TEACHERS' MATHEMATICAL KNOWLEDGE FOR TEACHING AND ITS INFLUENCE ON LEARNERS' ABILITY TO SOLVE WORD PROBLEMS IN SECONDARY SCHOOLS, NAKURU COUNTY, KENYA

By

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DECLARATION

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DEDICATION

This thesis is dedicated to my loving mother, Mrs. Jessie H. W. Nimely; my beloved aunt, Mrs. Roseline N. Gbeanquoi; and my loving wife, Ms. Bella Woodtor, for each of their prayers, support, and love towards me since the beginning of this study.

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LIST OF ABBREVIATIONS AND ACRONYMS

AST	Arithmetic Skills Test
CIT	Critical Incident Techniques
ICME	International Congress on Mathematics Education
IEA	International Association for the Evaluation of Educational Achievement
ISK	Interpersonal Social Knowledge
KCSE	Kenya Certificate of Secondary Education
KFLM	Knowledge of Features of Learning Mathematics
KICD	Kenya Institute Curriculum Development
KMLS	Knowledge of Mathematics Learning Standards
KMT	Knowledge of Mathematics Teachers
KNBS	Kenya National Bureau of Statistics
KNEC	Kenya National Examination Council
KOT	Knowledge of Topics
KPM	Knowledge of Practices in Mathematics
KSM	Knowledge of the Structure of Mathematics
MHOD	Mathematics Head of Department
MoE	Ministry of Education
MTSK	Mathematics Teachers Specialized Knowledge
NACOSTI	National Commission of Science, Technology and Innovation
NCTM	National Council of Teachers of Mathematics
NRC	National Research Council
PCK	Pedagogical Content Knowledge
QDA	Qualitative Data Analysis
RA	Research Assistant
RME	Realistic Mathematics Education
SCK	Specialised Content Knowledge
SMK	Subject matter Knowledge
SPSS	Statistical Package for Social Sciences
TCST	Text Comprehension Skills Test
TIMSS	Trends in International Mathematics and Science Study

TMKT	Teacher's Mathematical Knowledge for Teaching
TSC	Teachers Service Commission
TSG	Topic Study Group

ABSTRACT

Despite efforts, interventions, and studies across the world, learners' performance in Mathematics examinations is still below the expected standard. This has increased a concern surrounding the influence of teachers' mathematical grasp for teaching on the learners' ability to solving problems in Mathematics. The bourne of the study was investigating the influence of Teachers' Mathematical Knowledge for Teaching (TMKT) on ability of learners in solving word problems in Naivasha sub-County, Nakuru County, Kenya. The study's objectives are: 1) to determine the influence of the level of TMKT on learners' ability to solve word problems; 2) to establish the influence of teacher-learner classroom interaction in teaching word problems; and 3) to establish the relationship between learners' reading comprehension and arithmetic skills in solving word problems. The study was guided by two theoretical frameworks: the Mathematics Teachers Specialised Knowledge (MTSK) model and social constructivism theory. The study was underpinned by both quantitative and qualitative research approaches, as well as descriptive and correlational designs. The target population for the study included 65 Mathematics Heads of Department (MHOD), 65 Mathematics teachers, and 2,733 female and 2,450 male learners in Form two (2). Using stratified random sampling approaches, the study chose the gender of Form two (2) students, the categories of schools, and the mathematics teachers and department heads. The class level was chosen with the use of purposive sampling techniques. The necessary data was gathered with the assistance of a sample of 358 participants, which included 10 Mathematics teachers, 10 MHOD, and 338 form two (2) learners. This study's data collection tools were questionnaires, interviews, classroom observation checklists, Text Comprehension Skills Test (TCST), and Arithmetic Skills Test (AST). Worksheets from learners were chosen at random and distributed to each teacher in order to assess their TMKT. This allowed the teachers to see learners' mistakes and provide the appropriate steps and answers in accordance with the provided marking scheme. Descriptive and inferential statistics were used to analyse the data and produce frequency counts and tables. Relationships in the research were found using the Pearson product-moment correlation coefficient. The qualitative data was analysed using transcriptions. The findings demonstrated that the ability of learners to solve word problems is significantly influenced by TMKT. Learners' arithmetic skills and reading comprehension were shown to be somewhat positively correlated. Mathematics educators, policymakers, researchers, and all academicians are likely to find value in the study's findings.

CHAPTER ONE:

INTRODUCTION

Presented in this chapter are background, statement, purpose, objectives, research questions, significance, limitations, delimitations, assumptions, theoretical framework, conceptual framework, and operational definition of key terms of the study.

1.1. Background of the Study

Classroom teaching and learning processes are essential contributors to learning outcomes. Many scholars in the field of education have been paying close attention to the worldwide decline in student performance in Mathematics for decades. Many studies have attributed this significant decrease to various educational factors. It has been showed that learners' low Mathematics scores can be attributed to teachers' inadequate competences in the subject matter (Asami-Johansson and Attorps 2019; Campbell, Smith, et al. 2014). According to Jacobson *et al.* (2018), Mathematics education aims to increase knowledge, domain-cognitive constructs, and instilling the proactive disposition; the affect-related constructs, to teach Mathematics. The researchers considered the TMKT as a contributor to improving learners' mathematical achievement. It is, however, of crucial importance to know how this TMKT leads to the desired learning outcomes in the learners.

The Teachers' Mathematical Knowledge for Teaching (TMKT) is a specialised knowledge that supports teaching and learning processes of Mathematics (O'Meara et al. 2020). Researchers, Dahlgren *et al.* (2020) and Hoover *et al.* (2016) concluded that classroom teachers in the Americas must have a firm grasp of Mathematics as well as pedagogical strategies to Mathematics. According to researchers, Asami-Johansson

and Attorps (2019); Jeschke *et al.* (2021), the TMKT contains two critical components of knowledge: a) facts and concepts (literacy in symbols, rules of operations, definitions and theorems of numbers and figures); and b) performing of procedures; skill or know-how, calculating quickly and accurately, (National Research Council [NRC], 2017). Teachers' levels of knowledge in these three domains can be inferred from how well they apply the conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition of Mathematical competence. Orrill *et al.* (2015); Orrill and Polly (2016); Weiland *et al.* (2019) argued that teachers' knowledge goes beyond the classroom through the process standards; communication, connection, representations, reasoning, proof, and problem-solving (Carpenter and Gorg 2000).

Mathematics teachers' knowledge goes beyond just solving or teaching Mathematics. It also addresses how well teachers can teach Mathematics in a more interactive, engaging, and effective way. The importance of TMKT in the classroom has grown in recent years, prompting studies into the ways in which this knowledge affects both teachers' pedagogy and learners' Mathematical achievement. Exploring teachers' ability to achieve a high score in a Teachers' Mathematical Knowledge test, according to Ball (2005) depends on the level of their Mathematical proficiency. The teachers' level of Mathematical proficiency will increase their practical instructional skills and improve learners' performance in Mathematics examinations. Conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition, the five strands of Mathematics, are linked to Mathematical competence. Researchers have not adequately addressed teachers' proficiency in these five strands.

Research evidence globally in the field of education shows that the Subject Matter Knowledge (SMK) and the Pedagogical Content Knowledge (PCK) are inseparable. This position is supported by the fact that SMK is all the knowledge that teacher acquired about the subject throughout the educational journey, and PCK is the ability of combining the teacher's acquired knowledge and knowledge of teaching to teach what they know (Jacobson et al. 2018; Avcu 2019). The way in which approaches and techniques are presented in ways that help learners learn mathematical concepts is one of the domains covered by the TMKT (Campos-Navaa *et al.*, 2021; Jacob *et al.*, 2020). Maher *et al.* (2018) and Nixon *et al.* (2019) looked at the processes involved in teaching Mathematics, such as knowing how to deal with learners' negative perceptions and predispositions and being able to explain concepts through representations, analogies, illustrations, and explanations. By virtue of teachers' pedagogical training, they can employ a wide range of strategies and methods to boost their Mathematical knowledge. Sidabutar (2016) said that teacher's way of teaching Mathematics is one of the factors affecting learners' performance. This statement might prompt an argument that a knowledgeable content expert might have a deficiency in pedagogical knowledge. In other words, the SMK and PCK should work in parallel and transversal paths which will help in solidifying the learning ability and problem solving skills of the learners.

Research evidence shows that the TMKT and PCK improve instructional practices and help learners develop a strong mathematical and conceptual understanding of problem solving. Particularly for students learning how to solve word problems, this is a quite vital aspect of the Mathematics teaching profession. Rajagopalan (2019) defines teaching as both arts and science, emphasising that cultivating a classroom atmosphere that enhances learners' critical thinking skills and their ability for creative

problem-solving is fundamental to artistic aspect of teaching. Conversely, the scientific dimension necessitates meticulous attention to detail, precision, and procedure. The author elaborated on this definition of teaching by saying that it involves interaction between the instructor and the learners. Thus, these explanations and definitions of teaching should guide the mathematical understanding of teachers to influence the capacity of learners to solve word problems. According to Gasser *et al.* (2018), one important part of the TMKT is knowing Mathematics and knowing how to teach it.

Globally, studies have investigated learners' performance and the factors influencing their performance. These factors of learners' performance in Mathematics have been discussed and pointed out by Ayebale *et al.* (2020) and Stylianides and Hino (2018) and many other researchers as teachers' qualification, knowledge for teaching, motivation level, method of teaching Mathematics, attitudes, learners' perception, learners' attitudes, and parental influence. The extent to which teachers' Mathematical expertise affects learners' achievement is unclear, but it has been cited by some researchers as one of the factors that leads to learners' low performance in Mathematics. The 13th International Congress on Mathematics Education (ICME – 13) held an international conference in Hamburg, Germany, in 2016 which was aimed at advancing theories about the content and pedagogical alertness of teachers. It was also meant to put emphasis on teachers' method of teaching in developing learners' understanding Mathematically as well as promoting a logical reasoning (Maher et al. 2018).

Reporting learners' performance results internationally, the Trends in International Mathematics and Science Study (TIMSS), in collaboration with the International

Association for the Evaluation of Educational Achievements (IEA – TIMSS), presented Mathematics mean scores of 39 participating countries, with only 18 countries scoring at or above the scale centre point of 500 (IEA TIMSS 2019). The remaining 21 countries, according to the report, scored below the centre point. Even though not stated directly, this data demonstrates the necessity of teachers' mathematical understanding for teaching. The teachers' expertise in Mathematics can help their teaching practices and the learners' learning results. This knowledge supports the teachers in teaching Mathematics, especially the word problem-solving, which is the school Mathematics application.

In Tanzania, researchers identified weak Mathematical and pedagogical knowledge among teachers, which they ascribe to as factors for learners' poor performance in Mathematics (Mwinka & Tarmo, 2020). The researchers further noted that the Mathematical and pedagogical knowledge of the teachers were not resonating well. Some teachers have solid Mathematical knowledge but lower pedagogical knowledge. In agreement with researchers from European nations, the Tanzanian researchers argued that knowing how to teach content includes not only understanding it, but also teaching it by connecting the concept of the content to another subject area across grade levels (Ball *et al.*, 2008; Dachi, 2018; Hoover *et al.*, 2016). In response to the separation between Mathematical and pedagogical knowledge and experience, this research integrates how TMKT combines the PCK for effective teaching (Carrillo-Yañez et al. 2018).

In Kenya, Miheso-O'Connor and Berger (2016) examined teachers' proficiency in the pedagogical content knowledge in teaching Mathematics. The research studied the level of teachers' ability to teach Mathematics and how they evaluate learners'

distinctive problem-solving approaches in line with five constituents of Mathematics; conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition (National Research Council (NRC) 2017)). The study's results showed a wide range in teachers' Mathematical competence, with only 9.1% showing proficiency across all areas of Mathematics, while 1.7% showed competence in Mathematics at a level appropriate for teaching. In addition, Koross *et al.* (2012) found many elements that affect learners' Mathematical proficiency in Kenya. These issues include how learners behaved upon arrival, the impact of the passing grade, infrastructure and facilities, a lack of suitable human resources, the poor explanation of Mathematical ideas, and more. According to the study, these factors affect how Mathematics is learnt or taught in Kenya. Although numerous scholars have investigated various classroom pedagogical issues, learners' performance on the Kenya Certificate of Secondary Education (KCSE) remains alarmingly low. The Kenya National Examinations Council (KNEC) 2020 KCSE report reveals that, despite efforts to improve learners' Mathematical performance, many learners still have some challenges with word problems that arise in real-life applications of Mathematics.

According to KNEC 2020 report, most of the learners who sat the KCSE perform below the standard scale in real-life application problems. The report shows that in 2020 learners performed below the expected mean score in 50% of the questions in paper one (1), which shows a slight improvement but performed below the expected mean score in 79.17% of the questions in paper two (2). Those questions in these papers addressed real-life application problems written in word.

Table 1.1: KCSE Data Reported by KNEC in 2020

Year	Paper	No. of Candidates	Maximum score (%)	Mean score (%)	Standard deviation
2016	1	570,398	100	23.74	21.24
	2		100	17.84	21.09
2017	1	609,525	100	24.49	22.03
	2		100	26.47	22.43
2018	1	658,904	100	24.07	21.16
	2		100	28.82	20.85
2019	1	694,445	100	31.00	24.04
	2	694,347	100	23.00	20.90
2020	1	742,796	100	22.27	19.41
	2	742,760	100	14.45	14.97

Source: Kenya National Examinations Council (KNEC) – KCSE 2020 report

In Table 1.1, the report shows that learners' mean scores in paper two (2) progressed from 17.84% in 2016 to 28.82% in 2018. In 2019, there was a decline in performance in paper two (2), with 23.00% as the mean score and which decreased to 14.45% in 2020.

Khoshaim (2020) described problem-solving as the verbal description of scenarios in which one or more questions are raised and answered by applying Mathematical concepts. In other words, word problems can be written as text describing real-life situations requiring Mathematical concepts and operations to obtain the needed solution. This Mathematical concept or operation is the aspect wherein Mathematics involves a real-life situation. So, for the teacher to leave a long-lasting academic impact on the learners' achievement, their Mathematical knowledge for teaching must be commensurate with the world's growing needs to meet or fill the gaps in Mathematics education by building the learners' Mathematical and critical minds. If instructors have a deeper knowledge of Mathematics and are able to teach that understanding to learners, then the mathematical skills of learners will increase, as well as their ability to solve word problems.

The KCSE reports suggest that the learners had some weaknesses in geometry, statistics, transformation, and real-life application which are written in word problems and stressed the need for teachers to focus on teaching real-life applications. The problem could be the level of Teachers' Mathematics Knowledge for Teaching and how word problems are introduced.

Table 1.2: Nakuru County's Overall KCSE Performance Report From 2017 - 2021

Year(s)	Score
2017	3.77
2018	4.04
2019	4.39
2020	4.43
2021	3.86

Source: Nakuru County Education Office Report

Table 1.2 shows that the overall performance of Nakuru county showed some improvement from 2018 to 2020, with a mean grade of **D+ (D plus)**, which is 4.04% up to 4.43% but slightly experienced a decline in a mean score of **D (plain),** which is a mean score of 3.86% in 2021.

Table 1.3: Nakuru County KCSE Mathematics mean scores for the Years 2017 to 2021 per sub-county.

Sub-County	Year				
	2017 (%)	2018 (%)	2019 (%)	2020 (%)	2021 (%)
Bahati	3.04	3.14	3.42	2.79	2.73
Gilgil	2.46	2.97	2.65	2.08	2.25
Nakuru West	0.00	0.00	2.33	1.87	1.53
Nakuru East	3.03	3.88	4.15	3.67	3.44
Molo	2.49	2.60	3.09	2.82	2.15
Njoro	2.40	2.57	2.61	2.08	2.18
Kuresoi North	2.43	2.57	2.30	2.62	2.25
Kuresoi South	2.36	2.54	2.55	2.18	2.30
Naivasha	2.54	2.33	2.00	2.22	2.23
Rongai	2.75	2.43	2.36	2.32	2.26
Subukia	2.80	2.90	2.89	2.19	2.05

Source: Nakuru County Education Office Report, 2022

There was an overall mean grade of D- (D minus) with a numeric figure of about two points in Mathematics for the last five years in Naivasha. Table 1.3 shows that Bahati scored an overall mean grade of D from 2017 to 2019 and a D- (D minus) in 2020 and 2021. Nakuru East performed better with a mean score of D+ (D plus) in 2019 and Ds in 2017, 2018, 2020, and 2021 than Naivasha. According to the report, learners in the Naivasha Sub-County performed lowest of all.

1.2. Statement of the Problem

Despite substantial efforts towards improving Mathematics education in Kenya, particularly the recommendations outlined in the KNEC-KCSE 2020 report, the capability of learners to solve mathematical word problems continues to pose a considerable difficulty, particularly at the secondary school level. The KNEC report revealed that a significant number of learners in Nakuru County achieved low scores in Mathematics exams, particularly in Paper One (1) and Paper Two (2). These papers not only test mathematical calculations but also assess the learners' ability to apply mathematical concepts to real-life situations. Learners' unsatisfactory performance

may be influenced by an extensive variety of reasons, one of which could be the calibre of Mathematics instruction delivered by teachers.

Studies indicate that a TMKT encompassing teachers' profound comprehension of mathematical concepts and their adeptness in imparting this knowledge, significantly impacts learners' performance. Nevertheless, there is limited availability of empirical evidence directly connecting the TMKT to learners' academic achievement in solving word problems.

This research aimed to close this gap by examining the influence of TMKT on secondary school learners' ability to solve word problems in Nakuru County. This study is crucial as it may uncover possible areas for improvement in teacher training and classroom instruction. The study's aim is to strengthen the ability of learners to solve word problems and improve their performance on Mathematics examinations.

1.3. Purpose of the Study

The goal of the study was to investigate the influence of TMKT on the learners' ability to solve word problems in secondary schools in Nakuru County, Kenya. This research aimed to examine the influence of teachers' understanding of mathematical concepts, their pedagogical subject knowledge, and their proficiency in communicating mathematical ideas on learners' abilities to problem-solving, specifically in the setting of word problems.

1.4.Objectives of the study

The objectives of the study were:

1. To determine the influence of the level of Teachers' Mathematical Knowledge for Teaching on learners' ability to solve word problems.
2. To establish the influence of teacher-learner classroom interaction on teaching word problems.
3. To establish the relationship between learners' reading comprehension and arithmetic skills in solving word problems.

1.5. Research Questions

The study was guided by three (3) research questions:

1. Does the level of Teachers' Mathematical Knowledge for Teaching influence learners' ability to solve word problems?
2. How does teacher-learner classroom interaction influence learners' ability to solve word problems?
3. What is the relationship between a learner's reading comprehension and arithmetic skills?

