METACOGNITION AND MATHEMATICS ANXIETY AS PREDICTORS OF MATHEMATICS TEST PERFORMANCE AMONG SECONDARY SCHOOL STUDENTS IN KAKAMEGA COUNTY, KENYA

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E83/30586/2015

SCHOOL OF EDUCATION AND LIFE LONG LEARNING

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN EDUCATIONAL PSYCHOLOGY, KENYATTA UNIVERSITY

JUNE, 2025

DECLARATION

I declare that this thesis is my original work and has not been presented in any other university for consideration of any certification. This thesis has been complemented by referenced sources duly acknowledged. Where text, data, graphics, pictures or tables have been borrowed from other sources, including the internet, these are specifically accredited and references cited using current APA system and in accordance with anti-plagiarism regulations.

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DEDICATION

I dedicate this thesis to my beloved parents Madam Mary Mwikhali Andaya and the late "Prof." Abiud Oniang'o Andaya for their love and believe in me. To my wife, Dorcas Ngatha and two sons Ethan-Eliud Zakari and Aziel-Abiud Zeke, and all the young boys and girls who, despite the challenges they are facing, still believe in diligence, integrity, excellence and success in what they do.

ACKNOWLEDGEMENTS

First and foremost, I glorify the Almighty God for His sustenance through the entire period of my thesis writing. My sincere appreciation to my supervisors; Dr. Elizabeth Mwaniki and Dr. Peter Mwaura who granted their intellectual value, mentorship and guidance that shaped this study. A big thank you to all tutors who guided me throughout my studies and helped me attain the competence of writing this thesis. To all faculty and non-teaching staff in the department of Educational Psychology, Kenyatta University, I am very grateful for their support and encouragement in ensuring that I completed this work successfully.

My special appreciation to all schools that participated in this study, my course mates for always extending a helping hand whenever needed and always challenging me to be the best that I am, my family who did not tire to keep urging me on even when times seemed difficult and to countless others who gave me advice, encouragement and support in numerous forms in connection to this study.

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ACRONYMS AND ABBREVIATIONS

ANOVA	Analyses of variance
HA	High anxiety
IMU	International Mathematical Union
KCPE	Kenya Certificate of Primary Education
KCSE	Kenya Certificate of Secondary Education
LA	Low anxiety
MA	Mathematics Anxiety
MAI	Metacognitive Awareness Inventory
MARS	Mathematics Anxiety Rating Scale
MOEST	Ministry of Education Science & Technology
MT	Mathematics Test
MTP	Mathematics Test Performance
NACOSTI	National Commission for Science Technology & Innovation
NASA	National Aeronautics and Space Administration
OECD	Organisation for Economic Co-Operation and Development
PISA	Program for International Student Assessment

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ABSTRACT

Students' inability to perform well in mathematics has been a concern the world over. Not all factors related to this inability have been exhaustively investigated. Poor mathematics performance in Kakamega County may have made most students miss out on highly scientific courses during university selection. This may limit the goal of Kenya becoming an industrialized country as envisaged in the country's vision 2030 goals. The poor performance may be due to learners' lack of metacognitive abilities as well as anxiety experienced during mathematics exams. This study sought to examine how metacognition and mathematics anxiety predict mathematics test performance. Differences in metacognition and mathematics anxiety due to gender and age were also tested. Flavell's Metacognition Theory (1979) and Irwin Sarason's Cognitive Interference Theory (1988) guided the study. The study adopted a predictive correlation design. The study was conducted in Kakamega County, Kenya. Purposive, stratified and simple random sampling was used to select a sample size of 260 students (140 boys and 120 girls) from six schools. Data was collected using three instruments; Mathematics test exercise, Metacognitive Awareness Inventory for students (Schoenfeld, 1985) and Mathematics Anxiety Rating Scale for students (Mandlar & Sarazon, 1878). To check and enhance validity and reliability of the research instruments, a sample size of 40 students (15% of the actual sample) from one school in Kakamega County which was excluded in the final study was used for the pilot study. Quantitative data was analyzed using the Statistical Package for Social Sciences (SPSS) while qualitative data was analyzed using thematic analysis. The findings showed that there was positive and significant relationship between metacognition and mathematics test performance (r (258) = .47, p< .05), while there was negative and significant relationship between mathematics anxiety and mathematics test performance (r (258) = -.565, p <.05). Metacognitive strategy use showed a higher predictive value for mathematics test performance than metacognitive awareness. There were no significant gender differences in metacognition (t = 1.367, df = 258, p = .17). and mathematics anxiety (t = 1.27, df =258, p = .21). Significant differences in metacognition (F = 6.7, df = 2, p = .02) and mathematics anxiety (F = 7.2, df = 2, p = .001) due to age was found favoring older students (≥ 18.1 years category). Metacognitive strategy use combined with low mathematics anxiety had significant values for high performance in mathematics test. Significant differences were found among students from different types of schools in terms of their metacognition, mathematics anxiety and mathematics test performance. Overall, the findings upheld the guiding theories of the study that had indicated that when students are metacognitively aware of strategies to use and when they have no or low anxiety towards mathematics, they are likely to perform well in mathematics test. Recommendations from the findings were; including the teaching of metacognition in mathematics curriculum, students be assisted in building up confidence towards mathematics to reduce the anxiety levels, and that further studies use different study design apart from correlational studies to investigate the same variables.

CHAPTER ONE

INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 Introduction

This chapter presents the introduction and background to the study, statement of the problem, purpose of the study, objectives of the study, research questions and significance of the study. Delimitations and limitations of the study, assumptions of the study, theoretical and conceptual framework and operational definition of terms are also presented in this chapter.

1.2 Background to the Study

Mathematics expresses itself ubiquitously, in almost every facet of life; in nature all around us, and in technologies in our hands. Mathematics being the language of science and engineering helps us to describe our understanding of all that we observe. It must be because of this ubiquitous nature of mathematics that made Mapaire (2016) to argue that education should be started with Mathematics. This is so because mathematics plays a very important role in forming well designed brains with the capability of reasoning right. Mathematics is used everyday applications either knowingly or unknowingly. According to The International Mathematics and Science Study (Kadijevich, 2019) mathematics may be termed as the universal language of our environment.

In everyday life endeavours, be it determining the correct ingredient percentages in simple food recipes, getting the right medical prescription as per body weight and age or designing an architectural model, mathematics is applied (Asik & Erktin (2019).). For a student to get a chance to be enrolled in careers in physical sciences, health sciences, social sciences, technical sciences, business and commerce, actuarial sciences and many more, they need a high performance in mathematics at secondary school level. For this reason, mathematics is a compulsory subject to all students in primary and secondary schools in Kenya and many other countries.

The importance of Mathematics cannot be overemphasized at a school level. The National Center for Education Statistics (NCES, 2017) states that students who perform poorly in mathematics take a risk of forfeiting many future career opportunities. Despite this universally agreed importance of mathematics, learners the world over continue to fail in the subject. A study by the Organisation for Economic Co-Operation and Development (OECD, 2014) showed that of the 63 participating countries from Europe, Asia, America and Africa, with a mean score of 613 Shanghai-China ranks top, followed by Singapore, Hong Kong-China, Taipei, Korea, Japan and Liechtenstein respectively in the Program for International Student Assessment (PISA) 2012 study on mathematics performance. Switzerland, the best performing European country was a distant ninth with a mean score of 531.

Philippine students are reported to excel in knowledge acquisition but perform poorly in mathematical tests requiring higher order thinking skills (Ganal & Guiab, 2014). A similar observation is reported among pre-service teachers and mathematics teachers on the Philippine Professional Board Examination for Teachers. Kaplan (2019) report that most students end up dropping out of Indian schools for fear of sitting mathematics tests and performing poorly in them, affecting their overall academic performance.

The National Aeronautics and Space Administration (NASA) and the National Defense Education Act of congress approved large expenditure to provide facilities and training in mathematics and science in the United States (Ganal & Guiab, 2014). This was to improve mathematics performance of students and surpass that of other nations. Organization for Economic Co-operation and Development (OECD), (2022) report that United States' eight graders continue to perform just below the international average in mathematics when compared to 23 other nations. Zhao (2011) showed that perfect execution of mathematics curricula does not automatically lead to precise increase in mathematics test performance among Chinese learners.

In Africa, poor mathematics performance has led to reduction of probable numbers of talented students who take mathematics related courses at the university. Students in Egypt have recorded poor performance in mathematics compared to their peers in some African and Asian countries (Callan & Cleary, 2018). Good performance in mathematics is a major criterion for students entering higher institutions in Ghana. Despite the Ghanaian government giving priority in improving mathematics and science performance, poor performance by students is still registered in the country (Atepaor *et al,* 2022).

In Tanzania studies reveal poor performance in mathematics than in other science subjects (Kabote, Niboye & Nombo, 2014). Similarly, poor performance in mathematics has been reported among rural schools than urban schools in Zimbabwe (Baliyan *et al,* 2021). As Meroyi, Amosun and Sotoyinbo (2022) report, the growth of Ugandan society rests on development of personnel in science and technology. Yet, this may not be realized since mathematics performance is not as expected (Ministry of Education and Sport, 2014).

Locally, Kenya has relatively strong mathematics related university programmes. Poor performance in the subject at secondary level has seen very few admissions to these courses

(MOEST, 2014; 2015; 2016; 2017). This may have jeopardized the capability of students to take up career placements to realize the achievement of the government's vision 2030 initiative and achieve the 17 Sustainable Development Goals (SDGs). Kakamega County has shown dismal performance in mathematics as compared to other subjects and other counties. From the year 2012 to 2016, mathematics' mean score has been below 3.5 points compared to other counties which have been scoring above 4 points as shown in appendix G. Also, when compared to other compulsory subjects which have constantly registered means of over 7 points out of the possible 12, performance in mathematics has been low (MOEST, 2015; 2016; 2017) as illustrated in appendix E and F. Some researchers have cited lack of infrastructure such as Onyara (2013), negative attitude toward the subject (Owino, Yungungu, Ahmed & Ogola, 2015), poor teacher training (Odiembo & Simatwa, 2014) as some of the variables affecting poor mathematics performance. Despite of all these studies, poor mathematics performance still continues unchecked. The researcher hypothesized that there are various cognitive and affective factors that have not been studied systematically to check their influence on Mathematics performance. Such factors include metacognitive abilities of learners as well as anxiety which many students suffer during mathematical tests. Such factors if studied systematically may provide a hint on why students in Kakamega County are performing poorly in mathematics as compared to other counties.

Metacognition refers to a level of thinking that involves active control over the process of thinking that is used in learning or problem-solving situations (Flavel, 1979). This involves thinking about one's own thinking process such as study skills, memory capabilities, and ability to monitor learning and problem solving. According to Smith (2013), metacognition is categorized into three components. Metacognitive awareness is the knowledge by a reader or problem solver of the tasks and the strategies to be used to achieve goals. Metacognitive strategies refer to skills and methods one uses as a reader or a problem solver to accomplish the task before them. These skills are; planning which refer to appropriate selection of strategy and correct allocation of resources for the task to be performed; monitoring which refer to one's comprehension of the task to be performed; and evaluation which is appraising the end product of a task and how efficient it was performed (Barbara, 2017)

Metacognitive training and instruction have positive effects on students' performance in diverse fields such as reading and problem solving (Veenman, 2011). Metacognition in mathematics helps students continue solving problems without giving up their efforts. According to Suriyon, Inprasitha and Sangaroon (2013) learners are able to create new problem-solving approaches and express various ways of thinking when one approach fails. Additionally, use of metacognitive strategies may help students acquire effective study methods in mathematics. Du Toit and Kotze (2010) explain that this helps learners to like mathematics as they gain simplified ways of approaching the problems. They then start understanding the relevance of the subject in their everyday life and future.

