majority of the teachers reported that inability to derive the correct mathematical expressions from word problems was due to lack of practice and poor attitude towards mathematics, indicating that writing mathematical expressions was also not a priority. It also showed that the concept of word problems was not well introduced at the primary level. Further, if more practice was done, learners would be able to write correct mathematics expressions. From the regression expression, writing of mathematical expression was a contributing factor to inability to solve MWPs.

5.2 Conclusion of the Study

The study investigated students' difficulties when solving mathematical word problems in secondary schools in Tinderet sub-county. The findings from the study indicated that learners have poor comprehension skills which affect their understanding of the word problems. It was also realized that due to poor comprehension skills learners did not have the capability to solve mathematical word problems. It can be concluded that students' poor comprehension skills led to inability to solve mathematical word problems.

The findings also indicated that definitions of operational terms were teacher centered hence did not provide opportunities for learner participation in comprehension and mastery of definitions. It was therefore concluded that lack of student participation in definition of mathematical terms and problem-solving strategies led to inability to solve word problems. From inferential statistics, comprehension skills, interpretation of operational terms and writing of mathematics expressions affected solving word problems. However, from regression expression, writing of mathematical expressions took the highest unit. It can therefore be concluded that writing of mathematical expressions is a major contributor to inability to solve MWPs.

5.3 Recommendations of the Study

i. The study recommends that the school managements to look for ways of improving comprehension of mathematics operational terms.

ii. Mathematics teachers to present mathematics operational terms in form of charts and also create a mathematics room where these charts can be stored.

iii. The school managements to provide rooms which could be used as resource centers where learners could access all mathematics materials and practice mathematical concepts.

iv. The Teacher's Service Commission (TSC) employ more mathematics teachers so as to reduce the work load, which would provide adequate time for teachers.

5.4 Suggestions for Further Research

i. A study on the influence of information and communication technology (ICT) in solving mathematics word problems.

ii. The same study be done on difficulties students encounter in solving mathematics word problems in other counties.

iii. A study be done on the learners' difficulties in solving mathematics word problems in primary schools.

5.5 Summary

This chapter provides a summary of the findings on comprehension skills, interpretation of operational terms and writing of mathematics expressions as defined in the objectives, conclusions, recommendations of the study and suggestions for further research. Findings indicated that students' comprehension skills, interpreting operational terms and writing of mathematics expressions influenced solving of mathematics word problems. From regression model, writing of mathematical expressions influenced solving of mathematical word problems the most. The study gave three recommendations that school administration to look for ways of improving comprehension skills, mathematics teachers to provide definitions of operational terms in class and finally the TSC to employ more mathematics teachers to reduce their work load. The research suggested areas for further research; a study be done on the learner difficulties in solving mathematics word problems in primary schools, the same study be done in other counties and also a study on influence of ICT in solving mathematics word problems be done,

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APPENDIX I: QUESTIONNAIRE FOR STUDENTS

I am a master of education science (mathematics) student at the University of Eldoret currently pursuing my field study. The purpose of this questionnaire is to seek information from you concerning my study on "**Students' Difficulties When Solving Mathematical Word Problems."** I therefore as you to be part of this study to enable me achieve its objective. Kindly fill this questionnaire whose information shall be treated with confidentiality. The information obtained from you will be used for academic purpose only.

Thank you for participating in this study.

A: DEMOGRAPHIC INFORMATION

Please tick where appropriate

1. What is your gender?

   Male [ ] Female [ ]

2. What is your age bracket?

   16-17yrs [ ]

   18-19yrs [ ]

   Above 19yrs [ ]

3. What is the nature of your school?

   Boys school [ ]

   Girls school [ ]

   Mixed school [ ]

B: SPECIFIC RESEARCH QUESTIONS

Tick where appropriate using this rating scale: SA-Strongly agree, A-Agree, NS-Not sure, D-Disagree, SD-Strongly disagree.

To what extend do you agree with the following statements below? Use the above rating scale (SA, A, NS, D, SD) to answer questions I-IV

I: Effects of Comprehension Skills on Students' Solving Mathematical Word Problems.