1.6. Significance of the Study

This study holds significance because it examines the influence of TMKT on learners' ability to solve word problems. It offers valuable insights into how teachers' expertise in both content and pedagogy directly affect learners' ability to solve word problems. An understanding of the influence of TMKT on learners' ability to solve word problems could potentially enhance outcomes for learners. The findings may offer valuable guidance for teacher training programmes, helping them identify specific areas where teachers may need to enhance their knowledge and teaching approaches. This, in turn, could result in more impactful Mathematics instruction. The study's

findings may foster valuable insights to curriculum developers and education policymakers regarding the specific areas that require emphasis in teacher training. The results may be useful in providing guidance to make adjustments in the Mathematics curriculum to ensure that teaching strategies are better aligned with the needs of learners. Implementing this approach may facilitate the development of a nurturing educational setting that promotes academic achievement in Mathematics. The aim of this study was to contribute to the current body of knowledge of extent to which TMKT influences learners' ability in solving word problems, specifically in Kenya and other comparable educational settings. The findings of this study have the potential to be used as a point of reference for future studies on Mathematics education, the effectiveness of teaching methods, and the academic performance of learners in Mathematics in secondary schools.

1.7.Limitations and Delimitations of the Study

In this section, the researcher discusses the limitations of the study and delimitations of the study.

1.7.1 Limitations of the Study

The issue of one rating him/herself creates some biases, so in the case of this study wherein Mathematics teachers rated their own level of knowledge for teaching. Being of aware of this, the researcher developed some questionnaires for learners which also rated the teachers' Mathematical knowledge for teaching. Due to language barrier, the researcher had a Research Assistant who interpreted English statements into Kiswahili for the researcher and English statement to Kiswahili for the teachers and learners as needed. The study's findings did not include the whole of Kenya, nor the whole of Nakuru County. The findings did not also involve all the secondary schools in Naivasha Sub-County, rather it reflects responses from ten of the schools in Naivasha

Sub-County. Importantly, the study's focus was how teachers' Mathematical knowledge for teaching influence learners' ability to solve word problems. The research did not take into consideration how class size affects the pedagogical aspect of the TMKT.

1.7.2 Delimitation of the Study

This study used a descriptive and correlational approach to examine the influence of TMKT on learners' ability to solve word problems in secondary schools in the Naivasha Sub-County of Nakuru county, Kenya. Learner' extremely low performance shown in Mathematics on the Kenya Certificate of Secondary Education (KSCE) over the past five years made this a fascinating area to investigate. The study targeted the following subjects: Form two (2) learners, teachers of Mathematics, and Mathematics Heads of Department. The researcher chose the categories of schools, the gender of Form two (2) learners, Mathematics teachers, and MHODs using stratified random sampling, whilst the class level of the respondents was chosen using purposive sampling. Descriptive statistics, including the measure of central tendency, and the presentation of data in frequency tables, charts, and graphs was used to analyse the quantitative data, while the qualitative data was transcribed, coded, and presented in narrative form using the Qualitative Data Analysis (QDA) miner lite software. During an analysis of the data that was gathered, the researchers found that employing Statistical Package for the Social Sciences (SPSS) version 26, Microsoft Excel 365, and Qualitative Data Analysis (QDA) miner lite were all useful resources.

1.8. Assumptions of the Study

The researcher assumed the following: i) the level of teachers' Mathematical knowledge for teaching may depend on their level of educational qualification, ii) the level of teachers' Mathematical content knowledge for teaching might influence

learners' ability to solve word problems, iii) the teacher-learner classroom interaction may help teachers to develop a strong and better knowledge for learners' learning needs, it might also improves teachers' instructional knowledge for teaching, teachers' choices of the use of instructional strategies for teaching, and teachers' use of interpersonal skills support their pedagogical practices which influence learners' ability to solve word problems.

1.9. Theoretical Framework

The social constructivism theory by Lev Vygotsky in 1968 and supported by the Mathematics Teachers' Specialized Knowledge (MTSK) model by Carrillo-Yañez *et al.* (2018) were the theories that guided this study. Social constructivism is one of the social learning theories by Russian psychologist Lev Vygotsky in 1968, and it posits that individuals actively create their knowledge through social interaction (Davis et al. 2017). Social constructivists contend that learning through social interaction of activities and internalization of concepts influences the collective working that fosters intellectual growth and the acquisition of knowledge of the world around learners, predominantly if they are being guided by an adult or more senior peer (Johnson and Bradbury 2015).

Social constructivists claim that learning occurs when social interaction is formed, particularly in Mathematics classrooms. They perceive knowledge acquisition as an essential component of social interaction that promotes higher levels of thought and learning. Social constructivists concentrate on the fact that interaction, cooperation, and group effort are the only ways for learning to be effective (Idaresit Akpan et al. 2020; Stephan 2020). In distinguishing psychological and sociocultural constructivism, Cobb and Yackel in 1996 coined a term "socio-Mathematical norms" to describe the social interaction of teacher and learners in a Mathematics classroom.

Social constructivism is essential to this study because it addresses the social aspect of teachers' Mathematical knowledge for teaching. The social interaction in the classroom was done through the discussion teaching method, which Omwirhiren (2015) considers as application of social constructivism in the classroom. Social constructivism acknowledges that learning is a social process and that conversing, interacting with others, and using the information learners have learned are important parts of learning and ways to reach learning objectives (Akpan et al. 2020). In a constructivist Mathematics classroom, Balanlay (2021) argued that constructivist instructional practices improve learners' achievement in Mathematics.

The premise of the Mathematics Teachers' Specialized Knowledge (MTSK) model by Carrillo-Yaez *et al.* (2018) is that Mathematics educators require specialized knowledge to complete their work. They hold that pedagogical content knowledge and subject matter knowledge influence TMKT. Ball *et al* (2008) model of Mathematical knowledge for teaching is supported by the MTSK framework, which presents teachers Mathematical and pedagogical knowledge in a combined model with sub-domains that influence the TMKT.

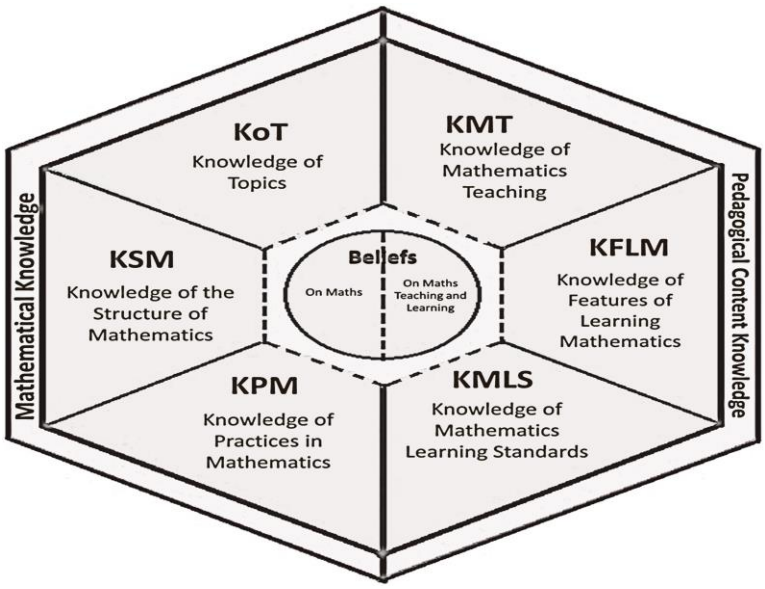

Figure 1.1: Mathematics Teachers' Specialized Knowledge (MTSK) Model adopted from Carrillo-Yañez *et al.* (2018)

Knowledge of Topics (KoT), Knowledge of the Structure of Mathematics (KSM), and Knowledge of Practices in Mathematics (KPM) are all part of the teachers' Mathematical knowledge. It is believed that teachers' practical instruction in the classroom is influenced and impacted by the level of the KoT, KSM, and KPM (Lo 2020; del Prado Hill, Friedland, and McMillen 2016; Miller et al. 2022), whereas the Pedagogical content knowledge domain contains Knowledge of Mathematics Teaching (KMT), Knowledge of Features of learning Mathematics (KFLM), and Knowledge of Mathematics Learning Standard (KMLS). This model supports this study in presenting the TMKT in a teachable structure that will influence learners' ability to solve word problems. The teachers' knowledge of the topic (word problem-solving) and Mathematics teaching will build the learners' ability to become good solvers, improving their performance. The teachers' knowledge of the topic is contained in the (Carpenter and Gorg 2000) content standards.

1.10. Conceptual Framework

The conceptual framework shows how the knowledge a teacher acquired in Mathematics will interact with other variables, which expects to bring out the intended outcomes.

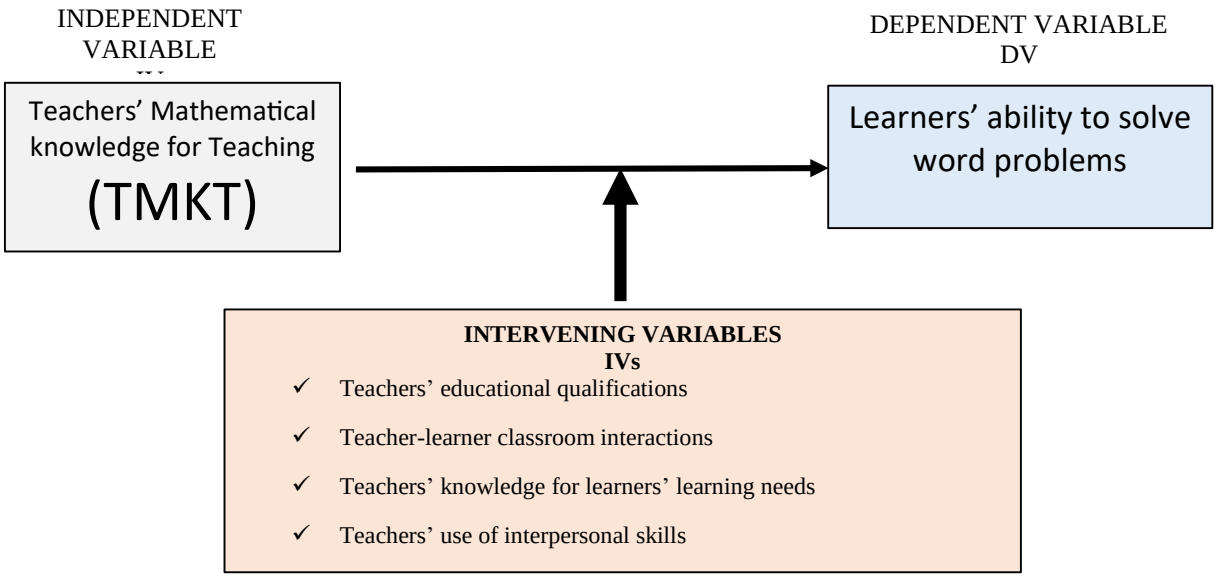

Figure 1.2: Conceptual framework adapted from (Hayes, 2018)

According to Hayes (2018), there might an interaction between the intervening and independent variable which influence the dependent variable. The study adapted this framework of the model to show how the intervening variables in the conceptual framework interact with the independent variable, Teachers' Mathematical Knowledge for Teaching, to influence the dependent variable, learners' ability to solve word problems. The interactions between the independent variable and the intervening variables might increase or decrease the intensity of the dependent variable. This means that the intensity of learners' ability to solve word problems might increase or decrease because of the interaction of teachers' level of educational qualifications, teacher-learner classroom interaction, knowledge of learners' learning needs, knowledge of instructional practices, interpersonal social knowledge, and

learners' reading comprehension skills with the Teachers' Mathematical Knowledge for Teaching.

1.11. Operational Definition of Terms

Adaptive reasoning	refers to thinking logically about how mathematical concepts and situations are related to the real world.
Conceptual understanding	as used in this research, implies the practical understanding or more profound comprehension of mathematical concepts for a more precise interpretation and transmission during teaching.
Mathematical knowledge	describes the knowledge one acquires from a Mathematics classroom through a formal education.
Pedagogical Content Knowledge	includes the teachers' teaching experiences, the knowledge of the subject matter and the overall interactions between teachers and the learners.
Procedural fluency	is the effective, flexible, and accurate use of mathematical procedures.
Productive disposition	acts of developing a strong sense of self-efficacy and belief that the knowledge of Mathematics applies to thereal world.
Strategic competence	implies the strategy or how to communicate well using Mathematical language or concepts for the intended meaning of the message presented.

Teacher	as used in this proposal, refers to a professional person who is knowledgeable in the given subject matter.
Teachers' Mathematical knowledge	considers specialised knowledge a teacher of Mathematics needs to support the teaching and learning processes in the context of Mathematics.
The pedagogy	involves teacher and learners' interaction in the classroom during the teaching and learning processes.
Word problem-solving	as used in this study, refers to a situation from daily life described in a verbal or written text where one or more questions are addressed. The solutions can be obtained using Mathematical operations on the data.

CHAPTER TWO:

REVIEW OF RELATED LITERATURE

2.1 Introduction

The fundamental concepts of Teachers' Mathematical Knowledge for Teaching (TMKT) are covered in this chapter along with how it influences the ability of learners to solve word problems. It focuses on how the ability of learners to solve word problems is influenced by the level of teachers' mathematical knowledge for teaching, by student-teacher interactions in the classroom, and by the relationship between learners' reading comprehension and arithmetic skills to solve word problems. It concludes with a summary of the major themes from the reviewed literature.

2.2 The Influence of the Level of Teachers' Mathematical Knowledge for Teaching on Learners' Ability to Solve Word problems.

Shulman's Pedagogical Content Knowledge (PCK) model of 1986 sparked a long-standing interest in TMKT. When Ball *et al.* (2008) presented their hypothesis about Mathematical Knowledge for Teaching, it triggered a great deal of research interest. Shulman's PCK model seemed like a model of logic, but Ball's model presents a practical approach on how a Mathematics teacher presents mathematical concepts for learners' learning outcomes. The significance of TMKT has led researchers to believe that teachers' Mathematical proficiency is a key factor for learners' success in Mathematics.

Chua (2020) meta-synthesis of several empirical studies indicated that teachers' lack of Mathematical knowledge influences their teaching practices; this affects learners' problem-solving achievement in particular scenarios. The study points out two

approaches; the deficit approach, which addresses the lack of connection of TMKT and PCK in the pattern of instructional practices and the affordance approach, which highlights how strong TMKT and PCK create an improved classroom culture and instructional practices. The study's findings showed that teachers with better Mathematical knowledge for teaching had improved class results for their learners, whereas those with a low level of TMKT negatively influence learners' performance. The TMKT and learners' achievement in Mathematics are significantly correlated in other studies, including those conducted by Campbell *et al.* (2014); Hill *et al.* (2016); Kariuki *et al.* (2018); and Kelcey *et al.* (2019).

Researchers from South Africa ascribed learners' poor performance in Mathematics to teachers' lack of TMKT. Pournara *et al.* (2015), found that teachers with stronger mathematical backgrounds increased their learners' learning gains in problem-solving. These findings in a quasi-experimental study involving 586 and 217 grade 10 (Form two (2)) learners from five schools in Johannesburg. Twenty-one teachers were chosen at random for the study, with 66.7% receiving professional development training and 33.3% not. Although the study did look at how TMKT affected learners' understanding of Algebra, Functions, and Geometry, it did not examine how that understanding affected their ability to apply what they had learned.

Mathematics teachers in secondary schools in Zanzibar showed low teaching strategies and intermediate pedagogical content knowledge. Researchers from four East African countries; Rwanda, Tanzania, Burundi, and Kenya; presented their findings utilising a mixed-methods study methodology (Moh'd *et al.*, 2021). The study recommended more emphasis on in-service training to raise the teachers' level of pedagogical content knowledge, which will eventually lead to improvement in the way Teachers of Mathematics teach and how learners achieve the learning outcomes.

Ma'Rufi *et al.* (2018) posited that the PCK forms a bridge between the TMKT, SMK, knowledge of the learners, and the way the teacher present the lesson which influence learners' learning outcomes.

Evidence from research reveals a significant difference between a Mathematician and Mathematics Educator. They believed that it is the PCK ("how") to teach and the TMKT ("what") the teachers know are the differences between the two (Gess-Newsome et al. 2019). Less research has been done specifically on the influence of TMKT on learners' ability to apply Mathematical concept in real-life, which is more practical (Csíkos and Szitányi 2020). Csíkos and Szitányi concluded that although the Hungarians' pre- and in-service teachers had good Mathematical knowledge which they acquired through training, but 76.7% of the respondents expressed that it was difficult to teach Mathematical application which relate real-life problems. The researchers affirmed that teaching applications of Mathematical content is one important aspect of TMKT.

2.2.1 The Level of Teachers' Mathematical Knowledge in Teaching Word problems

A teacher has to have a thorough grasp of mathematics in order to teach and support students in learning the subject. Mathematical proficiency and teaching proficiency are two sides of the same coin. The TMKT provides answers to two important questions: the "what" (Mathematical content knowledge or subject matter knowledge) and the "how" (pedagogical knowledge or instructional knowledge), according to Copur-gencturk (2021); Copur-Gencturk (2015); Jacob *et al.* (2017); Wu (2018). There is evidence that, if a teacher knows the 'what' about Mathematics teaching, they must also know the 'how' to teach. A teacher's Mathematical knowledge is the knowledge about the actual school Mathematics and the Mathematics of the society to

be taught, learned and applied (Stevens *et al.*, 2019). Learners' works in solving problems are more of procedural fluency, meaning that the teacher needs more Mathematical knowledge emanating from their Mathematical proficiency (Corrêa 2018). This proficiency further provides feedback and guidance for learners' problem-solving ability.

Koponen *et al.* (2017) added that a teacher's Mathematical and pedagogical knowledge during educational training provides vital explanations for the variations in learners' achievements in Mathematics locally, regionally, and globally. Many other researchers also added that the level of teachers' educational and years of teaching experience play a significant role in developing a strong expertise of TMKT and PCK (Oluwakemi Ewetan and Olukayode Ewetan 2015; Luitel 2020; Alshehri and Youssef 2022). Hill *et al.* (2019) put it in this perspective that teachers' preparation and teaching experience improve their pedagogical content knowledge and this in turn increase learners' achievement level. The TMKT incorporates and facilitates the cooperative and efficient presentation of the five Mathematics content standards (number and operations, algebra, geometry, measurement, and data analysis and probability) (Carpenter and Gorg 2000; Kilpatrick et al., 2003). Teachers may have knowledge of the content standards; still, having a strong sense of the principles and standards of Mathematics and ability in the five strands of Mathematical proficiency is vital; how the teacher teaches the content; word problem is of major concern. The answer to this question, "how" will also help educationists and researcher understand how the TMKT influence learners' ability to solve word problems.

Ishenyi and Wanjala (2019) found that teachers' Mathematical content knowledge for instruction does not correlate significantly with learners' Mathematical achievement.

It has been reported that teachers' Mathematical expertise does not affect their learners' performance in Kenya. Eighty teachers participated in the study, which employed a mixed design based on a descriptive survey. Odumosu and Areelu (2018) found that learners in the Nigerian school system did not benefit from their teachers' pedagogical knowledge on algebraic tests. Additionally, the researchers did not find any evidence of a correlation between subject matter knowledge and teaching methodology. They used a quasi-experimental design with 12 teachers and 421 learners in the upper level of Secondary two (2), administering tests before and after the intervention.