Metacognition is closely associated with the state of one's mind. For example, an anxious learner may not appropriately use metacognitive abilities they possess for the task at hand. Similarly, students with low metacognition are more likely to panic when required to sit a mathematics test (Herawaty *et al,* 2018). Mathematics anxiety is a feeling of fear or apprehension when considering any mathematics task. As Knox (2017) reports, Mathematics anxiety could have negative educational and personal consequences, the most evident being mathematics avoidance.

Mathematics anxiety has been shown to be negatively correlated to motivation and self confidence in mathematics (Ansari, Sulstri & Apriana, 2019). According to Gylo and Dales (2017) students who have medium and high mathematics anxiety are significantly less successful both in their examinations and in solving short mathematics concept tests than those of low mathematics anxiety. Miguel (2012) indicated that mathematics anxiety has a damaging effect on students' academic performance.

It may then imply that these relations between metacognition and mathematics anxiety have a predicting factor on students' mathematics test performance which if well studied and understood may be manipulated for the sake of the learner. This study therefore sought to find out how metacognition and mathematics anxiety predicts the mathematics test performance of secondary school students in Kakamega County. Differences due to gender and age were also tested.

1.3 Statement of the Problem

Previous research has highlighted multiple factors influencing mathematics performance. Kucuk (2020) found that teacher-related aspects, such as classroom preparedness, qualifications, teaching methods, experience, and instructional strategies significantly impact students' academic success in the subject. Additionally, the study revealed that a student's personal attitude toward mathematics is heavily shaped by peer perceptions. Parental engagement and broader societal views on the subject also play a crucial role in shaping student performance. Meanwhile, Mwove et al. (2022) identified resource-related challenges, including the availability of financial and physical resources, student-textbook ratios, and student-teacher ratios, as further contributing factors influencing mathematics achievement.

Studies indicate that through cognitive and emotional interplay, metacognitive strategies can either alleviate or intensify the impact of mathematics anxiety. Examining this connection offers valuable insights into how students manage their emotions and cognitive strategies while engaging in mathematical tasks (Scheibe et al., 2023). Tawaldi *et al* (2023) posits that metacognition and mathematics anxiety have a high impact on learning outcomes. They state that mathematics anxiety can greatly impair problem-solving abilities and logical reasoning. Tomasetto *et al* (2021) reported that mathematics anxiety is associated with poor mathematics performance among children across different cultural contexts and developmental stages.

As Eidli-Levy *et al*, (2023) found out, mathematics anxiety directly predicted career choices for high school and university students more that the primary going pupils. This shows that it is crucial to identify young students with mathematics anxiety so that they may be helped early in their academic years to prevent them from avoiding career choices which require high mathematics intensity. Strong mathematical skills are essential for success in science, technology, engineering, and mathematics (STEM) careers. Implementing metacognitive strategies to manage math anxiety can help more students embrace STEM disciplines, ultimately fostering a more competent workforce (OECD, 2022).

Given these considerations, the researcher found it essential to examine how metacognition and mathematics anxiety predict mathematical performance. This study sought to provide valuable insights into how lack of metacognitive knowledge, ineffective utilization of metacognitive strategies and heightened anxiety affect students to during mathematics assessments.

Despite Mathematics being a gateway to almost all careers in science, students' performance has continued to deteriorate over time the world over. Kakamega is one such affected County. The County has shown a poor performance in the overall results of the KCSE examinations from the year 2014 till 2017. Compared to other counties, Kakamega County has shown poor performance in mathematics over the recent three years (MOEST 2015; 2016; 2017) as shown in Appendix E. This trend continued in the following years with the county registering dismal performance in mathematics as compared to other subjects. Though there was a slight improvement in 2018, 2019 and 2020 when the county recorded means of 26.5, 27.8 and 18.4 against the aggregate mean of 34.7, 38.9 and 33.4 respectively (MOEST 2018; 2019; 2020). In 2023, more than half of the candidates scored below D- (MOE, 2023) and in 2025, over 55% of the candidates who sat for K.C.S.E. scored below D (MOE, 2024).

This may have made most students miss out on highly scientific courses during university selection. This may pose a challenge to the county's vision and the country's vision of making Kenya a medium industrialized country with its economy mainly supported by technology and industrialization as envisaged in the country's vision 2030 goals. The poor performance may be due to learners' lack of metacognitive abilities as well as anxiety experienced during mathematics exams.

These trends clearly depict a need to further find out why students in Kakamega County perform dismally in mathematics as compared to other counties. In as much as the researcher is cognizant of an array of variables that may influence a student's performance in a mathematics test, this study sought to find out whether metacognition and mathematics anxiety can be studied and manipulated to improve performance in mathematics. This could then place the students at a better place in being selected for university courses and hence boost their social mobility in the society by enhancing their employability in technical and industrial fields for the development of the County.

1.4 Purpose of the study

The purpose of this study was to find out if and to what extent metacognition and mathematics anxiety predicts mathematics test performance among secondary school students. It also examined how these variables differ due to gender and age of the students.

1.5 Research Objectives

The objectives of this study were to:

i) Establish the relationship between metacognition and mathematics test performance among secondary school students in Kakamega County.

ii) Determine the relationship between mathematics anxiety and mathematics test performance among secondary school students in Kakamega County.

iii) Test for differences in metacognition and mathematics' anxiety due to gender among secondary school students in Kakamega County.

iv) Find out if there are differences in students' metacognition and mathematics' anxiety due to age among secondary school students in Kakamega County.

v) Determine the relative predictive weights of metacognition and mathematics anxiety on mathematics test performance among secondary school students in Kakamega County.

1.6 Research Questions

The study attempted to answer the following research question;

i) What is the relationship between metacognition and mathematics test performance among secondary school students in Kakamega County?

ii) How is mathematics anxiety related to mathematics test performance among secondary school students in Kakamega County?

iii) What differences exist in students' metacognition and mathematics' anxiety due to gender among secondary school students in Kakamega County?

iv) What differences are there in students' metacognition and mathematics' anxiety due to age among secondary school students in Kakamega County?

v) What are the relative predictive weights of metacognition and mathematics anxiety on mathematics test performance among secondary school students in Kakamega County?

1.7 Significance of the study

This study's findings may be used to inform policy makers by giving direction how metacognition and mathematics anxiety may determine students' performance in mathematics examinations. It may also be used to contribute to the existing knowledge and literature on metacognition, mathematics anxiety and mathematics test performance among secondary school students. The findings may also be used by the school administrations to foster metacognition development among students and to emphasize metacognitive instruction among teachers with the hope of realizing the reduction of mathematics anxiety for better mathematics performance among secondary school students in Kakamega County.

1.8 Limitations and Delimitations of the study

1.8.1 Limitations of the study

The study could not have determined the effect of naturally occurring events that may have an effect on the overall results. To mitigate this threat, the researcher randomized students in each class to select those who took part in the study. The questionnaires relied on the honesty of the respondents and the researcher did not have any control over them neither was he be able to determine whether what they reported about themselves was true or not.

1.8.2 Delimitations of the study

The study was restricted to form three public secondary school students in Kakamega County. This is because past KCSE results have shown poor mathematics performance in public secondary schools. The findings may therefore not be generalized to students undergoing a different education system or who are exposed to different characteristics such as those in private schools or home schooling. Data was collected from students through questionnaires and from a mathematics test. Although metacognition has three aspects (awareness, strategies and experiences) the study only focused on two aspects (awareness and strategies). There are other factors other than metacognition and anxiety that can affect mathematics performance such as; student's attitude, student's motivation level, teacher's qualification, teaching style, classroom environment, demographic factors, gender stereotyping among others. However, for this study, the researcher focused on determining how metacognition and mathematics anxiety may predict mathematics test performance among secondary school students.

1.9 Assumptions of the study

In this study, the researcher assumed that

i. Students exhibit varying levels of metacognition and mathematics anxiety that can be measured on a rating scale.
ii. Schools and students share a relatively uniform learning environment, given that they follow the same curriculum.
iii. The respondents provide honest and truthful responses.

1.10 Theoretical and Conceptual Framework

1.10.1 Theoretical Framework

This research used John Flavell's (1979) Metacognition theory and Irwin Sarason's (1988) Cognitive interference theory.

John Flavell's Metacognition Theory (1979)

John Flavell's metacognitive theory propagates the notion of intentionality which presupposes thinking that is deliberate and goal-directed, and involves planning a sequence of actions. In this theory, three major components of metacognition are distinguished: metacognitive knowledge, metacognitive strategies and metacognitive experiences. Metacognitive knowledge refers to knowledge, beliefs and ideas and about their diverse interactions with cognitive tasks and strategies that can be employed to achieve these cognitive tasks.

This knowledge can be deliberately and consciously retrieved or it may be activated unintentionally and automatically by specific clues in a task situation. Metacognitive experiences accompany any success or failure in problem solving such as remembering to breakdown a mathematical problem into two or three parts for easy understanding. Metacognitive strategies refer to the skills and processes used to plan, guide, monitor, control, regulate and evaluate cognition and learning.

In this study the theory was used to show the function of metacognition in guiding students as they solved Mathematical problems, knowledge of themselves as problem solvers, demands of the task at hand and knowledge of what they want to achieve guided them to realize whether they understood what they were needed to do therefore helping them choose the best strategy to employ in solving a particular mathematical problem.

This made them aware of the appropriate approaches to use and easily discard those that could not work in favor of their desired outcome. Learners whose metacognitive abilities were high were therefore likely to use the necessary strategies to solve Mathematical problems thus scoring highly in mathematics tests, while those with low metacognitive abilities were most likely to score dismally since they were less likely able to know the strategies to use. These findings corroborate that of Aura et. al (2014) which provided supportive evidence that primary school pupils with high metacognition perform better at problem solving than those with low metacognitive abilities. They further support the notion of intentionality and deliberate effort a student may put in to enhance their metacognitive abilities.

Cognitive Interference theory by Irwin Sarason (1988)

Cognitive interference refers to the unwanted and often disturbing thoughts that intrude on a person's life. This theory has shown that cognitive interference plays an important role in stress, poor performance, slow learning, social maladjustment, psychopathology, and behaviors resulting in accidents. This theory explains that when a low anxiety (LA) and high anxiety (HA) group are tested on two intelligence test tasks, LA subjects perform better than HA subjects. Task relevant responses arise from anxiety drive and reduce anxiety by leading to successful completion whereas the task irrelevant responses are not specific to the task hence interfere with the performance of the task at hand. This is mainly a product of cognitive interference stemming from preoccupations with irrelevant and anxiety directed thought processes.