Comprehension skills	**SD**	**D**	**NS**	**A**	**SA**
I read through the word problem to the end before interpreting.					
We often do word problems in class.					
Mathematics teacher gives us time to read through the word problem in class.					
I explain what is required in the word problem before finding a solution.					
I have difficulties in reading word problems.					
I dislike word problems.					
I don't read word problems in an examination.					

II: How Interpreting of Operational Terms used Influence Students Ability in Solving Mathematical Word Problems

Operational terms	SD	D	NS	A	SA
It is difficult to assimilate familiar words into correct mathematical concepts.					
the terms used in word problems are difficult therefore I cannot construct meaning of the word problem					
Some mathematical vocabularies do not exist in the English vocabulary					
Some English words have different meanings in mathematics.					
Teacher defines mathematical terms in class before answering a question.					
Mathematics teacher gives us time to define every term in a word problem before solving.					
Words and their relevant mathematical meaning are provided in class in form of charts.					

III: Effects of Writing Mathematical Expressions on Students Ability to Solve Word Problems

Mathematical expressions	**SD**	**D**	**NS**	**A**	**SA**
Identifying a mathematical operation in a word problem is very difficult					
Writing a mathematical expression from a word problem is challenging					
Order of operation in a word problem is confusing					
Our teacher gives us time to identify mathematical operations in a word problem					
Words and their relevant mathematics symbols are provided in class in form of charts.					
We do group discussion to come up with mathematical expressions.					

IV: Strategies Adopted to Improve Students' Performance in Solving Mathematical Word Problems

Strategies adopted	**SD**	**D**	**NS**	**A**	**SA**
We explain mathematical terms before solving any mathematical problem.					
We formulate our own word problems and solve them in class.					
We use concrete objects and models in order to solve problems					
We experiment word problems in class using demonstration.					
Resources like models are available in school.					
We have maths laboratory/room where mathematics models and charts are kept.					

Comments ....

....

....

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APPENDIX II: TEACHERS' QUESTIONAIRE

I am a master of education science (mathematics) student at the University of Eldoret currently pursuing my field study. The purpose of this questionnaire is to seek information from you concerning my study on "**Students' Difficulties When Solving Mathematical Word Problems."** I therefore as you to be part of this study to enable me achieve its objective. Kindly fill this questionnaire whose information shall be treated with confidentiality. The information obtained from you will be used for academic purpose only.

Thank you for participating in this study.

A: DEMOGRAPHIC INFORMATION

Please tick where appropriate

1. What is your gender?

   Male [ ] Female [ ]

2. What is your highest qualification

   Doctorate [ ]

   Masters [ ]

   Bachelors [ ]

   Diploma [ ]

   Certificate [ ]

3. Your working experience in the current position
   1. 1-5 years [ ]
   2. 6-10 years [ ]
   3. 11-15 years [ ]
   4. 16-20 years[ ]
   5. Above 20 years [ ]

B: SPECIFIC RESEARCH QUESTIONS

To what extent do you agree with the statements below on Mathematical word problems and performance in Mathematics?

Use this rating scale to answer questions I-IV. Given SA=Strongly Agree, A-Agree, NS-not sure, D-Disagree, SD=Strongly Disagree

I: Effects of Comprehension Skills on Solving Mathematical Word Problems Performance

Reading comprehension skills	**SA**	**A**	**NS**	**D**	**SD**
Learners have difficulties in reading and comprehending word problems.					
Learners find solutions to a word problem before identifying the problem in question.					
Learners interpret words in the problem wrongly.					

II: Influence of Interpreting Operational Terms used on Students ability to Solve Mathematical Word Problems

Operational terms	**SA**	**A**	**NS**	**D**	**SD**
New terms in every topic are given to the learners.					
Mathematical vocabularies and their definitions are available either in class walls/mathematics lab					
Before finding solutions, definition of terms is always done by students.					

III: Effects of Writing of Mathematical Expressions on Students Ability to Solve Word Problems

Mathematical expressions	**SA**	**A**	**NS**	**D**	**SD**
It is difficult for a learner to identify mathematical operation in a word problem.					
It is very difficult for a learner to write a mathematical expression.					
Most learners do not carry out order of operation correctly.					
Mathematical words and their relevant mathematical symbols are provided in class in form of charts.					
Students are involved in writing mathematical expressions in groups.					