2.2.2 Teacher's Subject Matter and Pedagogical Content Knowledge

Teaching requires a multilevel approach to getting all learners the needed learning materials (the subject matter) and learning outcomes. These approaches include the instructional strategies and the classroom management techniques that the teacher has. The focus of this research is on the effect that teachers' Mathematical knowledge has on learners' ability to solve word problems in the classroom. In solving word problems, teaching and learning relies on a combination of specialized and common content knowledge, which is supported by pedagogical expertise (Al-Saadi, Adnan, and Ayop 2020; Leta, Ayele, and Kind 2021; Copur-Gencturk et al. 2019).

According to Cordova and Linaugo (2022); Muhonen *et al.* (2021) teachers' pedagogical content knowledge as well as their subject matter knowledge are developed and strengthened by their continued practices and professional development trainings or workshops which are translated in their teaching experiences. Subject matter knowledge and pedagogical knowledge are essential to the teaching and learning of Mathematics because they represent the "what" and "how" of a teachers' knowledge, respectively. The teacher's ability to solve problems

and make them understandable to learners is less important than their ability to conceptualize their own Mathematical knowledge in the classroom. A teacher can only teach what they know best for effective learning; for instance, if a teacher is well knowledgeable in Mathematics, but lacks the pedagogical skills to effectively carry out instruction, there will be some challenges in learners learning the Mathematical concepts needed. The TMKT is incomplete without the teachers' pedagogical content (subject specialized) knowledge.

An empirical study conducted in Malaysia by (Al-Saadi, Adnan, and Ayop 2020) reveals a weak relationship between physics teachers' pedagogical content knowledge and learners' achievement in the physics classroom. The study further found that teachers' good pedagogical content knowledge is insufficient to improve learning in science education. With the help of descriptive and analytical design, the researchers conducted empirical research, which means they reviewed journal articles, published thesis, and e-libraries. Previous research put more emphasis on how well teachers understood the basics of Mathematics. In their study of New Zealand's pre-service and in-service teachers, Young-Loveridge *et al.* (2012) discovered that teachers with weak subject matter knowledge also faced difficulties with their pedagogical content knowledge and it also affected their presentation. The study used assessment as the means of data collection and concluded that the pre-service and in-service teachers performed poorly in the Mathematics thinking assessment, thus making it that they have low levels in subject matter knowledge which will affect their pedagogical content knowledge. Luft (2020) perceives subject matter knowledge as the knowledge the teacher possesses in what they are teaching or have taught, its advances and what is known about that discipline.

Hannula (2017) described the Finish Mathematics education as having three parts that are distinct: Subject Matter Knowledge, educational studies, and teacher's practical teaching training. The study reviewed the Subject Matter Knowledge and teacher's practical teaching training or the pedagogical training as the foundation on which effective teaching happens following the quality of the SMK and PCK the teacher has or have gained, which will affect the learners' achievement in Mathematics. Seminar exercise was how the researcher gathered the needed data. The learners (prospective Teachers of Mathematics) were given tasks during the seminar to discuss and describe the diaries of the Finish Mathematics education of which the researcher found that the respondents discussed more of both subject matter and pedagogical expertise in Mathematics education. Due to relying on a single methodology for data collection, the researcher was unable to generalize the results to the student population but did suggest more research be done on how to improve teachers' Mathematical knowledge in the classroom.

Mbati *et al.* (2020) explored the issue of inadequate subject matter expertise for biology Teachers to teach the subject in Kenyan secondary schools. A descriptive research design was adopted in the study and surveyed 400 year-four Biology majors at undergraduate institutions. The results of this study showed that the biology curriculum in Kenya's secondary schools is not being implemented to its full potential due to a lack of knowledge about both the subject matter and how to teach it (pedagogical knowledge) among pre-service biology teachers. As a result, researchers in Kenya's education system have been able to focus on teachers' subject matter and pedagogical content knowledge.

2.3 Classroom Interactions in Word Problem-solving

Interactions between learners and the content, among learners, and between learners and the teacher all make up the three categories of classroom interactions. The research focuses on the third type of interaction, that between teacher and student. Hamre *et al.* (2012) defined interaction between learners and teachers as the daily exchanges in a back-and-forth conversation. These exchanges provide feedback on works learners do in the classroom, guide learners on the processes for problem solving, and guide learners to conceptualize Mathematics using real-life approaches. Some researchers argue that teacher-learners interaction helps to prevent discipline problems and foster effective ways of teaching and also bring out the desired learning outcomes (Pennings, 2017; Pennings *et al.*, 2018). This relationship was categorized by Gasser *et al.* (2018) into three domains: instructional support, classroom organization, and emotional support.

Pennings et al. (2018) argue that the social order of a classroom can be established and maintained through the interactions between the teacher and the learners. Wubbels (2017) added that teacher's style of interacting with the learners influences how learners will accept the information. For instance, an incredibly positive response of a teacher to a question asked by a learner, even if it seems not to make sense, will win the attention of learners and build a strong link between they and the learners. Also, teachers who understand the learners' emotional needs will quickly get their attention to the lesson.

Li and Yang (2021) found that the interaction between teachers and learners fosters enhanced productivity in problem-solving endeavours. The research examined the

dynamics of teacher-learner interactions alongside learners' self-efficacy and their preferences regarding the flipped classroom model. The research employed a qualitative design, focussing on a target population of undergraduate learners within Chinese universities, comprising a sample size of 649 individuals. Benny and Blonder (2018) emphasised the necessity for educators to possess a comprehensive understanding of the academic curriculum essential for effective teaching, alongside an awareness of the unique needs of gifted learners within the Israeli school system. The study examines the advantageous relationship that exists between gifted students to maintain their enthusiasm and participation in educational endeavours. The study revealed that learners with advanced cognitive abilities tend to withdraw when there is insufficient engagement between the instructional material and the instructor.

Majanga *et al.* (2019) underline the need of more classroom engagement especially the teacher-learner interaction in Kenyan education—but also point up elements influencing it. Factors influencing classroom interaction in Kenya included the report on teacher workload, classroom overcrowding, and teacher shortage. The researchers claim that these elements would prevent instructors in Nakuru Municipality from having a tailored relationship with their learners. Descriptive and inferential analysis under the ex-post facto study design helped the researchers. Notwithstanding the difficulties described in the past studies, evaluating how classroom interactions affect learners verbal problem-solving capacity is still essential applying several study approaches. Sen (2021) emphasises the need of this relationship by stating that teachers who engage favourably with their students create more suitable learning environments and satisfy their developmental, emotional, and intellectual requirements.

2.3.1 Interpersonal Social Knowledge and Classroom interaction

The interpersonal skills of both the teacher and learners are essential elements in the dynamics of interactions within a Mathematics classroom. Acquiring the ability to forge social connections and cultivate friendships stands as one of the most essential competencies that children develop throughout their formative years. The establishment of relationships with others is of such significance that numerous educators may remain oblivious to the extent of their influence. This social connection enhances learning outcomes and refines teachers' instructional methods (Li, 2021). Xie and Derakhshan (2021) highlighted the necessity for educators to cultivate robust interpersonal connections, not only between themselves and their learners but also among the learners themselves, to enhance all dimensions of the teaching and learning experience.

Münte *et al.* (2019) define relationships between people as social interactions that encompass more individuals. By engaging in group projects and cooperative learning, educators can foster robust interpersonal connections within the classroom, thereby promoting effective teamwork. Establishing and maintaining a robust relationship between educators and students necessitates a reciprocal exchange, fostering encouragement, providing emotional support, honing effective communication and listening abilities, and comprehending the educational needs of the learners (Gasser et al. 2018). Research Scholars have suggested that educators must cultivate a robust and affirmative interpersonal and social network with their students by comprehending the educational needs of those learners (Che et al., 2017; Lans et al., 2020). This facet pertains to the understanding of learners' educational requirements that educators must possess when instructing in Mathematics (Opic`, 2016; Pennings *et al.*, 2018).

The quality of interpersonal communication between the educator and the student has been demonstrated to significantly influence both the effectiveness of the lesson and the educational outcomes for the learner. A study conducted by Pennings and Hollenstein (2020) in the Netherlands revealed that students perceived teachers' interpersonal relationships as positive. The researchers employed interpersonal theory, asserting that the dynamics of teacher-learner interaction adhere to specific interpersonal patterns and relationships within the classroom setting. For example, when a teacher engages a nonconforming learner with a measured tone, the negative interaction can be transformed into a positive one, thereby enhancing the learner's problem-solving capabilities. The research highlighted two essential levels of positive interpersonal relationships, specifically directing and assisting, within the educational framework of the Netherlands. The research was conducted over a three-year period, utilising a sample size of 36 teachers.

2.4 Learners' Reading Comprehension and Arithmetic skills in Solving Word problems

Reading and understanding what has been read is vital to word problem-solving. According to Atkinson *et al.* (2017), learners can comprehend text from a global point of view through the schema reading theory. Dore *et al.* (2018) stated that learners' comprehension of the text relies on their previous experiences, vocabulary proficiency, and the capability of decoding words. The ability of learners to solve word problems is vital to their reading comprehension, and understanding the text will support their ability to word problem-solving greatly (Munsod-Fernandez 2021). It was evident that for learners to have commanding control on their thoughts and actions in solving word problems, they need to develop a strong cognitive ability through the Theory of Mind (Devine et al. 2016). Solving word problems requires the

student to have a firm grasp on the concepts read in a text and a vivid mental picture of the problem at hand (Boonen *et al.*, 2016; Daroczy *et al.*, 2015). The mental visualization of word problems and comprehending the text was emphasize on by (Kurshumlia and Vula 2021; Vula et al. 2017) to be one successful way learners solve word problems.

Solving problems involving mathematical application concepts presented in text form requires a higher level of conceptual understanding, as well as text comprehension. Instead of using standard Mathematical notation, teachers present word problems in the form of text and ask learners to provide the necessary information about the problem (Boonen *et al.*, 2016). Kendeou *et al.* (2015) asserted that to comprehend a text, a learner must identify and connect the phonological (speech sounds), orthographic (spelling), and semantic (language) representations of words. The problem should be read, analysed, conceptualised, solved, and evaluated in a Mathematics context. Reading the problem will employ the reading comprehension theory and reading concepts reported by Fuchs *et al.* (2017). The analysis and conceptualisation of the problem are made possible as the result of what was read and understood.

Boonen *et al.* (2016) added that Mathematics educators should add reading comprehension to Realistic Mathematics Education (RME), which, in their views, is a fundamental aspect of developing learners' ability to word problem-solving. Karogo *et al.* (2020) concluded a study in Kenya which revealed that 93.2% of the participants did not attain the benchmark in reading comprehension, 99.9% did not achieve the 50% benchmark in English, and 98.3% were unable to reach the minimum

benchmark in Algebra and Geometry. The study sampled the total participants of 7,353 from 244 schools in 30 counties also found in 109 sub-counties. The 7,353 participants included 5,877 Form two (2) learners, 1,232 teachers, and 244 principals. The role of the teacher, if any, in the learners' poor performance was not addressed in the previous study.

2.4.1 Text Comprehension and Arithmetic Skills

Word problems are verbal and written text presenting mathematical concepts in a real-life situation. It leads learners to answer one or more questions by applying mathematical concepts and operations. Learners' capacity to solve word problems depends critically on their text comprehension. This implies that the learner should be able to conceptualise mathematical equations from the written text in addition to being able to grasp written text or word problems. A study by Pongsakdi *et al.* (2020) investigated item characteristics in learners' word problems, text comprehension, and arithmetic skills. The study revealed four categories of 891 Finland's grade 4 learners' ability in text comprehension, with one group of learners performing very low in text comprehension but with an impressive score in arithmetic, some group of learners having a better score in text comprehension but scored very low scores in arithmetic, those who could not perform better in both concepts, and one other group that performed incredibly exceptional in both text comprehension and arithmetic. The study's proposition was that primary school learners would benefit from improving their ability to understand and apply text to solve word problems. The research findings indicate a significant correlation between achievement when solving word problems and the efficacy in text comprehension and arithmetic. The researchers used

qualitative techniques to conduct the study with a target population of primary schools' learners.

Özcan & Doğan (2018) in a longitudinal study conducted in Istanbul among public elementary schools, highlighted key things about learners' ability to read text and understand. The research comprised 185 grade 1 students aged 5 to 7 years, utilising measurement instruments such as the Bracken Basic Concept, which includes expressive language tasks, reading comprehension enquiries, and mathematical problem-solving challenges. The research sought to identify the relative influence of early Mathematics skills and reading comprehension as predictors of performance in mathematical problem-solving. The research indicated that foundational skills in Mathematics significantly influence students' abilities in reading comprehension and problem-solving in mathematics.

2.4.2 Text comprehension as important skill to solve word problems

Learning to understand text in Mathematical expressions is essential for learners pursuing or doing a Mathematics course. Khoshaim (2020) stressed a significant reason of text comprehension to solving word problem and how it will influence the ability of learners to solve word problems. Reading and understanding the text is vital to learners' ability in solving word problems. Learners must first understand what they have read before decoding it into the mind for mental representation and then putting the information on paper two (2) for a physical look (Fuchs et al. 2015).

Ngeno (2020) indicates that students in Tinderet Sub-County, Nandi County, Kenya, faced challenges in solving word problems, attributed to insufficient comprehension

of Mathematical concepts, incorrect interpretation of operational terminology, and challenges in constructing suitable Mathematical expressions. The study's authors advised Mathematics educators to help learners strengthen their grasp of the material. This proposal emphasises the significance of both teachers' and learners' proficiency in Mathematics and reading comprehension in solving word problems. Even though the study was concluded in the statement mentioned earlier, it is still necessary to conduct a study of this nature in Kenya, especially in the selected study location.

2.5 Summary

Mathematical literacy of teachers is highlighted as a critical factor for the success of Mathematics education programmes in the reviewed literature. Researchers ascribed learners' achievement level to how TMKT influences their learning needs. Chua (2020) pointed out the significant role and impact TMKT have on learners' learning outcomes in Mathematics. The researcher reported that teachers lack of TMKT affects their teaching practices which further affects learners' problem-solving ability. Pournara *et al.* (2015) found that teachers with an improved level of TMKT will increase the learning gains of learners problem-solving. The researchers added that improving the TMKT can impact learners' Mathematical retentions. The TMKT and PCK have shifted the field of Mathematics education with many significant findings of which this study reviewed. Research has showed the significance of this TMKT to learners' achievement in Mathematics exams, but there are little studies on how this TMKT influence learner's ability to solve word problems.

Wu (2018) posited that the TMKT answers two critical questions "what" and "how" about the teacher. Research findings on the crucial role of TMKT for learners'

mathematical achievement are strengthened by these two questions. Even though Ishenyi and Wanjala (2019) indicated that there is no significant association between the TMKT and learners' achievement in Mathematics in the Kenya educational system, however, other study findings have pointed out how this TMKT has affected learners' learning gains in Mathematics.

The TMKT is closely related to pedagogical knowledge, the combination of which is known as pedagogical content knowledge. The Mathematical knowledge a teacher has, on its own, is not sufficient to influence learners' learning outcomes without the pedagogical knowledge (Gess-Newsome et al. 2019). Supporting this argument, Jacob *et al.* (2017); Wu (2018) presented the two questions which give the "what" to be the Mathematical knowledge of the teacher and the "how" to be the pedagogical knowledge the teacher possesses to carry out the needed teaching task.

In Malaysia, Al-Saadi *et al.* (2020) found a weak relationship between Physics teachers' pedagogical content knowledge and learners' achievement in Physics lesson. Researchers from New Zealand also found that teachers with low subject matter knowledge had challenges in their teaching practices (Young-Loveridge, Bicknell, and Mills 2012). The content knowledge and skills required to teach secondary school biology in Kenya were deemed insufficient by Mbati *et al.* (2020). In other words, there were deficiencies in the content and pedagogical knowledge of Biology teachers.

In addition to the "how" about the TMKT, there should be a kind of interaction which will influence the learning activities and the learners' learning outcomes. One important classroom interaction skills researchers have identified is the interpersonal

social skills. Pennings and Hollenstein (2020), drawing on the interpersonal theory, posited that the dynamics between educators and students adhere to certain patterns characteristic of human relationships. In China, Li and Yang (2021) assert that the interaction between teachers and learners enhances learners' problem-solving capabilities. This interaction is underpinned by the educators' profound understanding of mathematics in the context of teaching.

The understanding of text and the proficiency in arithmetic are essential competencies that learners must acquire to effectively tackle word problems. Pongsakdi *et al.* (2020) categorised learners in Finland's grade 4 into four distinct groups: those proficient in understanding text yet lacking arithmetic skills; those deficient in understanding text but adept in arithmetic skills; those excelling in both understanding text and arithmetic skills; and those struggling in both areas. According to the findings of the research, learners who were proficient in reading comprehension as well as Mathematics had the capacity to work through challenges with words. In Kenya, Ngeno identified learners' poor comprehension, misinterpretation of operational term, inability to write Mathematical expressions were factor causing learners' low performance in Mathematics word problems. The previous studies did not address how the teachers' Mathematical knowledge for teaching influenced learners' text comprehension and arithmetic skills and how it will influence their word problem-solving ability.

A summary of the reviewed literature shows in general about how teachers' Mathematical knowledge for teaching impact learners' achievement and retentions in Mathematics, but the current study investigated how this TMKT influence learners'

ability to solve word problems. In light of this, the aim of the current study was to investigate the influence that teachers' mathematical knowledge for teaching has on the ability of learners to solve word problems. The research delved deeper into how the levels of TMKT affect learners' ability to solve word problems, as well as how teachers and learners interact when tackling word problems, and how learners' reading comprehension and numeracy in this area are affected.

CHAPTER THREE:

METHODOLOGY

3.1. Introduction

This section presented an overview of the methodology that was used in the research. This part is broken down as follows: the research design, the variables, the study location, the target population, the sampling procedures and sample size, the data collecting instruments, the pilot study, the reliability and validity of the data collection techniques, the data analysis methodologies, and the ethical issues.

3.2. Research Design

The study used descriptive and correlational designs with quantitative and qualitative research techniques. The purpose was to explain how a teacher's proficiency in Mathematics can influence their learners' ability to solve word problems. So, descriptive design was chosen because it helps to investigate those variables that are involved in the study (Siegle 2015). A correlational survey design helped the researcher assess relationships between teachers' Mathematical knowledge and learners' ability in solving word problems. A correlational survey examines relationships and makes prediction (Gay *et al.*, 2011). The researcher measured variables relatively and assessed the statistical relationship that a teacher's Mathematical knowledge for teaching has with learners' ability in solving word problems, which had less or no effort in controlling extraneous variables (Neuman 2014). The correlational design can be used to investigate either causal or non-causal relationships, which makes it appropriate for this study (Siegle 2015; Creswell 2012) given that the researcher's focus was on determining whether or not there is a correlation between the two variables.

Quantitative and qualitative research techniques were used to collect and analyse the data. According to Johnson *et al.* (2014) and Johnson and Christensen (2015), the use of both quantitative and qualitative research methods is important in a study because it uses both exploratory and confirmatory methods in a single study. The researcher intended to use these techniques in this study because the study collected, analysed, and presented quantitative and qualitative data. The report of the study had a mixture of numbers and narratives.

3.3.Variables

The variables in this study were broken down into three categories: independent, intervening, and dependent. The teachers' Mathematical knowledge in the classroom serves as the study's independent variable; the intervening variables moderate the study's dependent variable. Those intervening variables are teachers' level of educational qualification, knowledge of learners' learning needs, knowledge of instructional practices, interpersonal social knowledge, and learners' comprehension skills levels. The interaction of intervening variables and independent variable will influence the dependent variable.