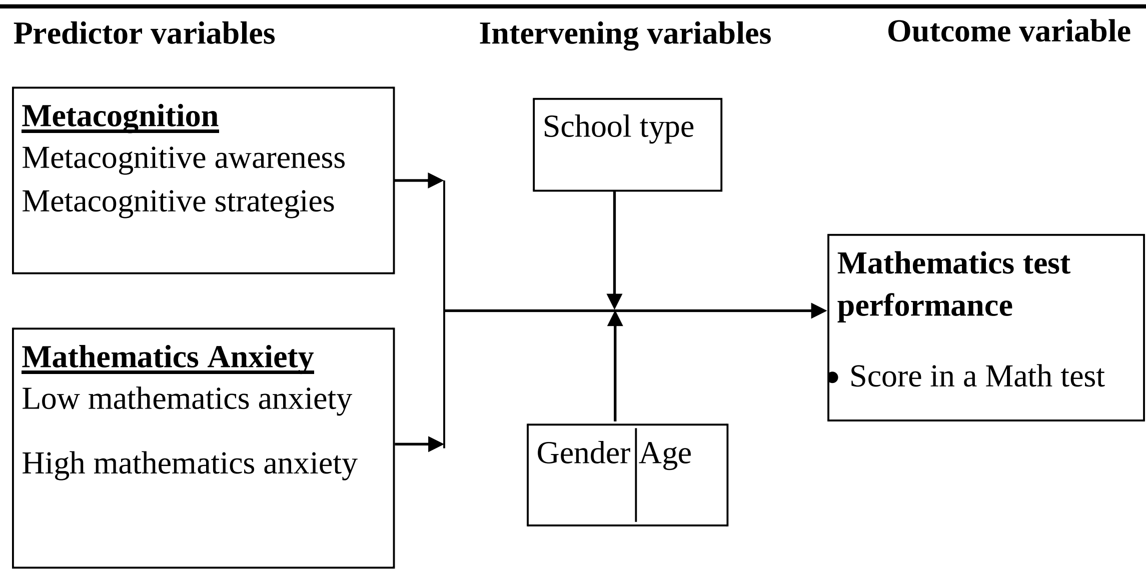
In the current study, this theory explains the role of anxiety as a disturbing thought that can affect Mathematics performance. The theory was used to show how mathematics test anxiety may be associated with increase in physiological arousal and negative distracting thought processes among students and how this arousal in turn affects their effective performance in any mathematics test despite of their personal capabilities.

This theory will be used because the first theory used on metacognition was not sufficient to explain about mathematics anxiety.

1.10.2 Conceptual Framework

Figure 1.1

Hypothesized relationship between study variables



Note.

→ Direction of Relationship

Source: Researcher (2025)

Figure 1.1 conceptualizes how, hypothetically, metacognition and mathematics anxiety influence a student's mathematics test performance. It illustrates how these variables may have interacted with gender, school type and age to predict mathematics test performance. It is hypothesized that students who are aware of the various metacognitive strategies and use these strategies experienced less mathematics anxiety during their mathematics examinations and hence were more likely to perform highly in a mathematics test. It is anticipated that the type of school attended may have an intervening effect in how these variables relate. Most co-educational schools have inferior facilities as compared to boys or girls only schools, the co-educational schools in most occasions admit students who have performed dismally in their primary education and those who have a challenge in raising the required school fees. Such students may miss many class sessions since they are always sent home for school fees and miss classes, including mathematics classes. The age and gender of the students may also intervene in the relationship since previous reports have shown boys performing better in mathematics than girls. Students who are delayed to start school due to various reasons also seem to have poor performance compared to those who join school early.

1.11 Operational definition of terms

Cognitive component: The thoughts that inform one's view of his/her academic ability and intellectual competence such as confidence.

Emotional component: The emotional manifestations by students when faced with a test, such as fear of failure, worry or panic.

Metacognitive knowledge: The knowledge of oneself as a problem solver, knowledge of the task at hand and knowledge of the skills for performing the task as measured on MAI scale at interval level.

Metacognitive strategies: The reported use of strategies for performing a task as measured on the MAI scale at the interval level.

Metacognition: The overall score on knowledge of oneself as a problem solver, knowledge of the task at hand and the appropriate skills for performing the task combined with perceived use of necessary strategies for performing a task measured on the MAI scale at interval level.

Mathematics anxiety: The feeling of fear or apprehension when doing mathematics test as measured on the MARS at the interval level.

Mathematics test performance: The overall score on the MT at the interval scale.

Physical component: The typical bodily reactions to acute anxiety before, during or after sitting for a test.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter contains a review of literature metacognition and mathematics anxiety. It quotes literature citing relationship between metacognition and mathematics test performance, relationship between mathematics anxiety and mathematics test performance, and differences in students' metacognition and mathematics anxiety due to gender. It further cites literature on age differences in metacognition and mathematics anxiety, predictive weights of metacognition and mathematics anxiety on mathematics test performance and gives a summary pointing out gaps in the reviewed literature.

2.2 Relationship between metacognition and mathematics test performance

Most theories of metacognition agree that there are at least two or three components of metacognition. Metacognition can be divided into knowledge about and control over one's own cognitive system (Flavell, 1979), thus, metacognitive knowledge; and metacognitive strategies which are skills of carrying out the task (Meroyi, Amosun & Sotoyinbo, 2022t).

Brown (1987) in Handel, Artelt and Weinet (2013) found out that spontaneous control of one's own learning process may occur without the person being aware of it. The conscious executions of strategies are thus manifested by planning, monitoring and meta-strategic activities through the implementation of metacognitive knowledge. Stillman and Mevarech (2010) investigated the effects of self-metacognitive questioning training on Year 3 students on problem solving and anxiety of mathematics of higher and lower achievers. They reported that the metacognitively trained students gained more than the control students in mathematical problem-solving performance. This study used the experimental design where generalization of the findings may not be possible, but in the current study, the researcher used the predictive correlational research design to find out if there was any relationship between metacognition and mathematics performance among secondary school students.

In a study done among Belgian children from Grade 1 to 6, it was reported that the metacognitive knowledge and skills of children were directly related to their accuracy in responding to mathematics problems. Children who scored low in metacognition also evaluated their own performance in mathematics as worse, (Desoete *et al,* 2019). This study employed the longitudinal cohort design with a difference of six months, January and June. The study correctly predicted the children's performance in mathematics in June from their scores in January among more than half of the participating children. The study further observed that poor mathematics performers are scored poorly in metacognition. They also overestimated their potential in solving mathematical problems. This study used the longitudinal cohort study design where findings are specific to the study group thus difficult to generalize. In the current study the researcher used predictive correlational design where findings may be easily generalized to a larger population.

In their investigation on effects of metacognitive scaffolding on grade four pupils' mathematics performance in a cooperative learning environment, Dagoc and Tan (2018) concluded that the use of metacognitive scaffolding was of great help to the pupils as it helped them benefit from cooperative learning. This was evident since pupils exposed to cooperative learning with metacognitive scaffolding performed better than their counterparts who were only exposed to cooperative learning. In their quasi-experimental study, interview protocols and mathematics achievement tests were used as instruments. They further reported that pupils whose metacognition were high found less difficulties in understanding the mathematics concept, could easily analyze the problems and suffered little memory challenges, possessed better basic mathematics skills and showed positive attitudes towards mathematics and less anxiety when faced with a mathematics problem. Similarly, Ohtani and Hisasaka (2018) in their meta-analysis using 179 samples from 118 articles revealed that metacognition greatly predicted academic performance when intelligence was controlled for. This showed the importance of metacognition in educational practice. Their study majored on how metacognition generally predicted the overall performance of the subjects. The articles reviewed were largely from the American and European studies. In the current study, the researcher focused on how metacognition and mathematics anxiety jointly predict mathematics performance in Kenyan population of high school students. The predictive correlational study design may show different outcomes compared to what the meta-analysis design showed.

In a study done among Belgian children from Grade 1 to 6, it was reported that the metacognitive knowledge and skills of children were directly related to their accuracy in responding to mathematics problems. Children who scored low in metacognition also evaluated their own performance in mathematics as worse, (Desoete *et al*, 2019). This study employed the longitudinal cohort design with a difference of six months, January and June. The study correctly predicted the children’s performance in mathematics in June from their scores in January among more than half of the participating children. The study further observed that poor mathematics performers had scored poorly in metacognition. They also overestimated their potential in solving mathematical problems. This study however did not find out why it could not correctly predict half of the children's performance from their previous scores. The current study sought to predict student mathematics performance as predicted by their score in metacognition and anxiety towards mathematics.

In their investigation on effects of metacognitive scaffolding on grade four pupils' mathematics performance in a cooperative learning environment, Dagoc and Tan (2018) concluded that the use of metacognitive scaffolding was of great help to the pupils as it helped them benefit from cooperative learning. This was evident since pupils exposed to cooperative learning with metacognitive scaffolding performed better than their counterparts who were only exposed to cooperative learning. In their quasi-experimental study, interview protocols and mathematics achievement tests were used as instruments. They further reported that pupils, whose metacognition were high found less difficulties in understanding the mathematics concept, could easily analyze the problems and suffered little memory challenges, possessed better basic mathematics skills and showed positive attitudes towards mathematics and less anxiety when faced with a mathematics problem. Similarly, Ohtani and Hisasaka (2018) in their meta-analysis using 179 samples from 118 articles revealed that metacognition greatly predicted academic performance when intelligence was controlled for. This showed the importance of metacognition in educational practice. These studies only focused on the importance of metacognition and did not look at other variable that may influence performance. The current study looked at how metacognition and mathematics anxiety may predict mathematics performance of secondary school students.

Handel, Artelt and Weinet (2013) using questionnaires on 1st year college students reported a positive relationship between metacognition and test performance. This study explored the relationship between metacognition and students' general performance. The current study sought to find out if there is a relationship between metacognition and mathematics test performance. Ortlieb and Norris (2012) in a quasi-experiment using kindergarten children in Texas America found out thinking aloud as they read increased the learners' comprehension of science concepts. The sample size for this study was kindergarten children who may have not fully developed their metacognitive abilities as compared to secondary school students who will be used in the current study.

Locally, using a sample of 310 class 6 pupils and a correlational research design, Mwaniki (2015) found a positive and significant relationship between metacognition and reading comprehension performance. This study tested primary school pupils who were below 13 years old. Young children may be low on metacognition because it is still developing as compared to students in secondary school who may have advanced in metacognition development which the current study has sampled. Metacognitive strategies used in reading may be different from strategies used in mathematics, thus the current study examined how metacognition relates to students' mathematics test performance in Kenya.

2.3 Relationship between mathematics anxiety and mathematics test performance

Mathematics anxiety has been one of the biggest concerns pertaining to education for a long time, it refers to the state of fear, nervousness, and apprehension when an individual engages with mathematics (Ashkenazi & Danan, 2017). A wide number of studies imply that this incident is a highly widespread problem among students right from elementary schools to universities (Skaalvik, 2018). According to (Carey *et al*, 2017) many empirical studies have demonstrated the negative mathematics anxiety-mathematics performance relationship.