IV: Strategies Adopted to Improve Students' Performance in Solving Mathematical Word Problems

Strategies adopted	**SA**	**A**	**NS**	**D**	**SD**
Learners formulate their own word problems and solve them.					
Concrete objects and models are always used when solving word problems.					
Demonstration guided by a teacher is done in class when a problem is not understood.					
Mathematics resources and models are available in school.					
The school has a mathematics laboratory /room where students can practice word problem solving steps.					

Comments ....

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APPENDIX III: MATHEMATICAL WORD PROBLEM TEST

SCHOOL ____________________CLASS______.

TIME: 30 MINUTES

Instructions to Students

Answer the questions below in the spaces provided showing your working in every step. **NOTE.** Explain your understanding in every step.

1. Kamau bought 4 planks of 2.5 m each. How many planks of 1 meter (m) can he saw out of these planks? (2 mks)
2. 445 Meteitei high school football fans will go to the stadium by bus. Each bus can hold 36 fans. How many buses will be needed? (2mks)
3. If the product of 2 and 4 is subtracted from twice a certain number the result is 22. a) Define the underlined word and explain the statement. (1mk)

   b) Find the number. (2mks)

4. If 12 is added to 7 times a certain number the sum is 250.

   a) Define the underlined word (1mk)

   b) Find the number. (2mks)

5. Jane bought a salad roll and a juice for lunch. The salad roll costs sh.24 more than juice and the total bill was sh.82.

   a) Explain the underlined statement. (1mk)

   b) How much did the salad roll cost? (2mks)

6. A turkey costs 5 times as much as a chicken. A farmer bought 20 turkeys and 50 chicken for sh 1200.calculate the price of one turkey. (3mks)
7. Otieno buys a pencil, a pen and a book for which he pays a total of ksh 531.If the price of the pen is twice that of a pencil and the price of the book is three times that of the pen. How much does each cost? (4mks)

APPENDIX IV: MATHEMATICAL WORD PROBLEM TEST MARKING SCHEME

SCHOOL ______________________CLASS______.

TIME: 30 MINUTES

Instructions to Students

Answer the questions below in the spaces provided showing your working in every step. **NOTE.** Explain your understanding in every step.

1. Kamau bought 4 planks of 2.5 m each. How many planks of 1 meter (m) can he saw out of these planks? (2 mks)

   Every plank produces 2 planks of 1m metre each

   $4 \times 2 = 8$ planks

2. 445 Meteitei high school football fans will go to the stadium by bus. Each bus can hold 36 fans. How many buses will be needed? (2mks)

   $\frac{445}{36} = 12.361111$ 1mk

   $13\ buses$ 1mk

3. If the product of 2 and 4 is subtracted from twice a certain number the result is 22.

   a) Define the underlined word and explain the statement. (1mk)

   it is a quantity obtained by multiplication of two or more numbers 1mk

b) Find the number. (2mks)

solution

let the number be x

$2\times x - 2 \times 4 = 22$

$2x - 8 = 22$ 1mk

$2x \quad = 30$

x = 15 1mk

4. If 12 is added to 7 times a certain number the sum is 250.

a) Define the underlined word (1mk)

solution

it is a quantity obtained by addition of 2 or more numbers 1mk

b) Find the number. (2mks)

solution

let the number be x

$7x \times +12 = 250$ 1mk

$7x = 238$

=34 1mk

5. Jane bought a salad roll and a juice for lunch. The salad roll costs sh.24 more than juice and the total bill was sh.82.

a) Explain the underlined statement. (1mk)

<u>Solution</u>

The price of the salad roll is 24 shillings higher than that of juice 1mk

b) How much did the salad roll cost? (2mks)

<u>solution</u>

let the price of salad be x

the price of juice will be x-24

x+x-24=82 1mk

2x=106

Salad roll =53 1mk

6. A turkey costs 5 times as much as a chicken. A farmer bought 20 turkeys and 50 chicken for sh 1200.calculate the price of one turkey. (3mks)