3.4. Study Location

This study was conducted in the Naivasha Sub-County, which is a region within Nakuru County, Kenya. The study's setting was ideal because it includes a wide range of schools with different demographics and environments, from National schools to Sub-County schools (Girls, Boys, and Mixed). Nakuru county is a home to 2,162,202

people as of the 2019 Kenya National Bureau of Statistics [KNBS] census. There are 16.44% of Nakuru county's population living in the Naivasha Sub-County, making it the most populated Sub-County in Nakuru County. Naivasha is the most populated Sub-County in Nakuru County, but its learners have consistently performed low than the county average in Mathematics over the past five years.

3.5. Target Population

In some contexts, factors that the researcher concentrates on and draw up conclusions by testing the sample to generalise findings is referred to as the population or target population (Orodho *et al.,* 2016). Therefore, the study concentrated on 5,313 participants from the 65 public and private secondary schools in Naivasha Sub-County, which was broken down into 65 Mathematics Heads of Department (MHOD), 65 teachers of Mathematics, and 2,733 female and 2,450 male learners in Form two (2). The study targeted four categories of schools in Naivasha Sub-County: National, Extra-County, Sub-County, and Private schools respectively. This location became of relevance to the study because Naivasha Sub-County having an urban characteristic and being the largest Sub-County performed below the country's standard score for the past five years in Mathematics and have also performed below the 50% standard score for Mathematics paper one (1) and paper two (2) which is word problems. The study saw a need for such research to be conducted in this area because the current research did not find enough literature on Teachers' Mathematical Knowledge for Teaching and how it influences learners' ability to solve word problems.

3.6. Sampling Techniques and Sample Size

In this section, the techniques of sampling and the sample size of the study was presented.

3.6.1 Sampling Techniques

The technique of stratified random sampling was the most appropriate technique because the study's population was not homogeneous. According to Johnson and Christensen (2015); Mugenda and Mugenda (2019), stratified random sampling is a variation of simple random and systematic methods used when there are a lot of unique subgroups. The study must include members of each sub-group for it to be considered valid. Therefore, stratified random sampling technique helped in considering every category of schools and the gender of learners in making the findings accurate. The class level was chosen by employing a purposive sampling strategy, and only learners in Form two (2) were included in the study. This sampling technique involves the researcher selecting a sample from the population base on their typicality (Orodho 2017). This class level in all the categories of schools has a common characteristic with each topic and lesson of the Mathematics syllabus concluding with an application, more besides, Form two (2) is selected because word problems were taught in Form I with more application of real-life problems.

3.6.2 Sample Size

The researcher used the Fisher *et al.* (1991) formula in determining the sample size which is written as: $nf = \frac{\frac{z^2pq}{d^2}N}{N+\frac{z^2pq}{d^2}}$, wherein nf is the sample size less than 10,000, z implies the critical z-value set at 1.96 with a confident level of 95%, p is the

proportion of the target population of 50%, q is $1-p$, d is the degree of accuracy of 5%, and N is the target population. Therefore, with this formula used, the sample of the study is 358 respondents. Additionally, the study's sample size of each category was determined by using the stratified random sampling formula: $\frac{Pi}{N} * n$, where pi is the stratum in each sub-population, N is the population, and n is the sample size of the study (Orodho *et al.*, 2016; Orodho, 2017).

Table 3.1: Sampling Grid

Target population		Sample size	Percent
Schools (Public and Private)	65	10	15.38
Teachers	65	10	15.38
Mathematics Heads of Department	65	10	15.38
Learners	5,183	338	7.72

In Table 3.1, the study sampled schools, teachers of Mathematics, and Mathematics Heads of Department which constituted (10) 15.38% respectively. The sample of learners was (338) 7.72%, whereby there were a total of 358 individuals that participated in the study as respondents.

3.7. Data Collection Tools

The fundamental principles of mixed research methods, according to Johnson & Christensen (2015), involve the careful combination of data collection methods and tools to provide various (vastly different and internally consistent) and complementary strengths as well as nonoverlapping weaknesses. Mugenda and Mugenda (2019) added that collecting data using different methods and instruments within the same study reduces bias and extraneous factors, allowing for a more accurate comparison. Therefore, in order to gather data for this study, the following instruments, including questionnaires, interviews, a classroom observation checklist, a

text comprehension skills test (TCST), and arithmetic skills tests (AST), were employed.

3.7.1. Teachers of Mathematics Questionnaires and Learners' Questionnaires

According to (Roopa & Rani 2012), questionnaires are often used as research instruments that help collect primary quantitative data in a standard way so that the data obtained are internally consistent and coherent. Questionnaires are essential to this study because the researcher collected quantitative data. The researcher formulated structured and unstructured questionnaires for Teachers of Mathematics and structured questionnaires for Form two (2) learners. The questionnaires were divided into two sections; section one contained the respondents' demographic data, and section two collected responses to the research objectives as presented in **Appendix I** and **Appendix III.**

3.7.2. Classroom Observation Checklist

A classroom observation checklist is also a tool for collecting qualitative data in research (Cohen *et al.*, 2018; Neuman, 2014). For the researcher to get the in-depth interaction of the teachers and learners and how the teachers' Mathematical knowledge for teaching influence learners' ability to solve word problems, classroom observation was necessary to the study. With the approval of the teachers, the researchers carefully documented, transcribed, and scrutinised classroom activities to determine the dynamics of teacher-learner interactions and their impact on students' proficiency in solving word problems as presented in **Appendix II**

3.7.3. Mathematics Heads of Department Interviews

Interview in research is meant to collect qualitative data (Mugenda, & Mugenda, 2019; Orodho *et al.*, 2016). Qualitative data was collected in this study using a structured interview schedule. This instrument helped the researcher collect data and make the analysis more accurate because it took care of the qualitative aspect of the study. The guided interview brought out more information about the teachers' Mathematical knowledge for teaching and how it influenced learners' ability to solve word problems as shown in **Appendix IV.**

3.7.4. Text Comprehension Skills Tests (TCST) and Arithmetic Skills Test (AST)

The TCST and AST assessed learners' reading comprehension and arithmetic skills. Tests of related items were administered to the learners, the results in the text were analysed, and the arithmetic test results was also be analysed. The researcher compared the scores of the text and arithmetic tests. Teachers' Mathematical knowledge for teaching were analysed by randomly selecting learners' worksheets for the teachers to mark and correct the working errors the learners made. The corrections were done in a process where the teachers answered those questions, then check learners' working steps, identify errors, and provide the right step to the solution to a question in line with the marking scheme which the researcher prepared. The results of these tests validated the observation of how the TMKT influences learners' ability to solving word problems. See **Appendix V(A) and Appendix V(B).**

3.8. Pilot Study: Validity and Reliability of the research instruments

This section discusses the pilot study, validity, and reliability.

3.8.1. Pilot Study

The researcher conducted a pilot study in a purposively selected secondary school which is 10% of the 10 sampled schools of the study location. The school did not participate in the actual study. Also, 10% of the study sample participated in the pilot study. According to (Cohen *et al.*, 2018; Creswell, & Creswell, 2018; Mugenda, & Mugenda, 2019) a pilot the study helps researchers to establish and make correction in the data collection instruments. They added that a small respondent for the pilot study is good, it ranges from 1% to 10% of the sampled respondents of the study. The researcher selected schools that participated in the pilot study purposively in Nakuru county, Kenya.

3.8.2 Validity

Validating research instruments is cardinal to every study; according to Creswell and Creswell (2018); Creswell (2012); it enables researchers to draw meaningful inferences from instrument scores. The instruments validity creates a valid and meaningful link between the collected data and the variable of interest (Cohen *et al.*, 2018; Mugenda, & Mugenda, 2019). The instrument's content, construct (predictive or concurrent) and criterion were validated. Content validity was vital to this study because it allows the researcher to test for the specific domain in the questionnaires, interviews, and the TCST and AST. Piloting the instruments helped to ensure high level of validity and the appropriateness of the mechanics of language used in the questionnaires and the test, as well as figured out any difficulty in the items.

3.8.3 Reliability

The researcher piloted all instruments to ensure their reliability. Its significance to all research works is that the instruments should show a consistent result after a repeated trial on different respondents. For the quantitative data, the numerical results of the instruments did not vary from one another (Neuman 2014). Testing the instruments helped to ensure their reliability and help to undergo a consistent measurement process. The study used an internal consistency technique wherein a single test form was administered using the split-halves methods (Orodho *et al.*, 2016). Kuder-Richardson's method of rational equivalence was used to determine the internal consistency of the tools. The researcher applied the Kuder-Richardson correlation coefficient as written below:

$KR_{20} = \frac{k(S^2 - \sum S^2)}{(k-1)S^2}$, wherein KR_{20} is the coefficient of reliability of the internal consistency, K represents the count of indicators used to evaluate the idea, S^2 implies the squares of the variance of each item, $\sum S^2$ denotes the sum of the squares of variance of all scores (Cohen *et al.*, 2018; Creswell, & Creswell, 2018; Mugenda, & Mugenda, 2019; Orodho *et al.*, 2016).

3.9. Data Collection Techniques

Data collection is the act of collecting and analysing information on relevant variables in a defined systematic way that makes it possible to respond to research objectives and research questions, test hypotheses, and assess results (Creswell, 2012; Johnson & Christensen, 2015; Mugenda & Mugenda, 2019). Kenyatta University Graduate School issued an introductory letter to the researcher, which enabled the researcher to have applied for a research permit from National Commission for Science, Technology, and Innovation (NACOSTI). Following receipt of the research permit

from NACOSTI, the researcher further obtained permit letters from Nakuru County and Naivasha Sub-County Education offices respectively. Those instruments enabled the researcher to visit all the sampled schools with no barrier. The study included interviews with 10 Mathematics Heads of Department, 10 Teachers of Mathematics, and 318 Form two (2) learners with the data collection tools being Teachers of Mathematics' questionnaires, classroom observation checklist, learners' questionnaires, MHOD interview, and Text comprehension Skills Test (TCST) and Arithmetic Skills Test (AST). The research instruments were accompanied by a cover letter explaining the study's significance to all participants and participants' consent form.

3.10. Data Analysis

The research instruments generated quantitative and qualitative data using open-ended and close-ended questionnaires, interviews, classroom observation checklist, and Text Comprehension Skills Test (TCST) and Arithmetic Skills Test (AST). The following objectives were used to guide the analysis of the data: 1) to determine the influence of the level of teachers' Mathematical Knowledge for Teaching on learners' ability to solve word problems, 2) to establish the influence of teacher-learner classroom interaction in teaching word problems, and 3) to establish the relationship between learners' reading comprehension and arithmetic skills in solving word problems. Objectives one (1) and two (2) generated quantitative and qualitative data with the help of questionnaires, classroom observation checklist, and interviews. The quantitative data were analysed using descriptive statistics with the measure of central tendency. The qualitative data were transcribed into codes and analysed. The following tools: Statistical Package for Social Sciences (SPSS) version 26, Microsoft

Excell 365, and Qualitative Data Analysis (QDA) miner lite helped the researcher in analysing the data. The data analysis yielded results that were presented in the form of frequency tables, charts, graphs, and narration.

Objective three (3) also generated quantitative and qualitative data through questionnaires, classroom observation checklist, and text comprehension and arithmetic skills test. The Pearson product-moment correlation coefficient, which is denoted by the formula below, was used to determine the correlation between learners' reading comprehension and arithmetic skills and teachers' Mathematical knowledge for teaching and learners' ability to solve word problem:

$r = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{(N\sum X^2 - (\sum X)^2)(N\sum y^2 - (\sum Y)^2)}}$, where N is the number of paired values, $\sum XY$ is sum of the product of variable X and variable Y, $\sum X$ is the sum of the values of the X variable, $\sum Y$ is the sum of the values of the Y variable, $\sum X^2$ is sum of the squares of the values of the X variable, $\sum Y^2$ is the sum of the squares of the value of the Y variable, $(\sum X)^2$ is the sum of value of X variable squared, and $(\sum Y)^2$ is the sum of the value of the Y variable squared. The data were analysed quantitatively using percent counts, means, and frequency distribution with the help of Microsoft Excel 365 and Statistical Package for Social Sciences (SPSS) version 26. The study presents the data using descriptive and inferential statistics with narration for better interpretations. The interview responses of this study were transcribed into codes with the help of Qualitative Data Analysis Miner Lite (QDA Miner Lite Software).

3.11. Logistical and Ethical Considerations

This section presents the logistical consideration and ethical consideration.

3.11.1 Logistical Considerations

The researcher carried careful pre-research activities before the actual study started. These pre-research activities included preparation of proposal to meet Graduate School standards, obtaining an introductory letter from Graduate School, applying, and obtaining of Research Permit from NACOSTI, and obtaining permission letters from the County and Sub-County Education office of Nakuru County and Naivasha Sub-County respectively. According to Mugenda and Mugenda (2019), it is crucial to consider the logistics that the study needs in conducting a meaningful, reliable, and successful study. All steps needed for the success of the study were considered before the researcher started.

3.11.2 Ethical Considerations

The researcher made all the participants to have familiarized themselves with the research instruments and the purpose of the study before they started filling them out. Participants' confidentiality and anonymity were taken in high esteem, which supports ethical research practice. As a best practice and virtuous part of the research process, participants firstly received and signed a consent form before the instruments were distributed to them. To ensure the level of confidential of the participants, the researcher eliminated and encouraged all participants not mentioned their or any other personal details that could have identified them. All relevant ethical documents were obtained before the entire process of data collection of the study started.

CHAPTER FOUR:

PRESENTATION OF FINDINGS, INTERPRETATION AND DISCUSSION

4.1. Introduction

In this chapter, the results of the study were analysed with generated conclusions in the order of the study's objectives, using tables, charts, and frequency counts. The data collected was from responses of 10 teachers of Mathematics, 10 Mathematics Head of Departments, and 338 learners with total respondents of 358. The data collection tools that generated these data were teachers of Mathematics' questionnaires, Mathematics Head of Department Interviews, classroom Observation Checklist, learners Questionnaires, Text comprehension Skills Test (TCST), and Arithmetic Skills Test (AST). These data collection tools that generated the data were derived from the following objectives:

a. To determine how the level of Teachers' Mathematical Knowledge for Teaching influence learners' ability to solve word problems.
b. To establish the influence of teacher-learner classroom interaction in teaching word problems.
c. To establish the relationship between learners' reading comprehension and arithmetic skills in solving word problems.

Related literature reviewed in chapter two helped in the discussion section of the study and also support the findings of this study.

4.2. General and Demographic Information

The demographics data of the respondents are shown in this section. The respondents' school types, gender, level of education, college major, years of teaching experience, learners' favourite subjects, and learners' ages are all included.

4.2.1 Response Rate

Table 4.1 displayed the response rate for the participants. Before taking part in the study, all participants signed a permission form, were thoroughly informed about it, and then got the data collecting instruments. They then completed the questionnaires and immediately sent them back to the researcher.

Table 4.1: Response Rate

Data collection tools	Number of tools distributed	Number of tools returned	Number of tools not returned	% of returned tools
Teachers' Questionnaires	10	10	0	100.0
MHOD interview	10	10	0	100.0
Learners' Questionnaires	338	318	20	94.1
Learners' TCST	338	318	20	94.1
Learners' AST	338	318	20	94.1
Total	**1,034**	**974**	**60**	**94.2**

The data presented in Table 4.1 shows that 100.0% of the Teachers' questionnaires and the Mathematics Heads of Department (MHOD) interviews were returned respectively. The data further shows that 94.1% of the instruments distributed to the learners were returned in the following categories: learners' questionnaires, Text comprehension skills test, and the arithmetic skills test respectively. The overall returned rate of the study was 94.2% with only 5.8% of the instruments not returned. This made the study response rate to stand out for according to Allen (2017); Doss *et al.* (2021); Fincham (2008) a response rate of at least 60% of a study shows high level of minimum non-response bias.

4.2.2 Demographic Data

This section presents the demographic information of the respondents.

4.2.2.1 Demographic Data of Mathematics Teachers

This section presents the demographic data of Teachers of Mathematics per schools.

Table 4.2: Gender of Mathematics Teachers per type of schools

	Gender			% of
	Male	**Female**	**Total**	**Frequency**
National School Mixed	1	0	1	10.0
Extra County School Mixed	1	0	1	10.0
Private School Mixed	0	1	1	10.0
Sub-County School Mixed	1	2	3	30.0
Sub-County School Boys	1	1	2	20.0
Sub-County School Girls	0	2	2	20.0
Total	**4**	**6**	**10**	**100.0**

Table 4.2 shows that 30% of the respondents are from Sub-County Mixed schools with Sub-County Boys and Girls schools making up of 20% respectively. The data further shows 60% of the respondents to be female teachers, while 40% are male teachers. According to the data presented in Table 4.2, there are more female Teachers of Mathematics than male teachers in the schools that participated in the study.

Table 4.3: Mathematics Teachers' Qualification

Qualification	Frequency	% of Frequency
PhD	0	0.0
M.Edu	0	0.0
B. Edu (Science)	3	30.0
B. Edu (Arts)	7	70.0
B. Sc	0	0.0
PDGE	0	0.0
Diploma (Arts/Science)	0	0.0
Total	**10**	**100.0**

In Table 4.3, it is shown that 70% of the respondents earned B. Edu (Arts) degree, whereas 30% earned B. Edu (Science). There were none of the teachers who have earned a Master or PhD.

Table 4.4: Mathematics Teachers' Mathematics Concentration

Mathematics Concentration	Frequency	% of Frequency
Major	4	40.0
Minor	6	60.0
Total	**10**	**100.0**

Data presented in Table 4.4 indicates that 40% of the Teachers of Mathematics majored in Mathematics while 60% of simply minored in the subject.

Table 4.5: Mathematics Teachers' Teaching Experience

Teaching Experience	Frequency	% of Frequency
1 – 6 years	1	10.0
7 – 12 years	3	30.0
13 – 18 years	3	30.0
19 years or more	3	30.0
Total	**10**	**100.0**

Table 4.5 shows that 30% of the respondents have teaching experience from 7 to 12 years up to 19 years and above respectively, whereas 10% have teaching experience of 1 to 6 years.

4.2.2.2 Demographic Data of Learners

This section presents the demographic data of learners per schools.

Table 4.6: Learners' Gender per type of Schools

Type of schools	Gender		Total	% of frequency
	Male	Female		
National School Mixed	10	18	28	8.8
Extra-County School Mixed	12	15	27	8.5
Private School Mixed	12	18	30	9.4
Sub-County School Mixed	51	60	111	34.9
Sub-County School Boys	52	0	52	16.4
Sub-County School Girls	0	70	70	22.0
Total	**137**	**181**	**318**	**100.0**

The data in Table 4.6 shows that 34.9% of the learners were from Sub-County Mixed schools, whereas 22.0% were from Sub-County Girls schools. A total of 43.1% of the participants were male learners while 56.9% were female learners. A little number of learners from National, Extra, and private mixed schools constituting 8.8%, 8.5%, and 9.4% were represented in the study.