In a Meta-Analytic Investigation done in Shanghai China to explore the link between mathematics anxiety and mathematics performance, Zhang, Zhao and Kong (2019) searched literature for studies on mathematics anxiety and mathematics performance from beginning of 2000 to end of 2018 through electronic databases. After filtering from 857 articles, 49 articles that yielded 84 independent samples were included in the study. The study demonstrated a significantly negative effect size in the mathematic anxiety – mathematics performance association. It further illustrated that the extent of the association varied across geographical locations, student grade level, tool for measuring mathematics anxiety and measurement facets of mathematics performance. They posed two theories to explain the negative association, first the Deficit Theory which argues that performing poorly in mathematics test may lead to higher anxiety and unpleasant experiences in the future and secondly the debilitating anxiety model propose that mathematics anxiety would manipulate mathematics performance by cognitive interference, where individuals who have higher level of mathematics anxiety will purposely avoid engaging in mathematical activities.

Various studies point out that anxiety affects performance negatively. In his study among European students studying in America, Leppavirta (2011) found out that students' anxiety towards mathematics test lowered their mathematics test performance. These findings agree with the analysis of PISA 2012 results by Balivan *et al* (2021). The findings from these studies may differ from the current study since they were performed on European immigrant children studying in America. Their social status and cultural dynamics are different from the situation in Kenya and may therefore affect anxiety levels of the students.

Using a questionnaire with second- and third-year students at the University of Sheffield, Thomas (2020) reported that most students dropped out any mathematics related course due to being anxious about mathematics. This study was done with university students undertaking various courses. The current study focused on secondary school students who may have lower anxiety levels towards mathematics due to their lesser exposure to mathematics test as compared to second- and third-year university students.

In an experimental study on 40 Zimbabwean high school students done by Denhere (2015), results failed to show that MA directly causes low MTP. Being an experiment, the sample size is generally smaller as compared to doing a correlational study. The researcher sought to find out if using a larger sample of students with the predictive correlational research design the findings could be different in any way.

Locally, using a correlational study and 120 form 2 students in Kanduyi Division of Bungoma District, Simiyu (2010) reported that test anxiety does not have a significant relationship with academic performance of a student. This assertion is however contrary to many studies such as Ong'uti, Aloka and Nyakinda (2019) with a sample of 360 form 3 students in a survey who reported that students who failed to monitor their mathematics performance showed high levels of mathematics anxiety which in turn lowered their mathematics test performance. These two studies, though done in close proximity in terms of time and in the same location of the current study, show contradicting results. This made the current study essential in helping to determine whether there is a significant relationship between mathematics anxiety and mathematics test performance among secondary school students.

2.4 Differences in students' metacognition and mathematics anxiety due to gender

2.4.1 Differences in metacognition due to gender

In a study that sampled 90 American pre-university students, Zakariya (2018) reported that female students used social strategies significantly more than male students. Kumar and Karimi (2010) used 424 high school students in a survey found out that female students scored higher than male students in their abilities of using metacognitive strategies in solving mathematical problems. Their results concur with those of Bogdanovic et al (2015) who used 358 male and 388 female students in their third high school in Novi Sad, city in Republic of Serbia and found that metacognitive abilities and problem-solving skills were significant in favor of female students. These studies having been done in countries outside Africa may have had an influence of the cultural set up of those places affecting the results. The current study was conducted in different cultural set-ups that may have a bearing on students, metacognition.

In their study, Yildiz, Baltaci and Kuzu (2018) used a sample size of 366 middle school students in Turkey found no significant differences in metacognition in the sub-dimension of gender. This was a descriptive study conducted using rational screening model that aimed at determining the degree of chance between metacognitive competencies and gender. In as much as there was a significant relationship between learning competencies and gender in favor of male students, there was no significant difference in metacognition due to gender in the same group of students. In the current study, the researcher used secondary school students to find out if there were any differences in metacognition due to gender.

In their study of middle school students in the Netherlands Lingel, Lenhart and Schneider, (2019) tested their performance on mathematics tasks in addition to academic self-concept of mathematics ability. They reported that boys scored significantly higher than girls on mathematics tasks and math-related concepts. However, they found out that girls were more prepared to invest effort into mathematics task than boys. These results concur with previous findings from Igbo *et al*, (2015) that girls were more actively engaged in the task and that they reported greater use of self-regulated learning strategies, though they judged themselves less self-efficacious than boys. As a result, they suggested that lack of self-referenced cognitions of competence present during the start of a mathematics test may contribute to gender differences in performance on mathematics tasks, but does not affect learning intention. Hence though girls are more motivated than boys to do well on mathematics tasks, they perceive their abilities to perform well on mathematics task as being lower than boys. These findings contradict those by Jenkins (2018) who using 146 sixth to eight grade students drawn from an inter-district magnet school in Hartford Connecticut found out that girls scored higher in metacognition than boys in mathematics, she also reported an interaction of gender by step as girls had higher scores than boys in all the five components of Task Assessing, Planning, Applying Strategy and Monitoring Performance, and Reflecting and Adjusting. The two studies reported contradicting findings about gender differences in mathematics performance and they used motivation and self-perception as the predictive variables. The current study sought to establish if there were any differences due to gender in mathematics anxiety that may influence the performance in mathematics test among secondary school students.

Ozcan and Gumus (2019) using seventh graders to study gender differences in metacognition by assessing their use of learning strategies reported that boys were higher than girls in their use of learning strategies. These results were contrary to Tian, Fang, and Li (2019) who reported that girls adopt a more superficial approach to learning in various self-regulated learning strategies and metacognition. Earlier, Liliana and Lavinia (2011) had attempted to address these inconsistencies by investigating gender differences in metacognitive skills by assessing metacognitive awareness in eight grade students. Their findings revealed significant differences in the use of metacognitive skills due to gender. However, they did not show any gender difference pattern nor did they report which particular gender had higher or lower scores in the different dimensions which was one of the objectives of the current study. Overall, the results showed that both boys and girls use metacognition to help them in problem solving and learning but only differ in terms of the various metacognitive skills they employ.

In India, using a quasi-experiment with 60 second grade high school students in a case study of Mumbai municipality high school, Jayakrishna, Rao and Reddy (2018) found out that gender has no significant role on metacognitive development. Results obtained from a case study may be impossible to generalize to the wider population and the researcher's own subjective feelings may influence the case study. The current study used the predictive correlational research where there is no researcher subjectivity since the researcher will have not spent a lot of time with the students.

Locally, in their quantitative survey involving 317 students in co-educational school in Siaya County, Ongowo & Hungi (2014) found no gender differences in metacognitive strategies. These results corroborated those of Mwaniki (2015) who found no significant gender differences in metacognition among class 6 pupils of Dagoretti Division. The current study used a predictive correlational research design with a sample of secondary school students to find out and any differences in metacognition due to gender.

In another study, Mutai (2015) used a quasi-experiment with 134 secondary students in Uasin Gishu County to investigate the effects of Gowin's Vee Heuristic strategy and use of metacognition. They attributed the better performance of the male students in the topic to their better metacognitive knowledge and strategies compared to female students. Use of a different methodology may have affected the results thus the current study employed the predictive correlational research design to find out if there are any differences in metacognition due to gender.

These studies show mixed findings on the gender differences. These inconsistencies are reported in both local and international studies. The current study was necessary so that the researcher could determine whether there were any differences in metacognition due to gender among secondary school students.

2.4.2 *Differences in mathematics anxiety due to gender*

The attainment of mathematics skills is fundamental for proper functioning in scholarly and professional settings as well as daily life. Various factors have been shown to unconstructively sway mathematics skills acquisition and performance, among them is mathematics anxiety. Various studies have argued the relationship between mathematics anxiety and mathematics performance. Other studies have even gone further to show the difference due to gender in mathematics anxiety. High mathematics anxiety cannot always be related to poor mathematics performance or the inverse of this. In a sample of 1,800 elementary and secondary school children, Devine *et al* (2018) reported that more than three quarters of the children who scored high in mathematics anxiety had average to high mathematics scores with only less than 20% of those who had high anxiety scored poorly in mathematics. Majority of studies focusing on gender differences in mathematics anxiety report that women have higher levels than men (Miller & Bichsel, 2004; Ferguson *et al.*, 2015; Jansen *et al*, 2016). In their study, Ashcraft and Moore (2009) computed that female approximately scored higher on mathematics anxiety by 0.3 SD than men starting from grade 6 all through to college. In a longitudinal study done by Ma and Xu (2004) involving boys and girls from grade 7 to 12 showed that girls had significantly stronger stability effects for girls than boys in mathematics anxiety even when they transitioned from year to year and from junior to senior schools. This means that girls have a tendency to sustain mathematics anxiety acquired in earlier years of study even when their performance improves as compared to boys. Various studies do not show any gender difference in mathematics anxiety among lower grade children (Harari *et al.*, 2013; Erturan & Jansen, 2015; Schleepen *et al*, 2019; Kucian *et al*., 2018)

The Sustainable Development Goals (SDGs) advocate for equity in education. African females are encouraged to take up mathematics courses and pursue science and technological oriented careers. Upon school entry, no significant differences are evident between boys' and girls' mathematics achievement, however as they progress in their studies, gender gaps start manifesting with girls performing dismally compared to boys (Ridge & Kippels, 2019).

The above conclusion has been contradicted by various empirical studies. Thien and Ong (2015) in a correlational study using 300 PISA 2012 participating students from Malaysia and Singapore found contrasting results between the students from the two countries. They found no significant gender difference in mathematics anxiety among the Singaporean students, while on the other hand; Malaysian female students showed a higher mathematics anxiety scored compared to Malaysian male students. This study was carried on subjects from the oriental countries who may have different cultural backgrounds unlike the Kenyan students.

Van Mier *et al* (2018) in the Netherlands carried out a study among 124 second and fourth grade children which revealed that although exhibited more or less similar levels of mathematics anxiety, correlation analyses showed that mathematics anxiety significantly and negatively correlated with mathematics performance only in girls. Furthermore, girls with high mathematics anxiety scored low in mathematics test as compared to boys. They further found out that only in girls the level of mathematics anxiety moderated the arithmetic test scores significantly and negatively with girls who had high anxiety scoring low in arithmetic while there was no effect on arithmetic scores among boys with similar anxiety levels. The current study sought to find out whether the level of mathematics anxiety significantly moderated the scores in mathematics test in both male and female students.

Mohammadpour and Shekarchzadeh (2015) using a survey, with 615 high school finalists in Iran reported that girls generally performed lower than boys, and there was high mathematics anxiety among the girls compared to the boys. These results were not consistent with those of Helal (2018). Using a questionnaire with 276 pre-university students in Egypt, he reported no significant gender difference in mathematics anxiety among the 144 male and 132 female students that he used in the study. These studies report two contradicting findings. There are different cultural dimensions in the Middle East nations as compared to Kenya in terms of schooling and socialization that may affect the results. This therefore prompted the researcher to find out if there were any differences in mathematics anxiety due to gender locally.

Yuksel-Sahin (2008) using a survey with 127 first grade Turkish high school students reported high scores of mathematics anxiety among female students. He reported that female students believed boys have the advantage of mastering mathematics concepts unlike them. These results concurred with a study done in South Africa by Hlalele (2012). In a correlational study with 987 second year high school students in Kwa Zulu Natal province, he reported that mathematics anxiety was evoked in more than half of the female students when introduced to a new topic and when they had to use calculators in solving a mathematical problem. The current study sought to determine whether the case is the same in Kenyan contest as it was reported in Turkey and South Africa.