   <u>Solution</u>

   Let the cost of chicken be x

   The cost of turkey =5x

   $20 \times 5x + 50 \times x = 1200$ 1mk

   $100x + 50x = 1200$

   $150x = 1200$ 1mk

   $x = 8$

   $5 \times 8 = 40$ 1mk

7. Otieno buys a pencil, a pen and a book for which he pays a total of ksh 531.If the price of the pen is twice that of a pencil and the price of the book is three times that of the pen. How much does each cost? (4mks)

<u>solution</u>

Let the cost of pencil be x

The cost of pen = 2x

The cost of book =6x 1mk

X+2x+6x=531 1mk

9x=531

X=59 1mk

Pencil = 59

Pen =118

Book = 354 1mk

APPENDIX V: RESEARCH AUTHORIZATION LETTER FROM THE UNIVERSITY

University of Eldoret

flame of knowledge and innovation

P.O. Box 1125-30100, ELDORET, Kenya
Tel: 053-2063111 Ext. 242
Fax No. 20-2141257
Email: soe@uoeld.co.ke
www.uoeld.ac.ke

UNIVERSITY OF ELDORET

SCHOOL OF EDUCATION
CENTRE FOR TEACHER EDUCATION

No objection
Permission granted.

SUB-COUNTY DIRECTOR OF EDUCATION
TINDERET
SIGN
P.O. BOX 159-40110, SONGHOR

REF: UOE/B/CTE/PGS/033/Vol.1
DATE: July, 26, 2018

The Executive Secretary,
National Council for Science Technology & Innovation
P.O Box 30623- 00100
NAIROBI.

Dear Sir /Madam

RE: RESEARCH PERMIT FOR:
CHEPKOSKEI LILIAN NGENO - EDU/PGSE/019/14

This is to confirm that the above named Post Graduate Student has completed Course Work and has successfully defended her thesis proposal.

She is currently preparing for a Field Research Work on her Thesis Proposal entitled: ***An investigation of students' difficulties when solving Mathematical word problems in Secondary School: A case of Tinderet Sub-Country, Nandi Country Kenya.***

Any assistance accorded to her to facilitate successful conduct of the research and the publication will be highly appreciated.

Yours faithfully,

HEAD
Teacher Education
UNIVERSITY OF ELDORET
MAIN CAMPUS

Dr. P. Waswa
HEAD, CENTRE FOR TEACHER EDUCATION

c. c. Permanent Secretary
Ministry of Higher Education, Science & Technology,
P. O Box 9583-00200,
Nairobi.

c. c. Post Graduate Coordinator – School of Education, University of Eldoret,

University of Eldoret is ISO 9001: 2008 Certified:

APPENDIX VI: LETTER FROM NACOSTI

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone:+254-20-2213471, 2241349,3310571,2219420
Fax:+254-20-318245,318249
Email: dg@nacosti.go.ke
Website : www.nacosti.go.ke
When replying please quote

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/18/57435/25709**

Date: **4th October, 2018**

Lilian Chepkoskei Ngeno
University of Eldoret
P. O. Box 1125-30100
ELDORET.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"An investigation on students' difficulties when solving mathematical word problems in secondary schools: Tinderet Sub county, Nandi County,"*** I am pleased to inform you that you have been authorized to undertake research in **Nandi County** for the period ending **4th October 2019.**

You are advised to report to **the County Commissioner and the County Director of Education, Nandi County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

BONIFACE WANYAMA
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Nandi County.

The County Director of Education
Nandi County.

National Commission for Science, Technology and Innovation is ISO9001:2008 Certified

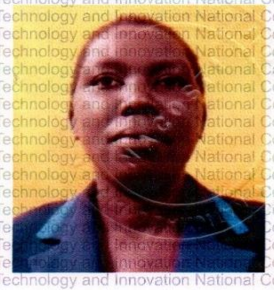
APPENDIX VII: RESEARCH PERMIT

THIS IS TO CERTIFY THAT:
MS. LILIAN CHEPKOSKEI NGENO
of UNIVERSITY OF ELDORET, 0-40110 SONGHOR,has been permitted to conduct research in *Nandi County*

on the topic: *AN INVESTIGATION ON STUDENTS'DIFFICULTIES WHEN SOLVING MATHEMATICAL WORD PROBLEMS IN SECONDARY SCHOOLS: TINDERET SUBCOUNTY, NANDI COUNTY*

for the period ending:
4th October,2019

Permit No : NACOSTI/P/18/57435/25709
Date Of Issue : 4th October,2018
Fee Recieved :Ksh 1000



....
Applicant's Signature

....
Director General
National Commission for Science, Technology & Innovation

THE SCIENCE, TECHNOLOGY AND INNOVATION ACT, 2013

The Grant of Research Licenses is guided by the Science, Technology and Innovation (Research Licensing) Regulations, 2014.