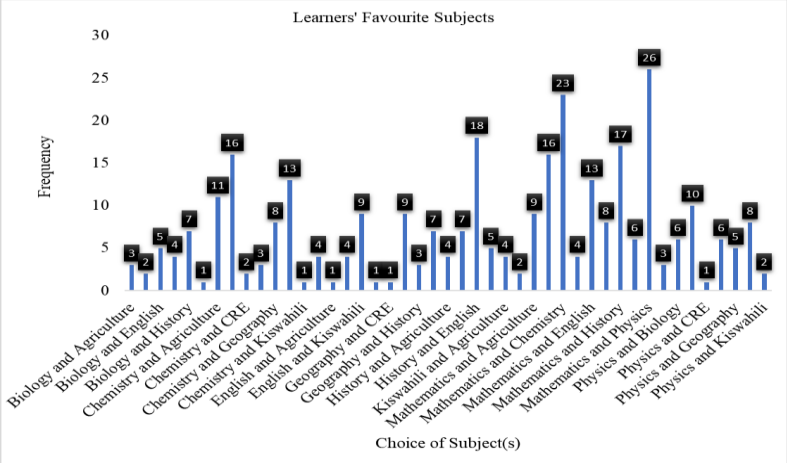

Figure 4.1: Learners' Favourite Subject(s)

Figure 4.1 shows that 8.18% of the learners' favourite subjects selected were Mathematics and Physics and 7.23% chose Mathematics and Chemistry. The data also reveals that 5.7% of the learners had History and English as their favourite subjects and 5.3% favouring Mathematics and History. The data presented in Figure 4.1 shows

that the total of 122 learners constituting 38.4% chose Mathematics along with other subjects as favourite, whereas 196 of the respondents representing 61.6% chose subjects order than Mathematics as favourite subjects.

Table 4.7: Learners' Age Range

Age Range	Frequency	% of Frequency
7 to 10 years	14	4.4
11 to 14 years	106	33.3
15 to 18 years	196	61.6
19 to 22 years	2	0.6
Total	**318**	**100.0**

According to the information presented in Table 4.7, it is shown that 61.6% of the learners were in the age range of 15 to 18 years, while 33.3% of the learners were in the age range of 11 to 14 years. 4.4% of the learners fell into the age bracket of seven to ten years, while just 0.6% were in the age range of nineteen to twenty-two years.

4.3 Teachers' Level of Mathematics Knowledge

The first objective of the study was ***to determine the influence of the level of teachers' Mathematical knowledge for teaching on learners' ability to solve word problems***. Data for this objective were gathered from Teachers of Mathematics, learners, and Mathematics Heads of Department. Data obtained from these items were displayed in tables with the responses of Teachers of Mathematics, Mathematics Head of Department, and learners.

Table 4.8: Teachers' Responses on the influence of the level of TMKT on learners' ability to solve word problems.

Statement	Frequency and % of Frequency in the parenthesis					
	Strongly Agree	Agree	Strongly Disagree	Disagree	Not Sure	Total
There are some topics in the syllabus which are unclear to me.	3 (30.0)	5 (50.0)	1 (10.0)	1 (10.0)	0 (0.0)	10 (100.0)
I have a strong sense of numbers but some challenges in converting text into solvable concepts.	2 (20.0)	4 (40.0)	1 (10.0)	3 (30.0)	0 (0.0)	10 (100.0)
I have a strong analytical skill which supports me in teaching word problems.	5 (50.0)	3 (30.0)	1 (10.0)	1 (10.0)	0 (0.0)	10 (100.0)
I follow procedure well but face some problem with conceptualizing the Mathematical ideas from text.	0 (0.0)	4 (40.0)	3 (30.0)	3 (30.0)	0 (0.0)	10 (100.0)
I have a high proficiency level in Mathematics.	3 (30.0)	4 (40.0)	2 (20.0)	1 (10.0)	0 (0.0)	10 (100.0)
I attend regular inter-school meetings quarterly, which involve all Mathematics teachers to help strengthen some areas in the syllabus.	7 (70.0)	2 (20.0)	1 (10.0)	0 (0.0)	0 (0.0)	10 (100.0)
My level of Mathematical knowledge has shifted learners' ability to solve word problems.	4 (40.0)	3 (30.0)	1 (10.0)	2 (20.0)	0 (0.0)	10 (100.0)
My ability to adapt textbook concepts into approachable concepts has helped my learners perform better on word problems.	3 (30.0)	5 (50.0)	1 (10.0)	1 (10.0)	0 (0.0)	10 (100.0)
I know a lot about my subject, but have only a minimum required knowledge about how to teach it.	1 (10.0)	3 (30.0)	5 (50.0)	1 (10.0)	0 (0.0)	10 (100.0)
My mathematical knowledge for teaching is well articulated through the five strands of Mathematical proficiency.	5 (50.0)	2 (20.0)	1 (10.0)	2 (20.0)	0 (0.0)	10 (100.0)

In determining the influence of the level of TMKT on learners' ability to solve word problems, data in Table 4.8 showed that majority of the teachers have strong sense of numbers, high proficiency in mathematics, the ability to adapt textbook concepts into approachable concepts. However, majority of the teachers agreed of finding some

topics in the syllabus that were not clear to them and many agreed of having some challenges in converting text into solvable concepts. The data showed that 8 (80%) of the teachers agreed that some topics in the Mathematics syllabus are unclear to them. Findings showed that 4 (40%) of the teachers agreed of facing some problems with conceptualizing the mathematical ideas from text, while 6 (60%) disagreed with the assertion. Additionally, 9 (90%) of the teachers agreed of attending regular inter-school meetings quarterly which support them in strengthening areas where there are challenges.

Table 4.9: Learners' Responses on the influence of the level of TMKT on learners' ability to solve word problems.

Statement	Frequency and % of frequency in the parenthesis					
	Strongly Agree	Agree	Strongly Disagree	Disagree	Not Sure	Total
My teacher shows many easy steps when solving word problems.	95 (29.9)	87 (27.4)	125 (39.3)	9 (2.8)	2 (0.6)	318 (100.0)
The teacher sometimes struggles to bring out the Mathematical idea from the text for us to solve.	110 (34.6)	65 (20.4)	80 (25.2)	34 (10.7)	29 (9.1)	318 (100.0)
My teacher always solves the word problems by drawing diagrams and following a step-by-step order.	93 (29.2)	72 (22.6)	133 (41.8)	10 (3.1)	10 (3.1)	318 (100.0)
The teacher identifies key terms and ideas before we start solving.	89 (27.9)	87 (27.4)	115 (36.2)	20 (6.3)	7 (2.2)	318 (100.0)
The way my teacher can explain the steps in solving word problems has helped me greatly.	106 (33.3)	71 (22.3)	124 (38.9)	8 (2.5)	9 (2.8)	318 (100.0)
I believe that the teacher who knows Mathematics well can help us understand better.	137 (43.1)	54 (17.0)	94 (29.6)	13 (4.1)	20 (6.2)	318 (100.0)
My teacher struggle at time to set the problem before we solve it.	101 (31.8)	71 (22.3)	84 (26.4)	50 (15.7)	12 (3.8)	318 (100.0)
My teacher has not taught any word problem in this class.	111 (34.9)	20 (6.2)	100 (31.4)	77 (24.2)	10 (3.1)	318 (100.0)
All the example problems that my teacher solves are those same solved problems in our textbook.	115 (36.2)	51 (16.0)	113 (35.5)	33 (10.4)	6 (1.9)	318 (100.0)
The way my teacher can explain the steps in solving word problems has help me greatly.	90 (28.3)	60 (18.9)	97 (30.5)	63 (19.8)	8 (2.5)	318 (100.0)

The learners made their contribution on the objective; to determining the influence of the level of TMKT have on learners' ability to solve word problems. The data in Table 4.9 showed that majority of the learners responded that their teachers take step-by-step approaches in solving word problems. Most of the learners expressed that their teachers' approaches of teaching have helped them in solving word problems. The data showed that 121 (38.1%) of the learners agreed that their teachers have not taught word problems, whereas 177(55.6%) of the learners disagreed. The findings in Table 4.9 also showed that 175 (55.0%) of the learners agreed that their teachers sometimes struggle to bring out the mathematical idea from the text problem, but 114 (35.8%) of the respondents disagreed. The findings further showed that 166 (52.2%) of the learners agreed that problems that were solved in the class are problems solved in their textbooks, but 146 (45.9%) disagreed with the assertion.

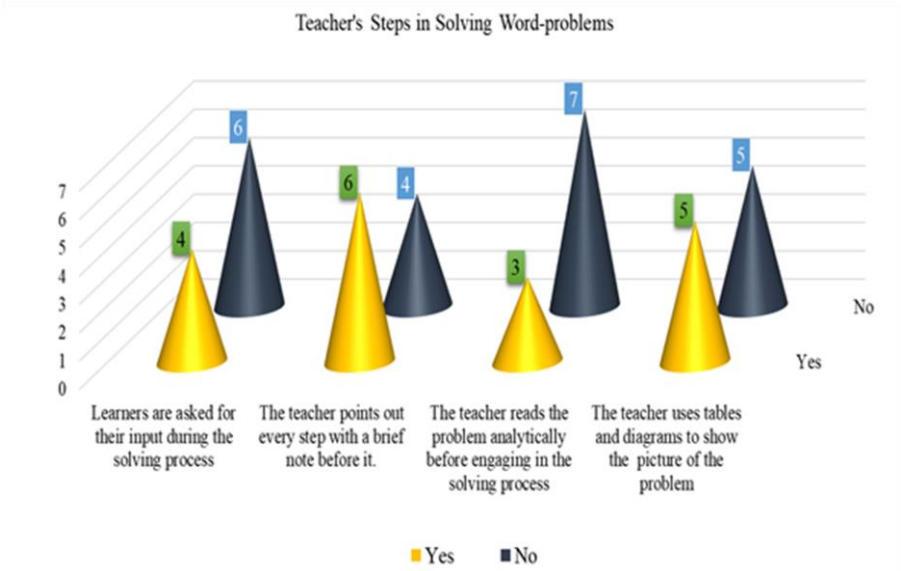

Figure 4.2: Classroom Observational Checklist on how teachers solve word problems

N = 10

Data in Figure 4.2 shows that during the classroom observation, 40% of the teachers asked the learners for help in solving the problems, while 60% just answered the problems on their own. It was also found that 60% of the teachers pointed out every important step with a short note during the teaching process, while the other 40% just

solved the questions without pointing out the steps. Fewer of the teachers, 30% solved the word problems analytically, whereas 70% were not focusing on analysis.

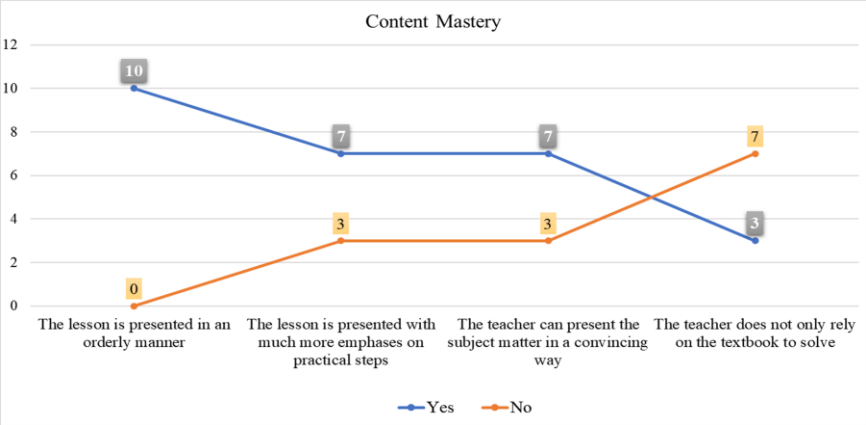

Figure 4.3: Classroom Observation Checklist on Content Mastery

The data presented in Figure 4.3 shows that 100% of the teachers presented the lesson in an orderly manner. Teachers who were observed, 7 (70%), presented the lesson with more emphases on practical steps as they were solving the word problems, but 3 (30%) of the teachers were not presenting with emphases on key steps. The researcher also found that 7 (70%) of the teachers were presenting the topics in a convincing way, with only 3 (30%) not showing convincing mastery over the topics. Findings further revealed that 7 (70%) of the teachers were relying on the exercises that are solved in the textbook, with only 3 (30%) of the teachers going beyond the textbooks' concepts.

Table 4.10: Mathematics Heads of Department Interview

Statement	Yes	No	Total
Do you think that the level of your teacher's educational qualification has influence on the way they teach their subject specific?	10	0	10
Why Yes	**Content Mastery**	**Exposure to various pedagogical skills**	
	6	4	10
	Yes	**No**	
Do your teachers' Mathematical content knowledge for teaching bring out the needed learning outcomes in learners	9	1	10

N = 10

The respondents in Table 4.10 said that teacher's level of educational qualifications influenced the way they teach. When the question was further discussed, 6 (60%) of the respondents said the teachers' level of educational qualification leads to content mastery and 4 (40%) responded that it exposes teachers to various pedagogical skills. The respondents further discussed the Mathematical content of the teachers wherein 9 (90%) agree that teachers' Mathematical content knowledge help to bring out the needed learning abilities and skills of learners.

4.3.1 Discussion of results

This section presents findings of the first objective: ***to determine the influence of the level of TMKT on learners' ability to solve word problems.*** Data was collected using Teachers of Mathematics' questionnaire which contained 10 items, learners' questionnaire, Mathematics Heads of Department scheduled interview, and classroom observation checklist. Data obtained from these items were displayed in tables with the responses of Teachers of Mathematics in Table 4.8, learners' responses in Table 4.9, Mathematics Head of Department interview responses in Table 4.10, as well as classroom observation checklist data presented in Figure 4.2 and Figure 4.3.

According to the data that is shown in Table 4.8, most of the teachers of Mathematics, which is 8 (80%), experienced some challenges in some topics that were included in the curriculum. On the other hand, only 2 (20%) of the teachers had no problems with the topics that were included in the curriculum. The data in Table 4.8 also points out some of the challenges teachers of Mathematics have faced, with over half of the teachers showing of having challenges to convert text into solvable concepts. The learners' responses in Table 4.9 show that little over half constituting 175 (55.0%) agreed that their teachers struggle to bring out the Mathematical idea from the text for solving, while other learners, 114 (35.9%), believe that their teachers do not struggle with word problems when solving them. These findings agree with Corrêa (2018), that teachers need more Mathematical knowledge emanating from their Mathematical proficiency.

Although the learners and teachers have identified some challenges in some topics, in Table 4.9, it was found that 177 (55.6%) of the learners agreed that their teachers explain steps when solving word problems which have helped them to solve word problems as well, but fewer learners, 132 (41.5%), did not agree to the assertion. As was observed in the classroom, the findings in Figure 4.3 showed that 6 (60%) of the teachers explain every step with a brief note as they solve the problem (arithmetic), but 4 (40%) of the teachers were only concern to solve the problems without pointing out any step or guided notes as they solve. In another instance, 7 (70%) of the teachers emphasized more on practical steps. The results of this study imply that learners may be missing instruction on difficult topics if teachers do not seek assistance in tackling them. The teachers' challenges in some topics might give rise to difficulties in the

teachers' pedagogical content knowledge as mentioned by Young-Loveridge *et al.* (2012).

In Table 4.8, most of the teachers of Mathematics, 6 (60%), agreed that there are some challenges in conceptualizing word problems into mathematical idea in finding solutions, but 4 (40%) perceive not challenges in conceptualizing word problems. As a means of finding solution to some of the challenges, 7 (70%) of the respondents in Table 4.8 attend quarterly inter-schools' meetings. The data collected, analysed, and presented suggest that one of the factors that might be causing learners low performance in word problems would be the challenges Teachers of Mathematics have. According to Chua (2020), the lack of Mathematical knowledge of teachers influences their teaching practices which in turn affect learners' learning outcomes. This finding is supported by Csíkos and Szitányi (2020) findings, that 76.7% of the participants had difficulties in teaching Mathematical applications which relate to real-life applications or word problems. This was also observed with the teachers wherein they expressed having challenges in some topics and converting text into solvable concepts. These challenges might create the continue low performance of learners in KCSE paper one (1) and paper two (2) which are related to real-life applications or more of word problems.

It was observed that 100% of the participants presented the lesson in an orderly manner during the classroom observation as presented in Figure 4.3. The researcher observed majority of the teachers during the classroom observation to have emphasized on practical steps in solving word problems. This observed attitude of the teachers agrees with Pournara *et al.* (2015), that teachers who have stronger

Mathematical knowledge increase the learning gains of their learners in problem-solving. In Table 4.10 when a further question was asked, 6 (60%) of the Mathematics Heads of Department (MHOD) said that the teachers' level of educational qualification brings about content mastery and 4 (40%) mentioned that the level of teachers' educational qualification leads to exposure of various pedagogical skills. In Table 4.10, 9 (90%) of the respondents believe that level of teachers' Mathematical content knowledge brings out the needed learning outcomes in learners.

4.4 Teacher-Learner classroom interaction in teaching word problems

This section presents responses of respondents to items that addressed objective two: ***to establish the influence of teacher-learner classroom interaction in teaching word problems***. The data was collected using a teachers' questionnaire, a learners' questionnaire, a classroom observation checklist, and a scheduled interview with the Mathematics Heads of Department, wherein the findings are presented in tables and charts.

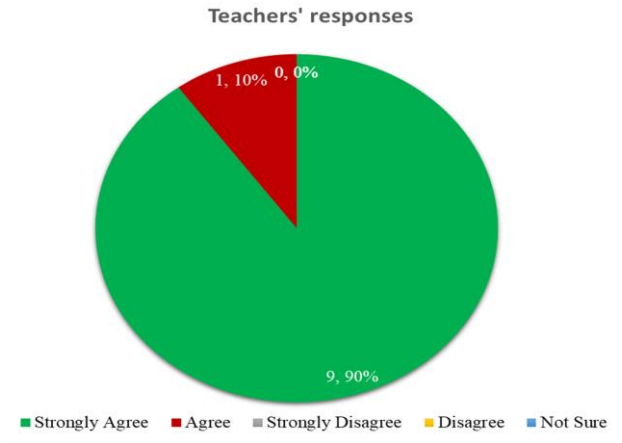

Figure 4.4: Mathematics Teachers' responses to "Learners' word problem-solving skills correlate with the amount of class discussion we have."

Figure 4.4 indicates that all teachers (100%) concur that there is a correlation between learners' word problem-solving skills and classroom interaction facilitated by discussion. No teacher was present to contest the statement.