2.5 Ages differences in metacognition and mathematics anxiety

2.5.1 *Differences in metacognition due to age*

Some studies have found age to be a strong determinant of self-reported metacognition among students. Other studies have shown no age difference in metacognition. In one such study, Gul and Shehzad (2012) using a survey with 345 3rd and 5th grade high school students in Punjab, they reported no significant difference on independent sample t-test conducted on 3rd graders (M:85.4 SD:7.7) and 5th graders (M:84 SD:6.1). Handel, Artelt and Weinert (2013) using a quasi-experiment with 212 Bavarian and 366 mixed federal state 5th to 9th grade secondary school students in Cologne, they found no significant difference in metacognition due to age among the students. These studies used different methodology which may have affected the results. The current study used the predictive correlational research design to find if there are any differences in metacognition due to age.

Using a questionnaire and interviews with 445 Spanish high school students, Theodosiou1, Mantis and Papaioannou (2008) found that students reported less frequent use of metacognitive strategies as they moved from the junior to senior high school. Jabor, Machtmes and Huang (2012) using a questionnaire and interviews with 500 graduating high school American students, reported that most students aged below 19 years had higher GPA scores in mathematics than those who were aged over 19 years; they explained that as students grew older, the relationship between their age and their metacognition reduced. These two studies give contradicting results yet they both used high school students and questionnaires and interviews. The researcher therefore used the predictive correlational research method to find out any differences in metacognition due to age.

Locally, Aurah, Cassady and McConnell (2014) using a quasi-experiment with 2,138 secondary school students in Western Kenya they reported that form 3 and 4 students were able to exhibit better and frequent use of metacognition strategies than those in form 1 and 2. This study used an experimental design which may have affected the results. The current study used a predictive correlational research design to find out whether there were any differences in metacognition due to age among secondary school students.

Aurah, Koloi-Keaikitse, Isaacs & Finch, (2011) using 150 pupils in a case study reported that upper primary pupils scored higher in metacognitive knowledge than lower primary school pupils. This study used a different sample hence the desire of the current study to find out if there is difference in metacognition due to age among secondary school students.

The relative paucity of studies of metacognition in Kenyan education among secondary school students indicated a need for the current study to be done so that more information can be obtained about age differences and metacognition.

2.5.2 *Differences in mathematics anxiety due to age*

Just as they are important for academic success, arithmetic capabilities are equally vital for daily living. Initially, these capabilities were once regarded as crucial for success exclusively in scientific and technical fields, however, mathematics capabilities have become fundamental to success in humanities, social sciences and business (Beilock & Maloney, 2015). According to Chiu (2017) many people shun executing mathematics operations or achieve poorer performance than their capability due to dread of failing in those functions. It is therefore very significant to understand mathematics anxiety so that we can develop ways of reducing its prevalence (Ashcraft & Moore, 2009). Mathematics anxiety is typified by the feeling of strain, fret or unfounded fear hence leading to a hurdle for learning mathematics. This hurdle then hinders with performing mathematics functions and mathematics achievements (Son *et al*, 2017). According to Gan, Lim and Haw (2016) one in every five people suffer this anxiety and not less than 17% of the population experience high levels of mathematics anxiety. This therefore suggests that mathematics anxiety may not just be limited to school going children or college and university students but it does affect people from all age sets.

Various literatures on mathematics anxiety due to age report differing findings. Shukla, Shukla and Singh (2016) in Lucknow, India, using a questionnaire and 1,000 secondary school students, reported no significant difference in mathematics anxiety due to age. Similar to this, Yeo, Tan and Lew (2015) using 214 Malaysian undergraduate students aged between 19 to 27 years with a questionnaire found no significant difference. These studies were done in the oriental and Indian countries with different cultural setup which may have affected the results. The current study sought to find out whether there were any differences in mathematics anxiety among secondary school students in Kakamega County.

Mutodi and Ngirande (2014) in their study among 150 South African 1^{st} year students of Limpopo province found out that, older students of 21 years and above experience higher levels of MA with a mean of 2.1 compared to the younger students of 16-20 years with a mean of 1.95. Kufakunesu (2015) reported contradicting findings. Using a questionnaire and 100 1^{st} – 3^{rd} year students from Kinbu Senior High School in Accra, Ghana he reported that MA decrease as age increase. Junior high school students showed a higher mathematics anxiety level at a mean of 60 compared to their senior counterparts who had a mean of 50. These two studies done in Africa show contradicting findings. The current study sought to find out if there were any differences in mathematics anxiety due to age among secondary school students in Kakamega County, Kenya.

In Kenya, studies did also show such contradictory findings. Adino (2015) using a survey and a questionnaire with 192 Form 4 students of Butere Sub County found no significant differences in mathematics anxiety due to age. These results confirmed the findings of an earlier study by Githua (2013) among 649 Form 1 to Form 4 Nairobi and Rift Valley provinces. Using an ex post-facto design and a questionnaire, they found no significant differences in mathematics anxiety due to age. However, Onderi, Edward and Baluku (2010) found contrary results. Using a questionnaire with 200 Form 1 to 4 students of Masaba Sub-County, they found out that older students showed low mathematics anxiety than young ones.

The reviewed literature clearly shows that research findings on age differences in metacognition and mathematics anxiety are inconclusive. Nevertheless, it is clear from the literature that age is a significant variable in both metacognition and mathematics anxiety. Most studies have used college and university students and done in foreign countries while others used primary school pupils. The current study focused on secondary school students in Kenya. This set a justifiable need to find out whether there were differences due to age in metacognition and mathematics anxiety among secondary school students in Kenya.

2.6 Predictive weights of metacognition and mathematics anxiety on mathematics test performance

Studies on weights of metacognition and mathematics anxiety on mathematics test performance are very little. This is so because most of these studies have looked at these variables independently and arrived at mixed results as has been already reported. There are few studies that have looked at the relative effects of these variables in association with other related variables such as attitude. The researcher inferred the expected predictions from these related studies.

In a study involving 323 Iranian female seventh grade students, Hoorfar and Taleb (2015) reported that positive attitude towards mathematics positively correlated with metacognition and consequently to mathematics test performance. Saricam and Ogurlu (2015) using 300 Turkish secondary school students compared the attitude of students to mathematics anxiety. They found out that more positive attitude towards learning mathematics resulted in a lower mathematics anxiety which in turn resulted into good test performance. The current study used metacognition and mathematics anxiety other than attitude to find out how they relate to students' mathematics performance.

Locally, Otieno (2015) using written and verbal protocols with 26 secondary school students in a case study found out that beliefs in fixed intelligence raised their concern about how clever they are hence creating anxiety about the intelligence challenge. Mwaniki (2015) using a correlational study with 310 standard 6 pupils reported that metacognitive knowledge had significant predictive values for reading comprehension. The few available local studies have used metacognition and a different variable other than mathematics anxiety to show significant predictive values for either reading or performance.

The reviewed studies are insufficient in helping predict weights of metacognition and mathematics anxiety on mathematics test performance. It is thus difficult to rank the two variables in the order of which they best predict mathematics test performance. This study therefore sought to determine the predictive weights of the two variables on mathematics test performance.

2.7 Summary of literature review and gap identification

The bulk of the reviewed literature was carried out in the Western, Orient and Asian countries where learning conditions both at home and in school are far different from those experienced in Kenya. Most of the reviewed studies clearly point out that metacognition and mathematics anxiety affect mathematics test performance of students. However, this does not clearly show how the two variables jointly affect a student's performance on a mathematics test. Some studies have illustrated significant correlations between metacognition, mathematics anxiety and mathematics test performance while others show no correlation at all. The studies have also suggested that there could be gender and age differences in metacognition and mathematics anxiety towards mathematics test performance. This has been shown on how these variables affect the academic achievement and learning attitude of students. The current study sought to find out how these variables predict the performance of mathematics test and to what magnitude each of them does. It is evident therefore that there was need to interrogate the interplay of these variables statistically within the Kenyan settings for a more informed conclusion that can be reliably used to improve the mathematics test performance in Kenyan secondary school students.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter describes the methodology that was used in the study. Specifically, it highlights the research design that was used, the study variables, research methodology, location of the study, the target population, the sampling techniques and sample size. It describes data collection instruments, data analysis and logistical and ethical considerations.

3.2 Research design

This study employed a Predictive Correlational Research Design (PCRD). According to Goodwin (2010) PCRD is normally used to determine various degrees to which a relationship exists between two or more variables. This design was used because it allowed the researcher to measure variance on the outcome variable relative to the predictor variables. In this case, this design helped the researcher to measure the degree of students' mathematics test performance in relation to the level of their metacognition and mathematics anxiety. The study used the quantitative methodology. There were no interventions to impart any of the variables being measured.

3.3 Research variables

In this study, the predictor variables were students' Metacognition and Mathematics Anxiety while the outcome variable was students' Mathematics test Performance. Students' metacognition was obtained from a total score at the interval level on a metacognition questionnaire. Students' mathematics anxiety was inferred from a score at the interval level on a mathematics anxiety questionnaire. Gender (being boy or girl) and age of students were the intervening variables and were at the nominal level of measurement. Students' mathematics test performance was inferred from mathematics test scores measured at interval level.

3.4 Location of the study

The study was conducted in Kakamega County owing to the consistent poor performance in mathematics over the years. In Kakamega, students perform fairly above average in most of the subjects in KCSE. However, statistics obtained from the Kakamega County Education Department (2016) revealed a below average performance in mathematics in more than 62% of the students as compared to other subjects and also the same subject in other counties. The implication of such performance is that most of the students do not qualify for admission in highly scientific courses at university after their secondary school education. Aurah, Cassady and McConnel (2014) recommended more studies on metacognition be conducted in Kakamega County on secondary school students to counter their findings on primary school pupils. These are what informed the selection of the location.

3.5 Target population

The population of this study was all secondary school students in Kakamega County. The researcher chose to use Form 3 students because they are assumed to have grown their metacognition to the optimum level being a higher grade in the school. They also have more time to engage in the study as compared to their seniors in form 4 who may have limited time to engage in the study since they are preparing for their national examinations.

Kakamega County has a total 276 secondary schools with an enrolment of 113,202 students (TSC, 2015).

3.6 Sampling techniques and sample size

3.6.1 Sampling techniques

The selection of the County and two (2) administrative divisions was done through purposive sampling because of the evident dismal performance in mathematics subject in the KCSE examinations as indicated in appendix E. Kakamega East and Kakamega South administrative divisions were selected as they had registered the least mean score in mathematics for the years 2015, 2016 and 2017. Six schools were sampled through stratified random sampling. The strata were drawn from boys' boarding schools, girls' boarding schools, and mixed day schools. The respective class lists for each were used to randomly sample the students who participated in the study for each school.

3.6.2 Sample size

There is a total of 2,254 (1,209 boys and 1,045 girls) form three students in Kakamega East and Kakamega South administrative divisions. A sample of 120 participants (60 boys and 60 girls) from the boys and girls boarding schools and 140 participants (80 boys and 60 girls) from the co-educational schools was used. This made up the total sample to be 260 participants (140 boys and 120 girls). This sample was manageable considering test administration procedure, available time and resources available to the researcher for the study. The sample represented 11.54% of the target population, thus conforming to the threshold of what Gorard (2011) considers as an appropriate sample from a normal distribution. Table 3.1 shows the sample composition.