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REPUBLIC OF KENYA

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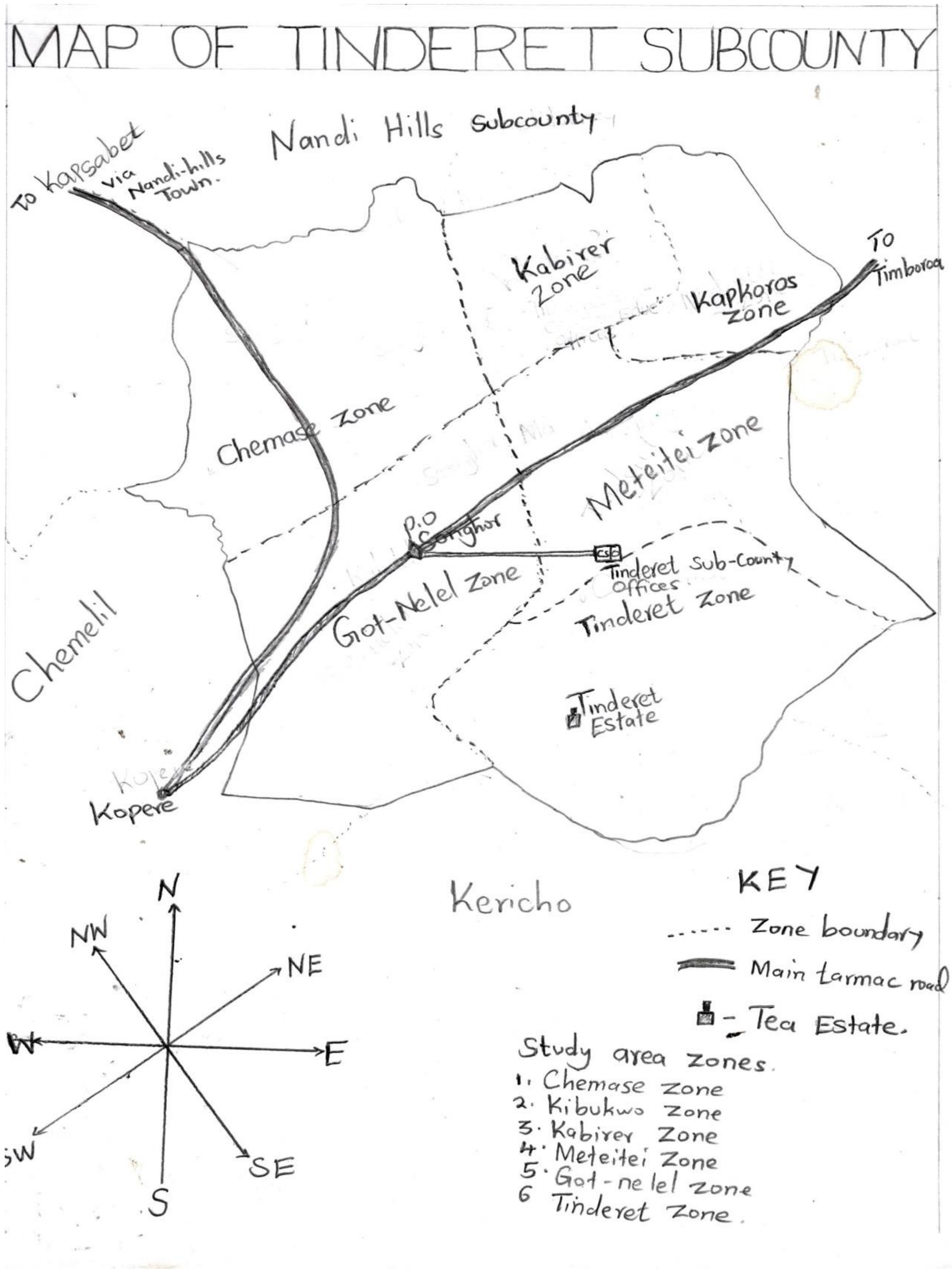