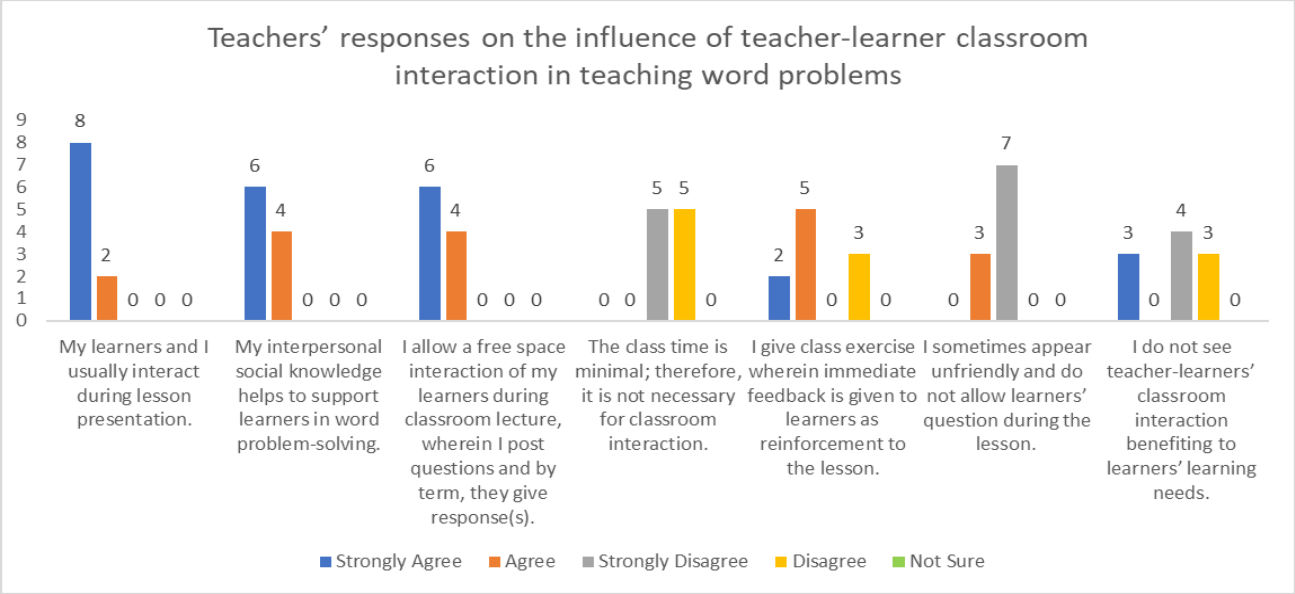

Figure 4.5: Teachers' responses

In assessing the effect of teacher-learner classroom contact on the instruction of word problems, virtually all educators concurred that such interaction significantly influences the teaching of word problems. The results depicted in Figure 4.5 indicate that all 10 teachers (100%) concurred that they and their students often engage in interaction during course presentations. All 10 responders (100%) concurred that learners are permitted a free area for engagement during classroom sessions.

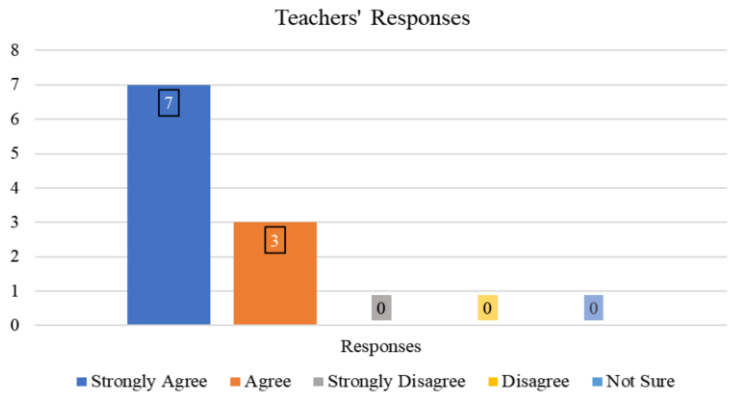

Figure 4.6: Mathematics Teachers' Responses to *"The learners and I have a strong bond of social connection, which supports learning."*

Figure 4.6 indicates that 100% of Mathematics Teachers agree that the strong relationships established with their learners have contributed to the learners' success in class.

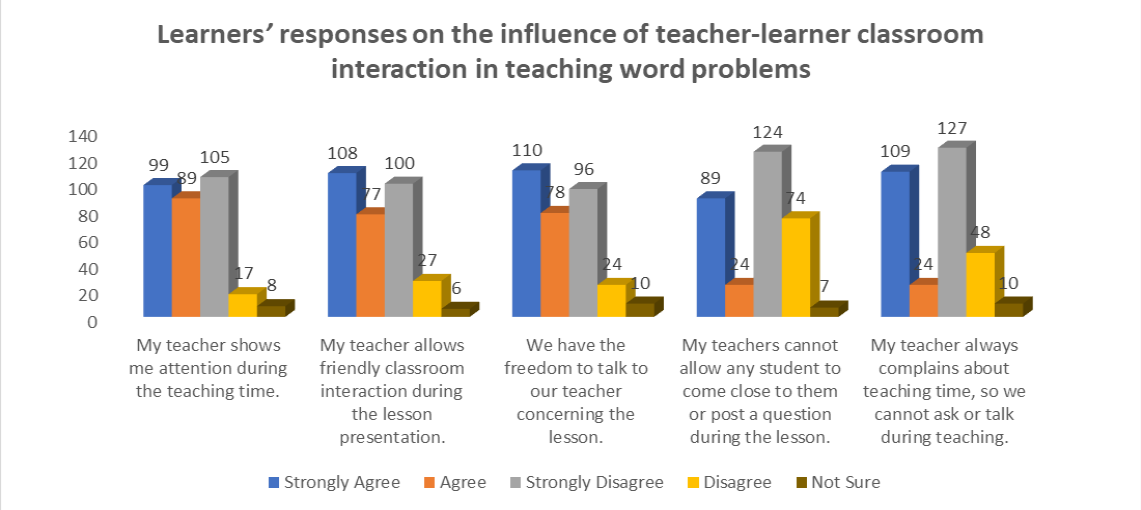

Figure 4.7: Learners' responses

To support the findings, majority of the learners affirmed the importance of teacher-learners classroom interaction in teaching word problem. According to the data in Figure 4.7, 38.4% of the learners disagreed with the assertion whereas 59.1% of them said their professors pay them attention throughout the teaching session. The learners in their response, 198 (62.3%), disagreed to "***My teachers cannot allow any student to come close to them or post a question during the lesson."*** This affirmed that the teacher-learner classroom interaction plays an important role during teaching.

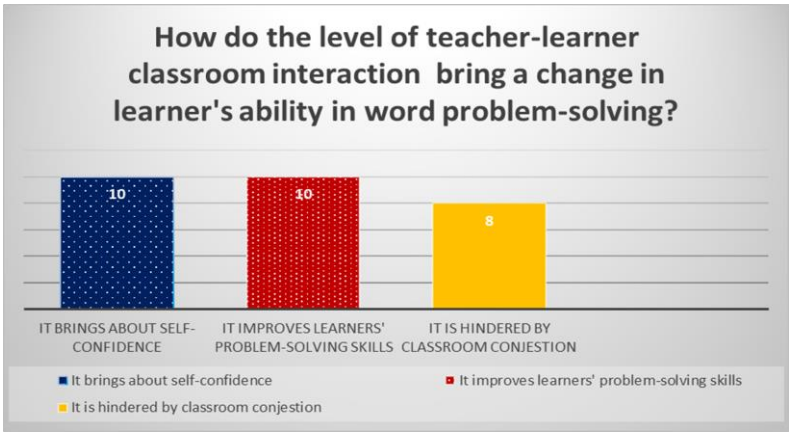

Figure 4.8: Mathematics Heads of Department Responses

No: 10

According to Figure 4.8, all, 100% of the Mathematics Heads of Department indicated that the extent of teacher-learner contact in the classroom fosters self-confidence and enhances learners' problem-solving abilities. The study indicates that 80% of Mathematics Heads of Department identified difficulties that rendered teacher-learner contact unfeasible, including classroom overcrowding.

Table 4.11: Classroom Observation Checklist

Observed Activity	Yes	No	Total
High level of motivation from the teacher to the learners	8	2	**10**
Learners are freely participating in the classroom discussion	4	6	**10**
Learners engage in the teaching process as the teacher teaches the lesson	3	7	**10**
Learners learn in groups and at some point, in time, they do some independent work	1	9	**10**
The classroom lively between the teacher and learners	5	5	**10**
The teacher can call out the name of the learners as a means of maintaining classroom order	2	8	**10**
The teacher shows a high level of confidence and passion for the topic and learners' learning needs	7	3	**10**
The word problem-solving in the classroom is like fun	5	5	**10**

N = 10

Table 4.11 demonstrates that whilst 2 (20%) of the teachers were not motivating in their instruction, 8 (80%) of them were displaying high degree of motivation to the learners. Six (60%) of the teachers did not provide their students the time, but learners may speak in the class lesson at a point with 4 (40%) of the professors enabling so. Regarding involvement in the class, three (30%) of the teachers let their students participate whereas seven (70%) did not let their students participate.

Data in Table 4.11 reveal that although 9 (90%) of the instructors could not succeed due of the class size, the teachers did their best to apply group learning methodologies with 1 (10%) of the teachers succeeding. Five (50%) of the teachers were excellent in making the classroom dynamic; five (50%) were not following along. While 2 (20%) of the instructors were able to call out their pupils and also point out a learner by

name throughout the session, 8 (80%) of the teachers could not call out the name of the learners for either input or attention. Seven (70%), of the professors display great degree of confidence and love for the material they were teaching as well as the learning requirements of the students. While five (50%) of the teachers were focused on the lesson, five (50%) of them responded well if the instruction was made enjoyable.

4.4.1 Discussion of Results

This section discusses the findings of objective two: ***to establish the influence of teacher-learner classroom interaction influence in teaching word problems***. Questionnaires for Mathematics teachers and learners, classroom observation checklist, and scheduled interview for Mathematics Heads of Department were research tools that were analysed and presented in tables and figures.

As shown in Figure 4.4, all the teachers, 10 (100%) believe that the classroom contact through discussion determines the capacity of students to answer word problems. Ten (100%) of the instructors in Figure 4.5 said they were able to engage their students in the classroom by means of their interpersonal social expertise and by establishing a free area for engagement. They felt that this contact improved students' capacity to solve word problems. Ten (100%) of the MHOD answers in Figure 4.8 said that interactions between teachers and students foster self-confidence and help learners to solve problems by means of improved abilities. The results confirm Pennings *et al.* (2018) conclusions that classroom engagement promotes social order and keeps learners in good conduct.

According to Li and Yang (2021), the teacher-learner classroom contact increases learners' capacity to solve difficulties, therefore fostering a good productivity. According to the figures in Figure 4.7, 59.1% of the students said they felt free to voice opinions on the course of instruction. Most of the responders admitted to have these good productivities. According to the figures in Figure 4.8, 8 (80%) of the MHOD mentioned various issues that hampered classroom contact; one of the typical concerns that does not support the necessity of classroom interaction is classroom overcrowding. Nine (90%) of the classes visited revealed that students in group for cooperative learning could not work well. Furthermore shown by the results are six (60%) of the teachers that forbade students from joining in classroom discussions. From a classroom observation as shown in Table 4.11, the researchers found that eight (80%) of the teachers shown great degree of motivation to the learners. As a support to all teaching and learning activities, Xie and Derakhshan (2021) underlined the need of instructors and students creating a strong interpersonal social network in the classroom. Maybe due to the class length, size of the class, or other variables, the activation of interpersonal social network among students was not evident. Teamwork and cooperative learning build interpersonal social networks in the classroom according to Münte *et al.* (2019) and Gasser *et al.* (2018), which increase a mutual give-and-eat, encouragement, emotional support, effective communication, and strong listening skills. Students in this survey confirmed the amicable contact between their professors and them in the classroom whereas their replies as shown in Figure 4.7 indicate that 58.2% of them agree. This finding aligns with Pennings and Hollenstein (2020) research conducted in Netherland whereby students found their professors' interpersonal interactions to be favourable. Although the respondents recognised the value of teacher-learners' classroom interaction, the observations and responses of the

Mathematics Heads of Department reveal one typical obstacle to the classroom interaction for establishing teams or implementing cooperative teaching and learning: class size. Among the elements underlined by Majanga *et al.* (2019), class size was considered one of the challenges that hindered classroom interaction in Nakuru Municipality.

4.5 Learners' reading comprehension and arithmetic skills in solving word problems.

This section presents findings of participants' responses to items that answer to objective three: ***to establish the relationship between learners' reading comprehension and arithmetic skills in solving word problems***. Questionnaires for Mathematics teachers and learners, classroom observation checklist, and Text Comprehension Skills Test (TCST) and Arithmetic Skills Test (AST) were the data collection tools for this objective. The researchers analysed and presented the findings in tables. The learners' scores were analysis by calculating the mean, standard deviation and finding the correlation.

Table 4.12: Teachers' responses on learners' reading comprehension and arithmetic skills

Statement	Frequency and % of Frequency in the parenthesis					
	Strongly Agree	Agree	Strongly Disagree	Disagree	Not Sure	Total
Learners in my class have strong arithmetic skills.	4 (40.0)	2 (20.0)	2 (20.0)	2 (20.0)	0 (0.0)	10 (100.0)
Reading comprehension is helping my learners to solve word problems.	3 (30.0)	2 (20.0)	4 (40.0)	1 (10.0)	0 (0.0)	10 (100.0)
I do not see any relationship between reading comprehension and arithmetic skills, because they two different concepts.	2 (20.0)	1 (10.0)	2 (20.0)	5 (50.0)	0 (0.0)	10 (100.0)
I believe that the learners' arithmetic skills and reading comprehension will support them in word problem-solving.	6 (60.0)	1 (10.0)	2 (20.0)	1 (10.0)	0 (0.0)	10 (100.0)
My learners find some difficulties translating the text into arithmetic concept before solving.	5 (50.0)	1 (10.0)	2 (20.0)	2 (20.0)	0 (0.0)	10 (100.0)
When problems are presented in arithmetic form, learners can response well.	9 (90.0)	0 (0.0)	1 (10.0)	0 (0.0)	0 (0.0)	10 (100.0)

In Table 4.12, 60% of the teachers agree that learners in their classes have strong arithmetic skills, while 40% did considered their learners to have strong arithmetic skills. The findings further show that 5 (50%) of the Teachers of Mathematics agreed that the reading comprehension of learners has helped in solving word problems, but 5 (50%) perceived that the learners' reading comprehension had not helped them to solve word problems. Seventy percent of the teachers agreed that there is a relationship between reading comprehension and arithmetic skills. Sixty percent of the teachers agreed that learners find it challenging to translate text into arithmetic

before solving it. Nearly hundred percent of the teachers agreed that learners response well when the problems are presented in arithmetic form.

Table 4.13: Learners' responses on learners' reading comprehension and arithmetic skills

Statement	Frequency and % of Frequency in the parenthesis					
	Strongly Agree	Agree	Strongly Disagree	Disagree	Not Sure	Total
I can solve the problems when they are not written as text	112 (35.2)	67 (21.1)	89 (28.0)	40 (12.6)	10 (3.1)	318 (100.0)
I love the Mathematics being given as text because it tests my reading comprehension.	109 (34.3)	62 (19.5)	126 (39.6)	13 (4.1)	8 (2.5)	318 (100.0)
I believe that my reading understanding and skills in arithmetic have helped me to solve word problems.	117 (36.8)	66 (20.8)	100 (31.4)	27 (8.5)	8 (2.5)	318 (100.0)
I am good at solving arithmetic problems, but find some challenges in converting the text into arithmetic concepts before solving.	109 (34.3)	89 (28.0)	85 (26.7)	25 (7.9)	10 (3.1)	318 (100.0)

In Table 4.13, the data shows that 56.3% of the learners agreed that the solve problems when they are not written in text form, but 40.6% did not agree with the statement. The findings in Table 4.13 further show that 53.8% of the learners agreed to the statement, ***"I love the Mathematics being given as text because it tests my reading comprehension."***, whereas 43.7% disagreed. The data shows that 57.6% of the learners agreed that they believe their reading comprehension and arithmetic skills have helped them to solve word problems, but 39.9% disagreed that reading comprehension and arithmetic skills have helped them in solving word problems. The findings in Table 4.13 show that 62.3% of the learners agreed that they are good at solving arithmetic problems but have some challenges in word problems by

converting the text into arithmetic concepts, whereas 34.6% of the learners were not in agreement.

Table 4.14: The mean scores of learners for Text Comprehension Skills Test (TCST) and Arithmetic Skills Test (AST)

Gender		Text Comprehension Skills Test (TCST)	Arithmetic Skills Test (AST)
Male	Mean	36.72	49.50
	N	**137**	**137**
	Std. Deviation	21.750	17.008
Female	Mean	44.46	49.75
	N	**181**	**181**
	Std. Deviation	26.550	20.327
Total	Mean	41.13	49.64
	N	**318**	**318**
	Std. Deviation	24.859	18.940

The reading comprehension and the arithmetic skills of the learners were tested with the data being presented in Table 4.14. The data shows the mean score of 41.13 in the Text Comprehension Skills Test of the learners and a mean score of 49.64 in the Arithmetic Skills Test. The standard deviation of 24.859 was obtained for the Text Comprehension Skills Test which implies that the scores of the participants for the TCST were not consistent, but the scores of the AST with a standard deviation of 18.940 shows consistency in learners' scores. The consistency in learners' scores in the AST show that learners performed better in the AST than TCST. Importantly, the mean score of the female learners was 44.46 and 49.75 respectively, while the male learners had the mean score of 36.72 and 49.50. noticeably, the male learners had a more consistent scores in both test than the female.

Table 4.15: The Pearson Product Moment Correlation Coefficient

		Text Comprehension Skills Test	Arithmetic Skills Test
Text Comprehension Skills Test	Pearson Correlation	1	.613**
	Sig. (2-tailed)		.000
	N	**318**	**318**
Arithmetic Skills Test	Pearson Correlation	.613**	1
	Sig. (2-tailed)	.000	
	N	**318**	**318**
**** Correlation is significant at the 0.01 level (2-tailed)**			

The Pearson product moment correlation coefficient presented in Table 4.15 of the TCST and AST was moderately positive and statistically significant at ($r = .613$, $p < .001$).

4.5.1 Discussion of Results

The third objective was to determine whether there is a correlation between the levels of learners' reading comprehension and arithmetic skills to solve mathematical word problems. The data was obtained by using questionnaire teachers and learners, Text Comprehension Skills Test (TCST) and Arithmetic Skills Test (AST).

The data in Table 4.12 shows that most of the Teachers of Mathematics, 6 (60%), perceive their learners of having strong arithmetic skills, whereas 4 (40%) of the teachers did not agree. In agreeing to the teachers' responses, the learners, 56.3%, as presented in Table 4.13, agreed that they can better solve problems when they are not written in text. The learners in their responses to the items in Table 4.13 show that 53.8% agreed that they love for their reading comprehension to be tested through word problems. Majority of the Teachers of Mathematics, 6 (60%) agreed that the learners find some difficulties translating the text to arithmetic concept before solving. These responses relate to the findings in Table 4.8 where Teachers of Mathematics

expressed having some challenges converting text into solvable concepts. This challenge of the teachers must have been translated into the learners.