Table 3.1

Sampling Frame

Type of school	**Number of Schools**		**Number of Students**	
	Schools	Schools sampled	Students	Sample Size
Boys Boarding	5	1	501	60
Girls Boarding	7	1	561	60
Co-Educational	41	4	1392	140
Total Sample				260

Author (2019)

3.7 Research instruments

The following instruments were used in data collection

3.7.1 Mathematics Test

In addition to providing demographic data, students in the study sat for a mathematics test exercise (see appendix B) with content appropriateness for form 3 students.

3.7.2 Metacognitive Awareness Inventory (MAI) for students

Questionnaires for student metacognition (MAI), Appendix C, were adapted from Schoenfeld (1985) metacognitive awareness inventory guide. This is an open-source Metacognitive Awareness Inventory for students as used by Smith (2013) in his study of an exploration of metacognition and its effect on mathematical performance in differential equations. The language was modified to fit the Kenyan context and for the age relevant level for example item 6 was modified to read

> ‘I rarely draw pictures or diagrams to help me understand while learning’ from ‘I hardly ever use illustrations to help me understand while learning’.

It is an 18-item questionnaire which is divided into two sections. The first section of nine items comprises of knowledge about cognition and the other nine items comprises strategies of cognition. These sections are not distinctly separated in their presentation. For example, items 1, 2, 4, 5, 9, 11, 12, 13, ad 14 are about knowledge about cognition while items 3, 6, 7, 8, 10 15, 16, 17, and 18 are about strategies of cognition. Each question was scored on a true of false scale. The total score was then divided by 2 to find out whether the student’s metacognition was low, average or high on a scale of 1-9 where, a score of 1-3 implies low metacognition, 4-6 is medium and 7-9 represents high metacognition.

3.7.3 Mathematics Anxiety Rating Scale (MARS) for students

Students further filled in a mathematics anxiety questionnaire (see Appendix D). This tool was adapted from Mandler and Sarason (1978). Students were expected to rate themselves on how anxious they feel about studying mathematics and sitting for mathematics tests. The questionnaire items were modified into first person speech before being administered. The questionnaire items by Mandler and Sarason (1978) are in the second person but the researcher modified them to first person for the students to easily identify with them. For example, item 11 read ‘You sometimes feel your heart beating very first during important math tests’ it was modified to read ‘I sometimes feel my heart beating very first during important math tests’. The items were put in Likert scale with responses of strongly disagree (SD), disagree (D), neutral (N), agree (A), and strongly agree (SA) and assigned values 1 to 5 respectively, 1 being a strong positive response indicating low anxiety while 5 being a strong negative response indicating high anxiety. The sum of the responses was done and divided by 3 to get the category of anxiety where scores up to 20 represented low anxiety while scores above 20 represented high anxiety.

3.8 Pilot study

The researcher piloted the instruments at a school that was not used in the final study. Forty (40) Form 3 students from a co-educational school in Kakamega County were used for the pilot study. The school was not included in the sample for the study. The exercise helped the researcher to be certain on the process of administering the instruments and the approximate time that students would have needed to complete the questionnaires and the test. Initially the Mathematics test was scheduled for 20 minutes but the pilot helped realize that the time was quite short so it was revised to 30 minutes. The data from the pilot helped the researcher in refining the instruments to be clearer and remove any ambiguities and complex aspects. Some of the items in the Metacognitive Awareness Inventory were difficult for some of the students to understand thus prompting the researcher to modify the language into a more user-friendly language that all students would understand irrespective of the school they are in. For example, item six was modified as below.

> 'I rarely draw pictures or diagrams to help me understand while learning' from 'I hardly ever use illustrations to help me understand while learning'.

3.8.1 Validity

A Metacognitive Awareness Inventory (MAI) tool which was developed by Schoenfeld (1985) and adapted by Smith (2013) was used with minimum alterations to suit the understanding of the Kenyan students. A Mathematics Test set from secondary school mathematics text book with content appropriate to form 3 students was used. The researcher relied on the expertise of teachers of mathematics to evaluate the test's relevance, clarity, and fairness. These subject specialists assessed individual questions to determine their effectiveness in differentiating between high- and low-performing students. They verified that the test accurately measured the intended skills and knowledge while ensuring comprehensive coverage of relevant topics aligned with the curriculum. Following the pilot phase, the test results were compared with previous independent assessments conducted in the school. A subsequent administration of the test to the same group after a set period further examined the consistency of the results. The Mathematics Anxiety Rating Scale (MARS) questionnaire was adapted from Mandler and Sarason (1978) with relevant adaptation to suit the Kenyan context. The instruments were reviewed using results from the pilot study to ensure they measured the traits supposed to be measured and the extent to which the instruments provide adequate coverage of the topic under study.

3.8.2 Reliability

Ensuring reliability in research tools is essential for maintaining consistency, accuracy, and reliability in data collection and analysis. Krieglstein *et al* (2022) assert that stable results across different instances indicate that findings are not distorted by random errors. High reliability boosts research credibility by ensuring measurements accurately reflect actual characteristics rather than inconsistencies. Reliable tools enable researchers to replicate studies and validate findings, reinforcing the strength of conclusions. When research instruments are dependable, stakeholders can trust the results for informed decision-making and policy development. Additionally, minimizing measurement errors enhances the precision and significance of interpretations.

The researcher used the test-retest method during pilot to check the reliability of the study tools. The instruments were administered twice at a two weeks interval and the findings correlated which gave a reliability of 0.91 for Mathematics test, 0.83 for Metacognitive Awareness Inventory and 0.79 for Mathematics Anxiety Rating Scale. The MAI and MARS are standardized open-sourced tests and have been used before with robust reliability of 0.87 and 0.81 respectively.

3.9 Data collection techniques

Data was collected by use of self-administered questionnaires. This technique was preferred because it is efficient and allowed the researcher to gather data from a large number of respondents quickly. Responses from questionnaires were of uniform manner for ease of analysis and their structured manner helped the researcher to produce measurable data, useful for statistical analysis. The questionnaires were responded to during normal class hours. Before responding to the questionnaires, participants were informed of the general goal of the study which is to help educators understand some predictors of mathematics test performance. Instructions for completing the questionnaires where explained. These included the need to fill in honest responses, respondents were requested to maintain silence as they responded to the questionnaire and they were told the duration they were expected to take in filling the questionnaires. Participants sat for the mathematics test for 30 minutes. This was then followed by the Metacognition Awareness Inventory and Mathematics Anxiety Rating Scale questionnaires for 10 minutes each respectively. The answer sheets were then collected for scoring and analysis.

3.10 Data analysis

Filled in questionnaires and the mathematics test were scored and the scores for each respondent were de-identified by assigning of specific codes per participant. Collected data was coded for statistical analysis. The data was analyzed using descriptive and inferential statistics. The following hypotheses were tested at $\alpha = 0.05$ level of significance.

H_{01} There is no significant relationship between metacognition and mathematics test performance among secondary school students in Kakamega County. - Since the data was at the interval scale of measurement, Pearson Product Moment Correlation Coefficient was used to test the hypothesis.

H_{02} There is no significant relationship between mathematics anxiety and mathematics test performance among secondary school students in Kakamega County. –Since the data was at the interval scale of measurement, Pearson Product Moment Correlation Coefficient was used to test the hypothesis.

H_{03} There are no significant differences in metacognition and mathematics anxiety due to gender among secondary school students in Kakamega County. - The t test for independent samples was used. This is because the two gender groups of boys and girls are mutually exclusive and do not influence each other's score.

H_{04} There are no significant differences in metacognition and mathematics anxiety due to age among secondary school students in Kakamega County. - Analysis of Variance which is suitable when testing for differences among groups or categories was used. In this case, differences in various age groups among the students.

H_{05} Metacognition and mathematics anxiety do not significantly predict mathematics test performance among secondary school students in Kakamega County. - In order to identify the relative predictive weights of the predictor variables on the outcome variable, multiple regression analysis was used to test this hypothesis.

3.11 Logistical and Ethical considerations

3.11.1 Logistical considerations

The researcher sought clearance from the graduate school Kenyatta University and the National Council for Science, Technology and Innovation (NACOSTI) to carry out the study. Permission from the County Education Offices in Kakamega and Kakamega County Commissioner's Office were also sought. The researcher conducted preliminary visits to the selected schools that the study was carried in before doing the study to seek permission from the head of schools and also inform them what the study was all about. It is during these visits that the researcher explained to the school head teachers of his intent, met the subject teachers he would work with during the study and set dates for the activities.

3.11.2 Ethical consideration

The researcher obtained consent through a letter to the parents/guardians requesting then to allow their children to participate in the study (see appendix A). During the study, the researcher explained the purpose of the study to participants, promised confidentiality, informed them of their voluntary participation and the freedom to withdraw from the study at any time if they felt uncomfortable, reassuring them that their decision will be respected and not used in any way against them. All data collected was treated confidentially and used solely for the purpose of the study. All responses to the questionnaires and the test were purely voluntary.

CHAPTER FOUR

PRESENTATION OF FINDINGS, INTERPRETATION AND DISCUSSION

4.1 Introduction

This chapter presents the findings of the study. Interpretation and discussion of the results are given in line with the study objectives and hypotheses. Specifically, details of the analyzed data are given, followed by the results, interpretation, discussion and an explanatory analysis of the data.

4.2 General and Demographic Information

This subsection first presents general information on the return rate of the questionnaires and data showing the sampling unit (schools). This is followed by information on the respondents' gender and age.

4.2.1 Return Rate

The Mathematics Test Exercise and the research questionnaires were administered to 260 participants. All the 260 questionnaires were found to be complete after data cleaning. Therefore, the return rate for all the questionnaires was 100%, representing 120 girls and 140 boys. The actual sample size as shown by the return rate is presented in Table 4.1

Table 4.1

Return Rate

Type of school	Target Return Rate				Actual Return Rate			
	F	**M**	**Total**	**%**	**F**	**M**	**Total**	**%**
Boys Boarding	-	60	60	23.07	-	60	60	23.07
Girls Boarding	60	-	60	23.07	60	-	60	23.07
Co-Educational	60	80	140	53.86	60	80	140	53.86
Total	120	140			120	140		
			260	100			260	100

Note. () indicate the percentage of the total target

The data in Table 4.1 indicates that 260 participants including 120 female and 140 males students were targeted for this study. All the 260 participants in the study completed and returned the questionnaires and they were all form three students in public secondary schools in Kakamega County. This accounted for 100% return rate of the targeted participants. The 100% return rate may have been possible due to the clear instructions and clarifications done during data collection.

4.3 Descriptive results of the study demographics in relation to mathematics performance

In this sub-section results of the study are presented in line with the study demographics and mathematics performance. The researcher sought to find out how gender of participant, the school type and age of the participant compared to the participants' performance in the mathematics test.