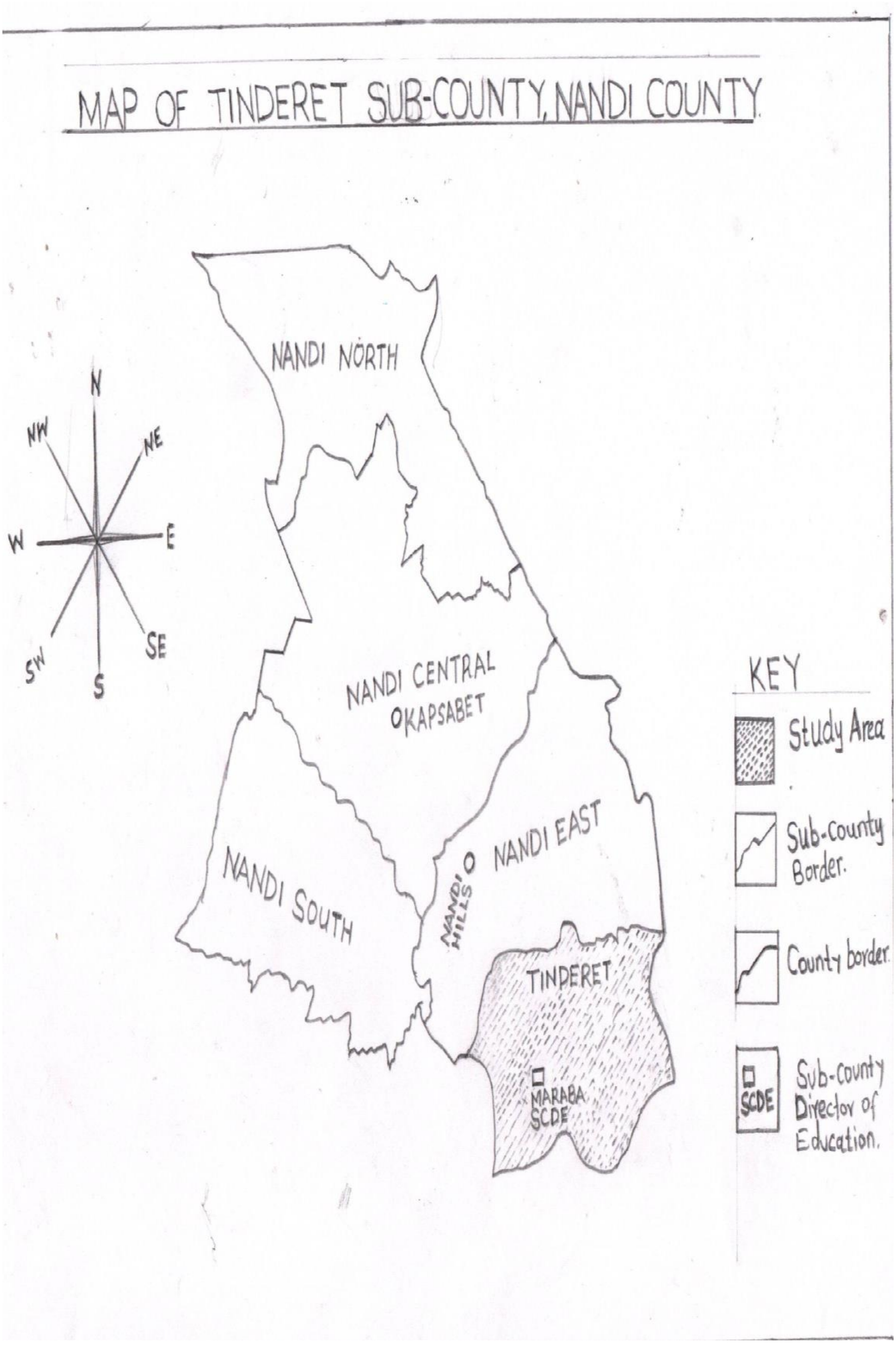
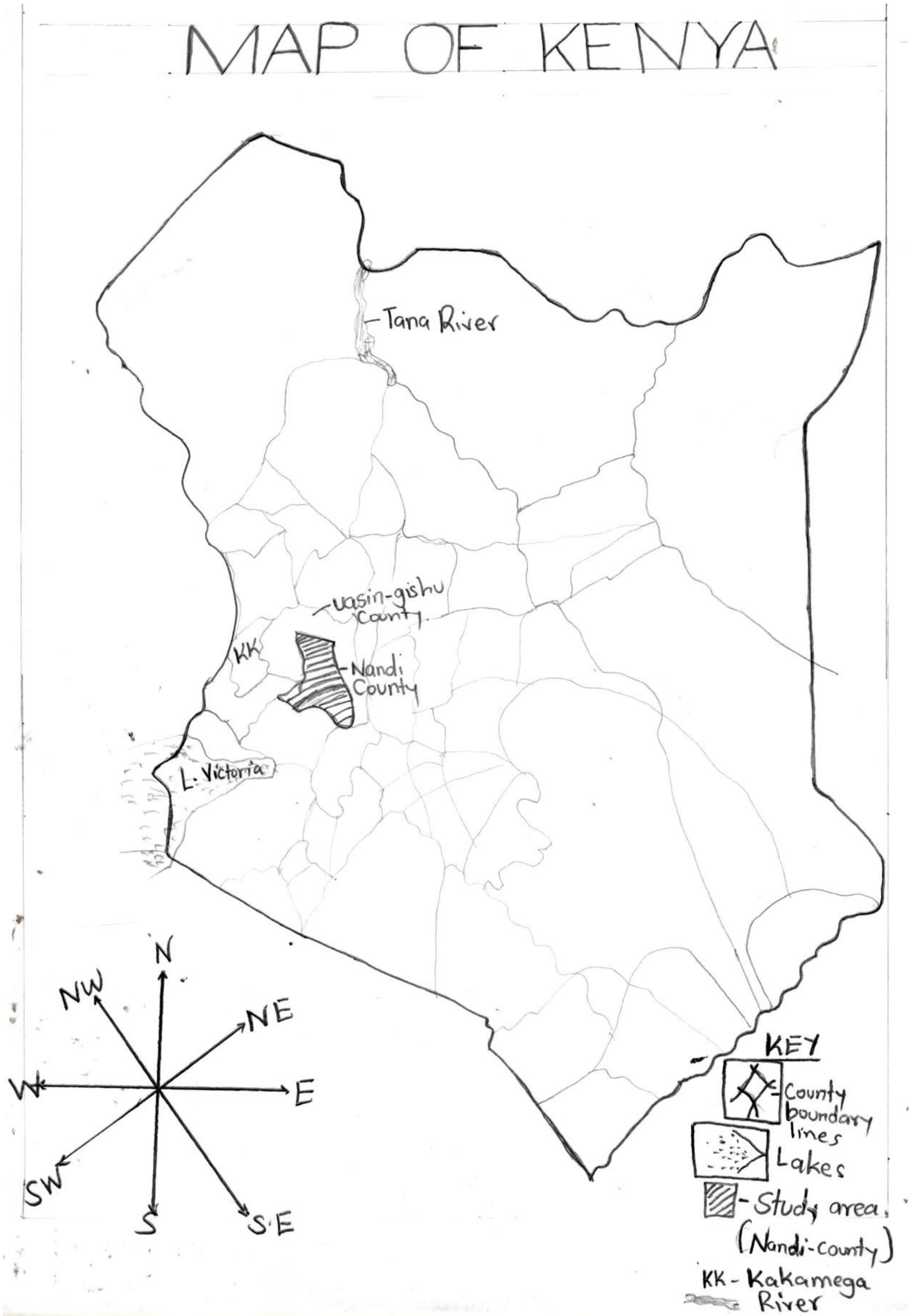
APPENDIX VIII: MAP OF TINDERET SUBCOUNTY



APPENDIX IX: MAP OF NANDI COUNTY



APPENDIX X: MAP OF KENYA



APPENDIX XI: SIMILARITY INDEX/ANTI-PLAGIARISM REPORT

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