According to Campbell *et al.* (2014); Hill *et al.* (2016); and Kelcey *et al.* (2019), the TMKT correlates with learners' learning outcomes. Pournara *et al.* (2015) ascribed learners in South Africa low performance to teachers' lack of Mathematical knowledge. Koponen *et al.* (2017) posited that the mathematical and pedagogical competence of teachers are important factors to consider when attempting to explain the diversity in learners' levels of achievement in Mathematics. Mbati *et al.* (2020), found that Biology teachers in Kenya were lacking the SMK and the PCK which was causing the teachers not to implement the biology curriculum to its fullest. However, Wanjala (2019) findings did not record any significant correlation between the TMKT and learners' mathematical achievement. The current study's findings aligned with the findings of Campbell *et al.* (2014); Hill *et al.* (2016); Kelcey *et al.* (2019); Pournara *et al.* (2015); Koponen *et al.* (2017); and Mbati *et al.* (2020); in that the teachers and learners acknowledged of having challenges in some topics found in the National curriculum. Comparing these findings, the researchers were tempted to ascribe learners' low performance in word problems to teachers' challenges in some topics.

The results of the two tests, Text Comprehension Skills Test (TCST) and Arithmetic Skills Test (AST), were presented in Table 4.14, with the mean score of the learners in TCST as 41.13 and for the AST as 49.64. The data further shows that the female learners have a mean score of 44.46 in the TCST and 49.75 in the AST whereas the male learners had a mean score of 36.72 in the TCST and 49.50 in the AST. From the analysis, it was found that the male learners have a more consistent scores in both

tests than the female learners. Noticeably, the overall scores of the learners in both tests show that the learners had a more consistent scores in the AST than the TCST. The correlation coefficient of the two tests was moderately positive and statistically significant at $r = .613$ and $p < .001$.

Karogo *et al.* (2020) found 93.2% of participants in their study could not attain the benchmark in reading comprehension which was seen in 98.3% of the participants not attaining the 50% benchmark in Algebra and Geometry. One of the reasons for the learners' low performance could be the challenges of teachers in some topics and even the issue of teaching word problems. Ngeno (2020) ascribed learners' low performance in solving word problems to lack of Mathematical understanding, misunderstanding of Mathematical terms, and their lack of ability to formulate appropriate Mathematical expressions. The study did not mention teachers' factors to learners' low performance; however, it was noted that learners are performing low in word problems due to the challenges (topical challenges, challenges in converting text to solvable concepts, and problem of conceptualizing Mathematical ideas) teachers are faced with.

CHAPTER FIVE:

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Introduction

This chapter presents summary, conclusions, and recommendations for policy makers and further research.

5.2. Summary

The purpose of the study was to investigate the influence that TMKT has on learners' ability to solve word problems in secondary schools in Naivasha Sub-County, Nakuru County, Kenya. The study was guided by three objectives: a) to determine the influence of the level of teachers' mathematical knowledge for teaching on learners' ability to solve word problems, b) to establish the influence of teacher-learner classroom interaction in teaching word problems, and c) to establish the relationship between learners' reading comprehension and arithmetic skills in solving word problems. These objectives helped the researcher in developing the questionnaires for both Teachers of Mathematics and learners as well as the interview for Mathematics Heads of Department and the classroom observation checklist.

The first objective was ***to determine the influence of the level of TMKT on learners' ability to solve word problems***. The Findings show that majority of the teachers of Mathematics struggled with some topics in the Mathematics curriculum and struggled to turn text problems into solvable ideas. This implies that the level of the TMKT was having some challenges. Data presented in Table 4.9 shows that 55.0% of learners believe that their teachers struggle to extract mathematical ideas from texts for solving. The study also found that 60% of the teachers of Mathematics as presented in

Figure 4.2 pointed out every step with a brief note as they completed the day's lesson, but it was observed that 70% of the teachers could not analyse the text problems.

The data collected, analysed and presented, imply that teachers of Mathematics challenges may be affecting learners' performance in solving word problems. According to Chua (2020), teachers' lack of Mathematical understanding affects their teaching techniques and learners' learning results. Cskos and Szitányi (2020) also discovered that 76.7% of teachers struggled to teach mathematical word problems. During the classroom observation, all the teachers, 100% delivered the lesson in an orderly manner. Data in Figure 4.3 showed that majority of the teachers, 70%, place an emphasis on practical measures when it comes to addressing word problems. The researchers observed that 70% teachers though they followed the practical steps, but were relying on only textbook solutions. Over half of the Mathematics Heads of Department, 60% believed teachers' educational qualifications lead to understanding the subject better, while 40% said exposure to pedagogical abilities does. Majority of the Mathematics Heads of Department, 90% considered teachers' mathematical content knowledge as a help factor for learners to learn.

The second objective was to establish influence of teacher-learner classroom interaction in teaching word problems. It was found that 90% of the teachers agree that classroom interaction affects the ability of learners in solving word problems. Most of the teachers, 80% believed that they have high interpersonal social understanding which have helped their learners in the classroom. Strong social bonds was considered by 70% of the teachers as common among they and their learners. All of the MHODs interviewed, representing 100%, believed that teacher-learner interaction boosts the self-confidence and the ability of the learners for solving word

problems. The study found that 80% of the teachers motivated their learners, yet 60% did not let the learners to engage in class discussions. The study also found that 90% of classes observed, the teachers had strong teacher-learner relationships. Xie and Derakhshan (2021) underlined the need for Teachers and learners to create a strong social network in classroom to support the teaching and learning activities. Teamwork and collaborative learning foster effective communication, encouragement, emotional support, and strong listening skills in the classroom as recorded by Münte *et al.* (2019) and Gasser (2018).

The data in Figure 4.7 showed that 58.2% of learners agreed that there is a positive classroom interaction provided by their teachers. The findings show that respondents acknowledged the importance of teacher-learner classroom interaction, but from the observation and responses of the MHOD, class size was a common challenge to building teams or doing collaborative teaching and learning.

The third objective of the study was to establish the relationship between learners' reading comprehension and arithmetic skills in solving word problems. Findings from the data collection tools: Text Comprehension Skills Test (TCST), Arithmetic Skills Test (AST), Teachers of Mathematics' questionnaire, and learners' questionnaire were presented in tables. Majority of the teachers representing 60% believe that learners have good arithmetic skills which could have supported them to solve word problems. The findings in Table 4.13 indicated that 56.3% agree that solving problems without text is simple. It was found that 53.8% of the learners prefer word problems to measure reading comprehension in a Mathematics examination.

In Table 4.1, the data shows that 60% of teachers agree that their learners have some challenges converting text to arithmetic before solving. Campbell *et al.* (2014), Hill *et al.* (2016), and Kelcey *et al.* (2019) found that the TMKT affects learners' learning. Pournara *et al.* (2015) ascribed South African learners' low performance in Mathematics on the lack of the TMKT and PCK. This study's findings agree with these findings, because Mathematics teachers were found having some challenges with some topics and particularly converting text problems to solvable concepts. This was also common among the learners.

The data presented in Table 4.14 shows the results of two tests, with TCST learners scoring 41.13 and AST learners scoring 49.64. Female learners scored 44.46 on the TCST and 49.75 on the AST, whereas male learners scored 36.72 and 49.50. The two tests had a moderately positive and statistically significant correlation value of r =.613 and p.001. Karogo *et al.* (2020) revealed 93.2% of participants failed the reading comprehension standard and 98.3% failed the 50% threshold in Algebra and Geometry. Ngeno (2020) attributed learners' poor word-problem solution to a lack of Mathematical comprehension, misunderstanding of Mathematical concepts, and inability to articulate Mathematical statements. The study did not mention teachers' factors, but it did note that learners' word-problem performance is low due to teachers' challenges (topical, converting text to solvable concepts, and conceptualizing Mathematical ideas).

5.3. Conclusions

The study's findings indicate that the majority of the teachers from the Naivasha Sub-County schools in Nakuru County, Kenya, minored in Mathematics while pursuing

their bachelor degrees. The researcher found majority of the teachers facing some challenges in teaching word problems, especially conceptualizing the text into a solvable problem. However, some of the teachers have proven to be over the lesson in teaching word problems by showing a step-by-step approach during the lesson presentation. Those teachers presented their lesson during the teaching time with some amazing teaching skills which motivated learners as they learned.

Furthermore, the teacher-learner classroom interaction was found to be hindered either by class size or teaching time, for many of the teachers were focusing on their class time and seeing the class size could not allow learners to go through collaborative learning wherein peer interaction could have been employed. The MHOD responses were cleared that classroom congestion was a factor of not favouring teacher-learner classroom interaction.

In conclusion, the study found that the TMKT plays a significant role in learners' ability to solve word problems. Most importantly, the Teachers' Mathematical Knowledge for Teaching (TMKT) is powered by the Pedagogical Content Knowledge (PCK) which help teachers to teach accordingly and improves learners' achievement level in solving word problems. The study further found that learners' reading comprehension and arithmetic skills correlate with their ability to solve word problems. The researcher believes that learners are performing low in Kenya Certificate of Secondary Education (KCSE) paper one (1) and paper two (2) due to the challenges their teachers are faced with and their lack of reading comprehension. This implies that the TMKT and learners' reading comprehension and arithmetic skills are key factors to learners' ability to solving word problems.

5.4. Recommendations

On the basis of the findings and conclusion of this study, the researcher has made key recommendations for policymaking and for further research.

5.4.1. Policymakers

The researcher recommend the following:

i. The Ministry of Education (MOE) in collaboration with the Teachers Service Commission (TSC) implement and enforce the inter-school professional development program for all Mathematics teachers.

ii. The Mathematics Heads of Department in every school across Kenya introduce and encourage a community of practice strategy wherein each teacher will interact with others on the subject matter.

iii. MOE and all educational stakeholders consider the class size by reducing it to a considerable size of 45 learners.

iv. The Kenya Institute of Curriculum Development (KICD) and all its partners integrate reading comprehension and arithmetic skills into the Mathematics curriculum.

5.4.2. Future study

The researcher suggested the following topics for more study based on the findings:

i. The influence of the relationship of Teachers' Mathematical Knowledge for Teaching (TMKT) and teaching on learners' ability to solve word problems.

ii. An experimental research on the relationship of TMKT and the interaction between teacher and learner in classroom and its effect on learners' ability to solve word problems

iii. A study on the integration of reading comprehension skills in Mathematics and its influence on learners' ability to solve word problems.

iv. The study can be replicated in other counties in Kenya.

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APPENDICES

Appendix I: Teachers' Questionnaires

These questionnaires will assist the researcher in collecting information necessary to address the study's aims of investigating the influence of teachers' Mathematical knowledge for teaching on learners' ability to word problem-solving in Naivasha Sub-County. On these surveys, there is no correct or incorrect response, and the findings will be used to improve teachers' and learners' understanding of how to teach and learn mathematical word problems.

Kindly tick the field that applies to you in the questionnaires below.

1) (a) Type of school: National School Mixed ☐ National School Boys ☐ National School Girls ☐ Extra County School Mixed ☐ Extra County School Boys ☐ Extra County School Girls ☐ Sub-County School Mixed ☐ Sub- County School Boys ☐ Sub- County School Girls ☐ Private School Mixed ☐ Private School Boys ☐ Private School Girls ☐

   (b) Gender

   Male ☐ Female ☐

2) Academic Qualifications

PhD ☐ M.Ed. ☐ B.Ed. (Science) ☐ B.Ed. (Arts) ☐ B.Sc. ☐ PDGE ☐ Diploma in Science ☐

3) Indicate your Mathematics concentration in college as

Major ☐ Minor ☐

4) What is your year of teaching experience in Mathematics?
   1 to 6 years ☐ 7 to 12 years ☐ 13 to 18 years ☐ 19 above ☐

The statements below are essential to this study because they focus on its objectives. In responding to these questionnaires, please check the appropriate option that best suit you. You can check strongly agree, agree, strongly disagree, disagree, and not sure as per the numerical order in the matrix.

QUESTIONNAIRES	1	2	3	4	5
LEVEL OF TEACHERS' MATHEMATICA KNOWLEDGE					
There are some topics in the syllabus which are unclear to me.					
I have a strong sense of numbers but some challenges in converting text into solvable concepts.					
I have a strong analytical skill which supports me in teaching word problems (application) problems.					
I follow procedure well but face some problem with conceptualizing the Mathematical ideas from text.					
I have a high proficiency level in Mathematics					
I attend regular inter-school meetings quarterly, which involve all Mathematics teachers to help strengthen some areas in the syllabus					
My level of Mathematical knowledge has shifted learners' ability to solve word problems					
My ability to adapt textbook concepts into approachable concepts has helped my learners perform better on word problems.					
I know a lot about my subject but have only a minimum required knowledge about how to teach it.					
My Mathematical knowledge for teaching is well articulated through the five strands of Mathematical proficiency					
TEACHER-LEARNERS CLASSROOM INTERACTION					
Learners' word-solving skills correlate with the amount of class discussion we have.					
My learners and I usually interact during lesson presentation.					
My interpersonal social knowledge help to support learners in word problem-solving.					
I allow a free space interaction of my learners during classroom lecture, wherein I post questions and by term, they give response(s).					
The learners and I have a strong bond of social connection, which supports learning.					
The class time is minimal; therefore, it is not necessary for classroom interaction					
I give a class exercise wherein immediate feedback is given to learners as reinforcement to the lesson.					
I sometimes appear unfriendly and do not allow learners' question during the lesson.					
I do not see teacher and learners' interaction benefiting to learners' learning needs.					
Relationship between reading comprehension and arithmetic skills in solving word problems					
Learners in my class have strong arithmetic skills					
Reading comprehension is helping my learners to solve word problems					
I do not see any relationship between reading comprehension and arithmetic skills, because they two different concepts					
I believe that the learners' arithmetic skills and reading comprehension will support them in word problem-solving					
My learners find some difficulties translating the text into arithmetic concept before solving					
When problems are presented in arithmetic form, learners can response well					

Appendix II: Classroom Observation Checklist for Teachers and Learners

Type of school: …… Day #: ……..

Note: This checklist is not to police you in the classroom but to observe the classroom interaction to collect data that will support the study.

TICK(S)	INTRODUCTION	COMMENT
	The teacher presents lesson outlines to learners	
	Teacher introduces new lesson and links learners' prior knowledge	
	The teacher explains vital terms in the lesson while starting the teaching	
	The teacher gets learners' views about the topic while introducing the new concepts	
	TEACHER-LEARNERS INTERACTION	
	The teacher shows a high level of confidence and passion for the topic and learners' learning needs	
	The teacher can call out the name of the learners as a means of maintaining classroom order	
	Learners engage in the teaching process as the teacher teaches.	
	The classroom is lively between the teacher and learners	
	Learners learn in groups and, at some point in time, they do some independent work	
	High level of motivation from the teacher to learners	
	Learners are freely participating in the classroom discussion	
	The word problem-solving in the classroom is like fun	
	TEACHER'S STEPS IN SOLVING WORD PROBLEMS	
	The teacher reads the problem analytically before engaging in the solving process.	
	The teacher uses tables and diagrams to show the picture of the problem.	
	The teacher points out every step with a brief note before it	
	Learners are asked for their input during the solving process	
	CONTENT MASTERY	
	The teacher can present the subject matter in a convincing way	
	The lesson is presented with much more emphases on practical steps	
	The teacher does not only rely on the textbook to solve	
	The lesson is presented in an orderly manner	
	CONCLUSION	
	The teacher ends the lesson with a recap and exercise	
	Learners can make comments during the ending of the lesson	

Remark:

……

……

……

……

Appendix III: Learners' Questionnaires

These questionnaires will help the researcher in gathering data needed to address the study's aims of investigating the influence of teachers' Mathematical knowledge for teaching on learners' ability to solve word problems in Naivasha Sub-County. There are no right or wrong answers on these questionnaires, and the information will be used to improve both teachers' and learners' understanding of how to teach Mathematics.

Kindly tick the field that applies to you in the questionnaires below.

1) (a) Type of school: National School Mixed ☐ National School Boys ☐ National School Girls ☐ Extra County School Mixed ☐ Extra County School Boys ☐ Extra County School Girls ☐ Sub-County School Mixed ☐ Sub- County School Boys ☐ Sub- County School Girls ☐ Private School Mixed ☐ Private School Boys ☐ Private School Girls ☐

   (b) Gender

   Male ☐ Female ☐

2) Indicate your favourite subject(s). You can tick two subjects but not more than two.

Mathematics ☐ Physics ☐ Chemistry ☐ Biology ☐ Geography ☐ History English ☐ Kiswahili ☐ Christian Religious Education ☐ Agriculture ☐

3) Age range: 7 – 10 years ☐ 11 – 14 years ☐ 15– 18 years ☐ 19 – 22 years

These statements below are important to this study because they focus on its objectives. In responding to these questionnaires, please check the appropriate option that best suit you. You can check 1 as strongly agree, 2 as agree, 3 as strongly disagree, 4 as disagree 5 as not sure.

QUESTIONNAIRES	1	2	3	4	5
THE LEVEL OF TEACHERS' MATHEMATICAL KNOWLEDGE					
My teacher shows many easy steps when solving word problems.					
The teacher sometimes struggles to bring out the Mathematical idea from the text for us to solve.					
My teacher always solves the word problems by drawing diagrams and following a step-by-step order.					
The teacher identifies key terms and ideas before we start solving					
The way my teacher can explain the steps in solving word problems has help me greatly					
I believe that the teacher who knows Mathematics well can help us understand better.					
My teacher struggle at time to set the problem before we solve it					
My teacher has not taught any word problem in this class					
All the example problems that my teacher solves are those same solved problems in our textbook					
The way my teacher can explain the steps in solving word problems has help me greatly					
TEACHER-LEARNER CLASSROOM INTERACTION IN TEACHING WORD PROBLEMS					
My teacher shows me attention during the teaching time					
My teacher allows friendly interaction in the classroom during the lesson					
We have the freedom to talk to our teacher concerning the lesson					
My teacher cannot allow any student to come close to them or post a question during the lesson					
My teacher always complains about teaching time, so we cannot ask or talk during teaching					
Relationship between reading comprehension and arithmetic skills in solving word problems					
I can solve the problems when they are not written as text					
I love the Mathematics being given as text because it tests my reading comprehension					
I believe that my reading understanding and skills in arithmetic have helped me to solve word problems					
I am good at solving arithmetic problems, but find some challenges in converting the text into arithmetic concepts before solving					

Appendix IV: Interview Guide for Mathematics Heads of Department

These guided interview questions are meant to collect data for this study. No respondent's name will be associated with the response provided in any part of this study.

1. How does the level of teacher-learner interaction bring a change in learners' ability in problem-solving?

2. Do you see your teachers as motivational when teaching word problem-solving? Yes ☐ No ☐

3. Do you think that the level of your teacher's educational qualification has influence the way they teach their subject specific? Yes ☐ No ☐
    i. If yes, how?

    ii. If not, why?
4. Does the level of teachers' Mathematical content knowledge for teaching bring out the needed learning outcomes in learners?

5. Do your teachers have a regular inter-school refresher workshop?

6. How can you scale the Mathematical content knowledge of your teachers? Please tick any of the options below.

    Low ☐ Intermediate ☐ Advance ☐

Appendix V (A): Text Comprehension Skills Test

This test is meant to assess learners' ability in solving word problems. It will assess their reading comprehension which will support their ability to solve word problems.

Direction: Answer the below questions following the necessary working steps. Please read each problem very carefully before attempting it.

1. A garden in the shape of a right-angled triangle has a length of 17m on the shortest side and an area of 346.8m^2. Find the length of the longest side of the garden.