4.3.1 Age by Gender distribution

The researcher cross tabulated the respondents' gender with their ages and the type of school and obtained the results shown in Table 4.2

Table 4.2

Description of Participants' Age by Gender

	Age in Years					
Gender	*M*	*SD*	*Min*	*Max*	*Rg*	*Sk*
Male	16.88	1.22	14.11	20.40	6.29	.41
Female	17.06	1.28	15.00	21.00	6.00	.45
Total	16.94	1.25	14.11	21.00	6.89	.44

Note. N= 260. M= mean; *SD*= Standard deviation; *Min*= minimum age; *Max*= maximum age; *Rg*= range; *Sk*= skewness

In table 4.2 above, the data indicates that the mean age for male students who participated in the study was 16.88 years (*SD = 1.22),* this was slightly lower than the mean age for female students which was 17.06 years (*SD = 1.28).* The combined mean age for all participants was 16.94 years *(SD = 1.25)*. This mean age is within the range of years of form three students in Kenya. Performing an independent-samples *T* test indicated that the difference in the mean ages for females and males was not statistically significant (*t*(258)

= - 1.14; *p* = 0.26). the mean age for females (*M* = 17.06, *SD* = 1.28) was not significantly higher than the mean age for males (*M* = 16.88, *SD* = 1.22). the degree of the difference in the means was 0.18 years with a 95% confidence interval of -.48 to .13.

Through a Levene's *F* test, the assumption of equality of variance was tested and satisfied at *p* = 0.49 to show that equal variance was assumed. For the measures of distribution shape, that is, skewness (*Sk* = 0.41) for males and (*Sk* = 0.45) for females were between the values of -0.5 to 0.5, indicating an approximately symmetrical distribution. The participants were further grouped into four age groups according to gender and the summary presented in Table 4.3.

Table 4.3

Description of Participants' Age Category by Gender

		Age Category (Years and months)				
		14.8 - 15.0	15.1 - 16.5	16.6 - 18.0	18.1 - 21.0	Total
Gender	Male	9(3.46)	52(20.00)	59(22.69)	20(7.69)	140(53.84)
	Female	6(2.31)	44(16.92)	49(18.85)	21(8.08)	120(46.16)
Total		15(5.77)	96(36.92)	108(41.54)	41(15.77)	260(100.00)

Note. *N* = 260; () indicate percentage

Table 4.3 shows the participants' ages ranged from 14 years 8 months to 21 years. Most male participants (22%) were aged between 16 years 6 months to 18 years, while (20%) were aged between 15 years one month and 16 years 5 months. The least percentage of male participants (3.46%) were aged 15 years and below while less than 8% were aged between18 years 1 month and 21 years. The highest percentage of female participants

(18.85%) were aged between 16 years 6 months to 18 years, while (16.92%) were female participants aged 15 years 1 month and 16 years 5 months. Female participants aged between 18 years 1 month and 21 years constituted 8.08% of the participants similar to their male counterparts who constituted 7.69%. Female participants aged 15 years and below made up 2.31%. in general, majority of the participants were aged between 16 years 6 months and 18 years, and 15 years 1 month and 16years 5 months at 41.54% and 36.92% respectively, participants aged 18 years and above made 15.77% of the population while those aged 15 years and below constituted 5.77%.

Participants who were aged above 17 years registered better mathematics test scores and also showed to have higher metacognition compared to the younger participants. The average age for Form 3 students is between 16 – 17 years. The better performance by older students may be interpreted as them having advanced development of metacognition hence they are aware of and able to utilize the different and helpful metacognitive strategies while solving the mathematics problems. This may have also enabled them to be less anxious about solving a mathematics problem.

Further, the participants' mean ages were compared across the three different types of schools and the results presented in Table 4.4.

Table 4.4

Description of Participants' Mean Age by Type of School

Type of School	*M*(Age)	*N*	*SD*	*Min*	*Max*	*Rg*	*Sk*
BB	16.87	60	1.32	14.11	20.00	5.89	.36
GB	17.02	60	1.25	15.00	20.00	5.00	.26
Co-Ed	16.97	140	1.22	15.00	21.00	6.00	.58
Total	16.96	260	1.25	14.11	21.00	6.89	.44

Note. *N* = 260. BB= boys' boarding; GB = girls' boarding; Co-Ed = co-educational; *M* = mean; *SD* = standard deviation; *Min* = minimum age; *Max* = maximum age; *Rg* = range; *Sk* = skewness.

The data in Table 4.4 shows the mean age for participants in boys' boarding schools was 16.87 *(SD* = 1.32*)* this was slightly lower than that of girls' boarding schools which was 17.03 (*SD* = 1.25). the mean age for participants in Co-educational schools was 16.98 (*SD* = 1.22) which was similar to the combined mean age of all participants which was 16.96 (*SD* = 1.25). This data falls within the range of normal ages among form three students in Kenya which is between 16 – 17 years (MOEST, 2015).

4.3.2 Description of the comparison between gender of respondent and performance in mathematics test

The participants' scores on their performance in mathematics test were compared to their gender. The results were presented as shown in Table 4.5

Table 4.5

Description of Mathematics test score due to Gender

	Gender	*N*	*M*	*SD*
Mathematics test score	Male	140	41.30	17.47
	Female	120	37.89	17.74

Note. *N* = 260. *M* = mean; *SD* = standard deviation

Table 4.5 shows that the male participants had a slightly higher (41.30, *SD* = 17.47) mean score in mathematics test as compared to the female participants (937.89, *SD* = 17.74). Bothe gender had approximately same measure of spread around the mean at 17.47 for the males and 17.74 for the females. An independent-samples *t* test was performed to determine whether the differences in the means was statistically significant. The results are shown in Table 4.6.

Table 4.6

Mean differences in mathematics score by gender

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% CI	
		F	Sig.	t	df	Sig. (2-tailed)	M dif	*SE dif*	L	U
MTS	Equal variances assumed	.405	.525	1.55	258	.121	3.41	2.19	-.90	7.72
	Equal variances not assumed			1.55	250.70	.121	3.41	2.19	-.91	7.722

Note. *N* = 260. MTS = mathematics test score; *M dif* = mean differences; *SE dif* = standard error difference; L = 95% confidence level Lower; U = 95% confidence level upper.

When an independent-samples *t* test was performed, it indicated that the difference in the mean mathematics scores for females and males was not statistically significant ($t(258) = 1.55$; $p = 0.121$). The mean age for females ($M = 37.89$, $SD = 17.74$) was not significantly lower than the mean age for males (*M* = 41y.30, $SD = 17.47$). the degree of the difference in the means was 3.41 marks with a 95% confidence interval of -.90 to 7.72. This data shows that, on average, a form three female student will most probably attain a similar mathematics score in a common exam. The slight difference in scores may be attributed to the general belief that boys are better in mathematics than girls and also it may be attributed to the individual student, teacher or school characteristics.

4.3.3 Description of the comparison of school type of respondent and performance in mathematics test

In order to establish the comparison between school type of respondent and performance in mathematics test, the researcher compared the means of mathematics test scores across the type of schools. The findings are shown in Table 4.7

Table 4.7

Mathematics test score by Type of school

	School	*N*	*M*	*SD*	*St. EM*
MTS	BB	60	48.17	20.19	2.607
	GB	60	42.55	19.13	2.470
	Co-Ed	140	34.90	13.93	1.177

Note: N = 260. BB = Boys Boarding; GB = Girls Boarding; Co-Ed = Co-Educational School; *M* = mean; *SD* = standard deviation; *St. EM* = standard error to mean.

Table 4.7 indicates that participants from boys boarding schools had a high mathematics test score (48.17, *SD* = 20.19) in comparison to participants from the other two types of schools. Participants from girls boarding schools scored higher (42.55, *SD* = 19.13) than co-educational school participants (34.90, *SD* = 13.93). Participants in boarding schools had a higher dispersion of scores around the mean as compared to participants from co-educational schools. Boys boarding schools had a standard deviation of (*SD* = 20.19) which was very close to that of girls boarding schools (*SD* = 19.13) compared to that of co-educational schools at (*SD* = 13.93).

An independent-samples *t* test was performed to determine whether the differences in the means was statistically significant. The results indicated that the differences in mean mathematics score was statistically significant for co-educational schools and each of the boarding schools, that is, the boys boarding schools (*t* (198) = 5.36, *p* = 0.001) and girls boarding schools (*t* (198) = 3.16, *p* = 0.002). However, an independent-samples *T* test results showed that the difference in mean mathematics test score for boys boarding and girls boarding schools was not statistically significant (*t* (118) = 1.56, *p* = 0.12). The mean mathematics test score for co-educational schools (34.90, *SD* = 13.93) was significantly lower than the mean for boys boarding schools (48.17, *SD* = 20.19) and girls boarding schools (42.55, *SD* = 19.13).

From these findings, the researcher can report that in Kakamega County, students in Boys Boarding schools performed better than students in Girls Boarding and Co-Educational schools. Students in Co-Educational schools performed poorly in mathematics test compared to their counterparts in boarding schools, this may be attributed to the fact that public boarding schools enroll students with higher pass marks in their primary education as compared to public co-educational schools. At the same time, public boarding schools tend to have better equipped resources and adequate teacher to student ration than public secondary schools. Most co-educational schools are located in rural areas and mainly attract local pupils who may have failed admission in “prestigious” public boarding schools either due to their dismal performance in their primary school national examinations, or because their parents/guardians lack adequate finances to pay for them in boarding schools hence their schooling also gets disrupted since occasionally they are sent home for school fees hence missing on some classes.

4.3.4 Description of the comparison between age of respondent and performance in mathematics test

An analysis of the respondents' score in the mathematics test as per their age categories was done to determine which age category had the lowest and highest scores. Their responses were analyzed to get the frequencies. The results are tabulated in Table 4.8

Table 4.8

Performance by Age category

		Age of respondent in Years				
		≤15.0	15.1 - 16.6	16.6 - 18.0	≥18.1	Total
MTS	70 -75	0	3	5	3	11
	65 - 69	1	5	4	2	12
	60 - 64	0	8	5	3	16
	55 - 59	0	4	8	3	15
	50 - 54	0	5	10	4	19
	45 - 49	2	7	8	3	20
	40 - 44	1	10	11	4	26
	35 - 39	5	6	5	3	19
	30 - 34	4	18	19	4	45
	25 - 29	0	12	13	5	30
	20 - 24	1	10	9	4	24
	15-19	1	8	11	3	23
Total		**15**	**96**	**108**	**41**	**260**

Note: MTS = Mathematics test score in percentage

As indicated in Table 4.8 above, only 7% of respondents aged below 15.0 years managed to score above 50% in the mathematics test. Respondents aged 18.1 years and above had majority of its members score more than 50% in the mathematics test. On the flip side, majority of respondents aged 15.1 – 16.6 registered scores below 30% in the mathematics test. Looking at the overall performance, less than half of the respondents scored above the pass mark of 40%. On the other hand, 54.2% of the responded scored below the pass mark in the mathematics test. This implies that, generally, there is poor performance in mathematics among secondary school students in Kakamega County. Older students, i.e. 18 years and above have been seen to score higher than their younger counterparts in the same class. This may be due to the level of commitment to learning among the older students than the younger ones.