2. The base of a triangle sum of two numbers exceeds their product by one, and their difference is equal to a product of less than five. Find the two numbers.

3. A triangle has sides in the ratio 7:8:9 with a perimeter of 48cm. Using the Heroes formula, find the area.

4. The age of a mother five years ago was four times her daughter, and she will be $2\frac{1}{2}$ times as old as her daughter in four years to come. What are their ages now?

5. Ksh 900,000 was given to James, Peter, and Paul to be divided in the ratios 3:4:5 according to the arrangement of their names. If Paul receives twice the share of James, what will be James' share?

Appendix V (B): Arithmetic Skills Test

This test is to measure learners' arithmetic skills and how it support their ability to solve word problems.

Direction: Solve the below problems.

1. Find the value of $x + y$ in the equations:

$$x + 3y = 4$$
$$2x - y = 29$$

2. Solve for in the equation

$$128 \div 2^{y} = 64^{(y-3)} \div 16^{(y-4)}$$

3. Evaluate this expression where x = -4, m = 16, y = 2, p = 6, and k = 1

$$\frac{(x+m)^{y}}{p^{2k}}$$

4. Using the Heroes formula, $A = \sqrt{s(s-a)(s-b)(s-c)}$, find value of A, if s = 8, a = 4, b = 5, and c = 6

5. Evaluate $\frac{3}{8} \times \left[7\frac{3}{5} - \frac{1}{3}\left(1\frac{1}{4} + 3\frac{1}{3}\right) \times 2\frac{2}{3}\right]$

Appendix VI: Work Plan and Schedule

No.	Activity	Months					
		May – September 2022	October 2022	November – December 2022	January 2023	February – April 2023	May 2023
1	Proposal Writing						
2	Proposal Defence and correction						
3	Pilot Study and adjustment of data collection tools						
4	Data collection						
5	Data Analysis and writing of the report						
6	Thesis Defence and correction						

Appendix VII: Research Budget

NO.	ITEMS	QTY	KSH UNIT COST	USD UNIT COST	TOTAL COST KSH	TOTAL COST USD
STATIONARY						
1	Realm of paper	5 realms	950*5	8.10*5	4,750	40.50
2	Assorted pen	2 pks	1,200*2	10.23*2	2,400	20.46
3	Notepad	30 pcs	320*30	2.73*30	9,600	81.90
Sub-total					16,750	142.86
RECORDING EQUIPMENT						
1	Camera (Canon)	1	25,752	219.50	25,752	219.49
3	Camera Trapper	1	8,500	72.45	8,500	72.45
Sub-total					34,252	291.94
RESEARCH PERMIT AND ETHICAL DOCUMENTS						
1	Research Permit	1	2,000	17.5	2,000	17.50
2	Ethical Letter	1	1,500	12.79	1,500	12.79
3	A permit from KNEC (Kenyan National Examination Council)	1	1,200	10.23	1,200	10.23
Sub-total					4,700	40.52
PRINTING OF PROPOSAL, FINAL THESIS AND OTHER DOCUMENTS						
1	Printing of Proposal	4 copies (60 pages each)	15*60*4	0.13*60*4	3,600	31.20
2	Printing of Final Thesis	6 copies (125 pages each)	125*15*6	125*0.13*6	11,250	97.50
2	Printing of Learners' Questionnaires	400 (2 copies each)	2*15*400	2*0.13*400	12,000	104.00
3	Printing of Teachers Questionnaires	10 (3 copies each)	3*15*10	3*0.13*10	450	3.90
4	Printing of classroom observation checklist	70 (3 copies each)	3*15*70	3*0.13*70	3,240	27.30
5	Printing of Assessment Items	400 (2 copies each)	2*15*400	2*0.13*400	12,000	104.00
5	Printing of Interview Questionnaires for Principals and MHOD	20 (2 copies each)	2*15*20	2*0.13*20	600	5.20

Sub-total					43,140	373.10
BINDING OF PROPOSAL AND THESIS						
1	Binding of proposal	4 copies	315*4	2.68*4	1,260	10.72
2	Binding of Final Thesis	6 copies	450*6	3.84*6	2,700	23.04
Sub-total					3,960	33.76
TRANSPORTATION						
1	Transport to Nakuru County	To and from	1,500*2	12.79*2	3,000	25.58
2	Travel within Nakuru County	30 days (10 schools)	1,500*30	12.79*30	45,000	382.70
Sub-total					48,000	408.28
ACCOMMODATION						
1	Hotel Room	30 days	2,545*30	21.69*30	76,350	650.70
Sub-total					76,350	650.70
RESEARCH ACTIVITIES						
1	Research Assistant/Local Language Interpreter	2 persons	9,500*2	80.97*2	19,000	161.94
Sub-total					19,000	161.94
COMPENSATION						
1	Teachers Compensation	10 persons	2,000*10	17.05*10	20,000	170.50
2	Principal & Head of Departments	20 persons	3,500*20	29.83*20	70,000	596.64
Sub-total					90,000	767.34
DATA ANALYSIS						
1	Data Analysis Consultant	1 person	36,500	311.10	36,500	311.10
Sub-total					36,500	311.10
PUBLICATION						
1	Publication of Article	1 Journal	62,500	532.71	62,500	532.71
2	CDs for graduate uploading of Thesis online	3 pcs	450*3	3.84*3	1,350	11.52
Sub-total					63,850	544.23
Total					436,502	3,725.77
Miscellaneous @ 5%					21,825.10	186.29
Grand Total					458,327.10	3,912.06

Appendix VIII: Participants' Consent Form

Dear Participants:

Ref.: Participants' Consent Form

Dennis R. Nimely, Jr., a Master of Education candidate in Mathematics Education at Kenyatta University, is undertaking study titled **"Teachers' Mathematical knowledge for teaching and its influence on learners' ability to solve word problems in secondary schools, Nakuru county, Kenya."**

I write this consent form to request your volunteer participation and acceptance into this research. This study's findings may help teachers and learners in the classroom as well as educational stakeholders in making inform decision. Your participation into this study will help the researcher in gathering the needed data and drawing a logical conclusion.

Note, your personal details will not be used in any part of this work. The researcher assures you high level of confidentiality. To be well pleased in participating into this study, please do not mention your personal details in any part of the documents you will be responding to.

Participant acceptance and signature

I have read and accept to participate into this study voluntarily.

Signed: …… Date: ……..

(*Please, only your signature is required here)*

Appendix IX: LETTER OF INTRODUCTION

Dennis R. Nimely, Jr.
Kenyatta University
P.O. Box 43844
Nairobi

Dear Sir/Madam:

Ref.: Letter of Introduction

"Teacher Mathematical knowledge for teaching and its influence on learners' ability to solve word problems in secondary schools in Nakuru county, Kenya" is the topic of my research for the Master of Education in Mathematics Education at Kenyatta University.

The intended respondents the researcher is interested in are Mathematics Heads of Department, Mathematics Teachers, and Form two (2) learners. The findings of this study are expected to assist teachers, principals, Mathematics Heads of Departments, learners, and every educational stakeholder in decision making in Naivasha Sub-County, Nakuru county, and the country at large.

Your support toward this process is very important, at such, the researcher sees it fit to present this letter to you for permission of entrance into your institution.

Kind regards,

Dennis R. Nimely, Jr.
Researcher
Kenyatta University

Appendix X: Approval of Research Proposal

KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: dean-graduate@ku.ac.ke
Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 020-8704150

Internal Memo

FROM: Executive Dean, Graduate School

DATE: 15th February 2023

TO: Dennis R. Nimely, JR
C/O Ed. Comm.Tech

REF: E55F/21643/2020

SUBJECT: APPROVAL OF RESEARCH PROPOSAL

==========

This is to inform you that Graduate School Board, at its meeting on **15th February 2023**, approved your Research Proposal for the M.Ed. Degree entitled, **"Teachers' Mathematical Knowledge for Teaching and Its Influence on Learners Ability to Solve Word Problems in Secondary Schools, Nakuru County, Kenya."**

You may now proceed with your Data collection, subject to clearance with the Director General, National Commission for Science, Technology & Innovation and Ethics Review Committee, Kenyatta University.

As you embark on your data collection, please note that you will be required to submit to Graduate School completed Supervision Tracking and Progress Report Forms per semester. The Forms are available at the University's Website under Graduate School webpage downloads.

Also, please ensure that you publish article(s) from your thesis before submitting it to Graduate School for examination as per the Commission for University Education and Kenyatta University guidelines.

Thank you.

JOHN ODONGI
FOR: EXECUTIVE DEAN, GRADUATE SCHOOL

CC. Chairman, Ed. Comm.Tech

Supervisors:

1. Dr. Florence Nyamu
   C/o Ed. Comm.Tech
   Kenyatta University

2. Dr. Michael Waititu
   C/o Ed. Comm.Tech
   Kenyatta University

Appendix XI: Research Authorization, Graduate School

KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: dean-graduate@ku.ac.ke
Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 020-8704150

Our Ref: E55F/21643/2020 **DATE:** 15th February 2023

Director General,
National Commission for Science, Technology and Innovation
P.O. Box 30623-00100
NAIROBI

Dear Sir/Madam,

RE: RESEARCH AUTHORIZATION FOR MR. DENNIS R. NIMELY, JR REG. NO. E55F/21643/2020

I write to introduce Mr. Dennis R. Nimely, JR who is a Postgraduate Student of this University. He is registered for M.Ed. degree programme in the **Department of Educational Communication and Technology.**

Mr. Dennis Nimely intends to conduct research for a M.Ed. Thesis Proposal entitled, **"Teachers' Mathematical Knowledge for Teaching and Its Influence on Learners Ability to Solve Word Problems in Secondary Schools, Nakuru County, Kenya."**

Any assistance given will be highly appreciated.

Yours faithfully,

PROF. ELISHIBA KIMANI
EXECUTIVE DEAN, GRADUATE SCHOOL

Appendix XIII: NACOSTI Letter

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **421210**

Date of Issue: **20/March/2023**

RESEARCH LICENSE

This is to Certify that Mr.. Dennis R. Nimely, Jr. of Kenyatta University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Nakuru on the topic: Teachers' mathematical knowledge for teaching and its influence on learners' ability to solve word problems in secondary schools, Nakuru County, Kenya for the period ending : 20/March/2024.

License No: **NACOSTI/P/23/24283**

421210

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

See overleaf for conditions

THE SCIENCE, TECHNOLOGY AND INNOVATION ACT, 2013 (Rev. 2014)
Legal Notice No. 108: The Science, Technology and Innovation (Research Licensing) Regulations, 2014

The National Commission for Science, Technology and Innovation, hereafter referred to as the Commission, was the established under the Science, Technology and Innovation Act 2013 (Revised 2014) herein after referred to as the Act. The objective of the Commission shall be to regulate and assure quality in the science, technology and innovation sector and advise the Government in matters related thereto.

CONDITIONS OF THE RESEARCH LICENSE

1. The License is granted subject to provisions of the Constitution of Kenya, the Science, Technology and Innovation Act, and other relevant laws, policies and regulations. Accordingly, the licensee shall adhere to such procedures, standards, code of ethics and guidelines as may be prescribed by regulations made under the Act, or prescribed by provisions of International treaties of which Kenya is a signatory to
2. The research and its related activities as well as outcomes shall be beneficial to the country and shall not in any way;
    i. Endanger national security
    ii. Adversely affect the lives of Kenyans
    iii. Be in contravention of Kenya's international obligations including Biological Weapons Convention (BWC), Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO), Chemical, Biological, Radiological and Nuclear (CBRN).
    iv. Result in exploitation of intellectual property rights of communities in Kenya
    v. Adversely affect the environment
    vi. Adversely affect the rights of communities
    vii. Endanger public safety and national cohesion
    viii. Plagiarize someone else's work
3. The License is valid for the proposed research, location and specified period.
4. The license any rights thereunder are non-transferable
5. The Commission reserves the right to cancel the research at any time during the research period if in the opinion of the Commission the research is not implemented in conformity with the provisions of the Act or any other written law.
6. The Licensee shall inform the relevant County Director of Education, County Commissioner and County Governor before commencement of the research.
7. Excavation, filming, movement, and collection of specimens are subject to further necessary clearance from relevant Government Agencies.
8. The License does not give authority to transfer research materials.
9. The Commission may monitor and evaluate the licensed research project for the purpose of assessing and evaluating compliance with the conditions of the License.
10. The Licensee shall submit one hard copy, and upload a soft copy of their final report (thesis) onto a platform designated by the Commission within one year of completion of the research.
11. The Commission reserves the right to modify the conditions of the License including cancellation without prior notice.
12. Research, findings and information regarding research systems shall be stored or disseminated, utilized or applied in such a manner as may be prescribed by the Commission from time to time.
13. The Licensee shall disclose to the Commission, the relevant Institutional Scientific and Ethical Review Committee, and the relevant national agencies any inventions and discoveries that are of National strategic importance.
14. The Commission shall have powers to acquire from any person the right in, or to, any scientific innovation, invention or patent of strategic importance to the country.
15. Relevant Institutional Scientific and Ethical Review Committee shall monitor and evaluate the research periodically, and make a report of its findings to the Commission for necessary action.

National Commission for Science, Technology and
Innovation(NACOSTI),
Off Waiyaki Way, Upper Kabete,
P. O. Box 30623 - 00100 Nairobi, KENYA
Telephone: 020 4007000, 0713788787, 0735404245
E-mail: dg@nacosti.go.ke
Website: www.nacosti.go.ke

Appendix XIV: Research Authorization, Education Office, Nakuru County

MINISTRY OF EDUCATION
State Department for Early Learning and Basic Education
Telegrams: "EDUCATION",
Telephone: 051-2216917
Fax: 051-2217308
Email: cdenakurucounty@gmail.com
When replying please quote

COUNTY DIRECTOR OF EDUCATION
NAKURU COUNTY
P. O. BOX 259,
NAKURU.

Ref. NO. CDE/NKU/GEN/4/1/21 VOL IV/106

22nd March, 2023

TO WHOM IT MAY CONCERN

RE: RESEARCH AUTHORIZATION – DENNIS R. NIMELY JR

Reference is made to the above named individual letter dated 22nd March, 2023 seeking permission to conduct research in Nakuru County having been approved by NACOSTI through Research Reference **No. 421210** and license No. **NACOSTI/P/23/24283** dated 20th March, 2023.

Permission is hereby granted to him to carry out research on topic ***"Teachers' mathematical knowledge for teaching and its influence on learners' ability to solve word problems in secondary schools, in Nakuru County, Kenya"*** for the period 20th March, 2024**.**

The findings of the research to be shared with this office when through with the research.

Kindly accord him the necessary assistance.

COUNTY DIRECTOR OF EDUCATION
NAKURU
P.O. Box 259 - 20100,
NAKURU

Victoria W. Mulili
COUNTY DIRECTOR OF EDUCATION
NAKURU

My Education My Future My Education My Future

Appendix XV: Research Authorization, Education Office, Naivasha Sub-County

MINISTRY OF EDUCATION
STATE DEPARTMENT OF BASIC EDUCATION

Telephone: 0202352776

Fax No: 254 0202352776

SUB-COUNTY EDUCATION OFFICE,
NAIVASHA
P. O. BOX 2053 – 20117.
NAIVASHA
DATE: 5TH APRIL, 2023

Ref: MOE/NVS/ GEN/112/245

TO PRINCIPALS
NAIVASHA SUB-COUNTY

RE: RESEARCH AUTHORIZATION – DENNIS R. NIMELLY JR ID NO. 421210

Following your request to conduct research on **"Teachers' mathematical knowledge for teaching and its influence on learners' ability to solve word problems in secondary schools, in Naivasha Sub-County, Nakuru County"**, authority is hereby granted to visit schools and interact with the school communities. The exercise should be conducted professionally and with no cost to the schools.

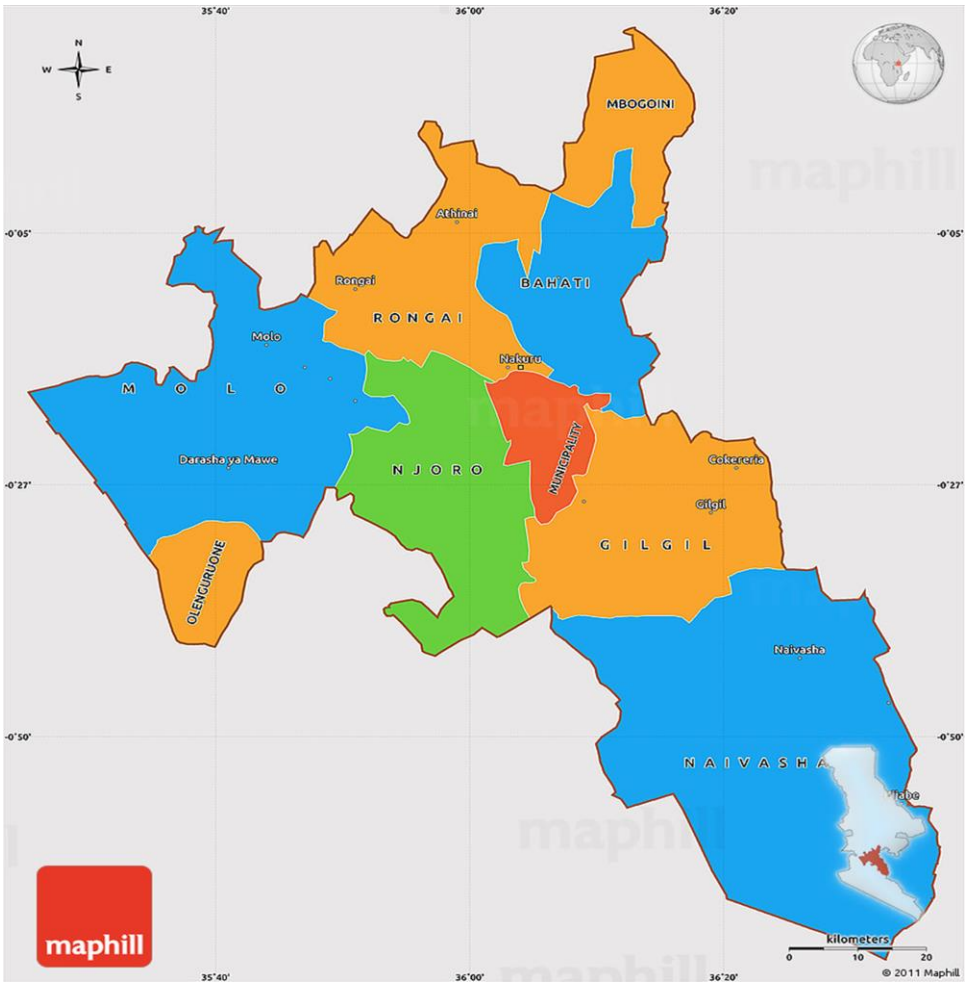
You will however be required to give a copy of your findings to this office on completion of your studies.

FOR
SUB-COUNTY DIRECTOR
OF EDUCATION
NAIVASHA

RAPHAEL NGANGA
FOR SUB -COUNTY EDUCATION OFFICER,
NAIVASHA

MINISTRY OF EDUCATION

Appendix XV: Map of Study Location



Naivash

Source: www.maphill.com