4.3.5 Summary of the demographic variables

The findings of the current study point out that there were more boys' respondents than girls, with the bulk of the boys being drawn from the co-educational schools. It indicates that majority of the respondents are aged between 16.1 to 18.0 years old with less than 10% of the respondents being below 15 years and approximately 15% being aged above 18.1 years old. In relation to the performance in the mathematics test, slightly more than half of the boys scored above the test's pass mark of 40% while only 38.4% of the girls managed to score above the pass mark. Approximately the same number of girls and boys scored below 19% in the mathematics test. It further indicates that more boys from Boys Boarding Schools scored above the pass mark as compared to boys in Co-Educational schools and girls both in Girls Boarding and C-Educational schools. Majority of the respondents from Co-Educational schools scored below 40%. The results also show that most of the respondents aged 15.0 years and below scored below 40% in the mathematics test while respondents aged 18.1 years and above were evenly distributed in their scores which range from below 19% to above 70%. These findings contradict findings by Anjum (2015) who reported that girls in upper primary outperform boys in mathematics because they have higher reading comprehension capabilities than boys. Gimbert *et al* (2019) also reported contrary results in their study which they found out that, female students tend to score high in mathematics than boys so long as they understand the usefulness of the subject and enough confidence in learning mathematics. However, the results of the current study corroborate findings of many studies such as one by Contini *et al* (2017) in their study across Organisation for Economic Co-operation and Development (OECD) countries found out that, girls significantly underperformed boys in mathematics achievement with Italy having the greatest difference. Similar findings by PISA (2017) reported that girls systematically performed dismally compared to boys even when a range of personal, home and school factors were controlled for. According to Recber *et al* (2017) girls keep losing ground relative to boys during their educational progress. Similarly, Gevrek *et al* (2020) reported that there is a small gender mathematics gap favoring boys in their study that comprised 56 countries under the PISA program.

4.4 Relationship between metacognition and mathematics test performance.

In this sub-section results of the study are presented in line with the relationship between metacognition and mathematics test performance. The researcher sought to find out how the two aspects of metacognition; metacognitive awareness and metacognitive strategies of the participants are related to the participants' performance in the mathematics test. The researcher also sought to find out how these aspects were related to the type of school from which the respondent was from.

4.4.1 Metacognition and mathematics performance scores

In order to establish the relationship between the participants' metacognition level and their respective mathematics test performance, the researcher cross tabulated the mean scores of metacognitive awareness inventory with the mathematics test scores and obtained the results as shown in Table 4.9

Table 4.9

Metacognition and Mathematics Test Performance

		Score in MAI			
		Low	Medium	High	Total
MTS	70 - 75	0	1	10	11
	65 – 69	0	1	11	12
	60 – 64	2	1	13	16
	55 - 59	3	0	12	15
	50 - 54	6	3	10	19
	45 - 49	9	5	6	20
	40 - 44	12	9	5	26
	35 - 39	9	6	4	19
	30 - 34	19	16	10	45
	25 - 29	18	8	4	30
	20 - 24	12	11	1	24
	15 -19	10	9	4	23
Total		**100**	**70**	**90**	**260**

Note: *N* = 260. MTS = Mathematics test score in percentage; MAI = Metacognitive Awareness Inventory

The results in Table 4.9 show that majority of the respondents scored Low in the MAI inventory followed by High and Medium respectively. Majority of respondents who scored Low in the MAI inventory also exhibited low grades in the MTS scores, most of whom scored 34 marks and below. None of those in this category scored above 64 marks, with only 11 out of 100 scoring above 50 marks. Respondents who scored Medium in the MAI inventory showed a fairly representation of scores in all grades in the MTS however, most of them scoring below 35 marks. Respondents who scored High in the MAI inventory showed high scores in the MTS scores. More than half of them scored above 50 marks and a quarter of them scored below 40 marks. This implies that there is a positive correlation between a student's metacognition score and their performance in a mathematics test. It therefore means that when students' metacognitive awareness and strategies are improved, then their performance in mathematics is more likely to improve. Based on these observations, the researcher can report that in Kakamega County, students who scored low in metacognition with all other factors held constant, may not perform well in mathematics test thus calling for the need to improve their metacognitive capabilities for them to realize better performance in mathematics.

4.4.2 Metacognitive awareness and mathematics performance scores

Table 4.10

Metacognitive Awareness cross tabulated with the Type of School of respondent

		ToS				
		BB	GB	Co-Ed B	Co-Ed G	Total
MA	Low	27 (10.30)	39 (15.00)	61 (23.52)	46 (17.69)	173 (66.51)
	High	33 (12.70)	21 (8.00)	19 (7.48)	14 (5.31)	87 (33.49)
Total		**60 (23.00)**	**60 (23.00)**	**80 (31.00)**	**60 (23.00)**	**260 (100.00)**

Note: N = 260. MA = Metacognitive Awareness; ToS = Type of School; BB = Boys Boarding; GB = Girls Boarding; Co-Ed B= Boys in Co-Educational School; Co-Ed G= Girls in Co-Educational School

As shown in Table 4.10, more than half of the respondents scored low in the metacognitive awareness. More boys in the Co-Educational schools scored Low as compared to those who scored High in MA. Girls in Co-Educational schools scored the least in metacognitive awareness with 5.3% scoring High and 17.7% scoring Low. Similarly, fewer girls in Girls Boarding schools (8.0%) scored High in metacognitive awareness as compared to those 15.0% who scored Low. On the contrary, more boys in Boys Boarding schools scored higher in metacognitive awareness with 12.7% scoring High and 10.3% scoring Low. This may imply that boys have better metacognitive capabilities as compared to girls, and these capabilities improve further when they are in boarding secondary schools. This may be attributed to the supposed different approaches that may be experienced in boys only schools, girls only schools and co-educational schools.

4.4.3 Metacognitive strategies and mathematics performance score

Table 4.11

Metacognitive Strategies cross tabulated with the Type of School of respondent

		ToS				
		BB	GB	Co-Ed B	Co-Ed G	Total
MS	Low	23 (8.78)	22 (8.39)	51 (19.72)	33 (12.71)	129 (49.60)
	High	37 (14.22)	38 (14.61)	29 (11.28)	27 (10.29)	131 (50.40)
Total		**60 (23.00)**	**60 (23.00)**	**80 (31.00)**	**60 (23.00)**	**260 (100.00)**

Note: MS = Metacognitive Strategies; ToS = Type of School; BB = Boys Boarding; GB = Girls Boarding; Co-Ed B= Boys in Co-Educational School; Co-Ed G= Girls in Co-Educational School

N= 2,254; *n* = 260

From Table 4.11, it can be observed that roughly half of the respondents scored Low while the other half scored High in metacognitive strategies. In both Boys Boarding and Girls Boarding schools, more respondents scored High in metacognitive strategies (14.2% and

14.6% respectively for boys and girls) as compared to those who scored Low (8.8% and 8.4%). However, in the Co-Educational Schools, more respondents scored Low for both boys and girls (19.7% and 12.7%) respectively as compared to those who scored High (11.3% and 10.3%). This shows that students learning in boarding schools have superior metacognitive capabilities when it comes to performing a mathematics test as compared to those in co-educational schools. This could imply that students in boarding schools have a better approach to mathematics test solving skills as compared to their counterparts in co-educational schools.

4.4.4 Metacognition scores and type of school

Table 4.12

Metacognition and Type of School

		Type of School				
		BB	GB	Co-Ed B	Co-Ed G	Total
MAI	Low	12 (4.60)	20 (7.70)	37 (14.30)	31 (11.92)	100 (38.52)
	Medium	23 (8.77)	8 (3.03)	18 (7.01)	21 (8.12)	70 (26.93)
	High	25 (9.63)	32 (12.27)	25 (9.69)	8 (2.96)	90 (34.55)
Total		**60 (23.00)**	**60 (23.00)**	**80 (31.00)**	**60 (23.00)**	**260 (100.00)**

Note: *N* = 260. MAI = Metacognitive Awareness Inventory

Table 4.12 indicates that less than half of the respondents were rated as having Low metacognition, approximately a quarter of the respondents had Medium and slightly above one third had High metacognition. Majority of respondents from the Girls Boarding Schools showed high metacognition as compared to those who showed Low and Medium respectively. Similarly, most of the respondents from Boys Boarding Schools showed high metacognition as compared to those who showed Low and Medium respectively. On the contrary, most respondents from the Co-Educational Schools were rated to have Low metacognition. The high metacognition among students in boarding schools may be attributed to the fact that students in boarding schools have more time for remedial classes since they don’t have to struggle rushing back home in the evenings and commuting to school every morning. This extra time may be used by students in boarding schools to do personal studies or even have tutorials by their teachers which improves their mathematics problem solving skills by becoming aware of the metacognitive strategies to use and how to use them during mathematics test.

4.4.5 Hypothesis testing on relationship between metacognition and mathematics test performance

In order to find out if there is any relationship between metacognition and mathematics test performance, the following null hypothesis was formulated and tested.

H_{01}: There is no significant relationship between metacognition and mathematics test performance.

To test this hypothesis, Pearson's correlation coefficient was used. This was the best test to use to measure for any linear correlation, the strength of the correlation and what direction between the two variables of interest. The results are shown in Table 4.13

Table 4.13

Hypothesis testing: correlations between metacognition and mathematics test performance

		MTS	MAI	MA	MS
Pearson Correlation	MTS	1.00	.47	.55	.42
	MAI	.47	1.00	.51	.39
	MA	.55	.51	1.00	.38
	MS	.42	.39	.38	1.00
Sig. (2-tailed)	MTS	.	.000	.000	.000
	MAI	.000	.	.000	.000
	MA	.000	.000	.	.000
	MS	.000	.000	.000	.

Note: MTS = Mathematics Test Score; MAI = Overall score in metacognition; MA = Metacognitive Awareness; MS = Metacognitive Strategies

N = 260

The results revealed that there was a significant relationship between metacognition and mathematics test performance as it was expected in the alternative hypothesis. This relationship was also a positive one. The highest correlation was between metacognitive awareness and mathematics test performance $(r\ (258) = .55, p < .05)$; followed by overall score in metacognition and mathematics test performance $(r\ (258) = .47, p < .05)$; then finally metacognitive strategies and mathematics test performance $(r\ (258) = .42, p < .05)$.

The null hypothesis was thus rejected. These findings may indicate that many students are aware of the various metacognitive strategies that can be used to solve mathematics problems but they do not use them when solving the problems. This could be due to other prevailing variables that were not included in the study. Examples of such variables maybe but not limited to; student's achievement motivation, teacher's competency, and student's level of interest in mathematics.

Further analysis was done to measure the representative portion of variance for mathematics test performance that is explained by the 2 components of metacognition. The adjusted R^2 of metacognition was computed as shown in Table 4.14

Table 4.14

Adjusted R2 from the correlations between metacognition and mathematics test performance

Model	R	R Square	Adjusted R Square	SEE
1	.55[a]	.30	.30	2.64
2	.59[b]	.35	.35	2.54
3	.62[c]	.38	.37	2.49

Note: SEE = Standard Error of Estimate; a. = Predictors: (Constant), Metacognitive Awareness; b. = Predictors: (Constant), Metacognitive Awareness, Metacognitive Strategies; c. = Predictors: (Constant), Metacognitive Awareness, Metacognitive Strategies, Mean Score in Metacognitive Awareness Inventory

N= 260

From the results, it was established that metacognitive awareness alone accounts for R^2.30 or 30% of variance in mathematics test performance. However, metacognitive awareness and metacognitive strategies jointly account for 35% of variance in mathematics test performance, and a mean of metacognition accounts for 37% of variance in mathematics test performance.

Table 4.15

Beta coefficients for metacognitive awareness, metacognitive strategies and overall score in metacognition

	Unstandardized Coefficients		Standardized Coefficients	
Model	B	Std. Error	B	Sig.
(Constant)	8.76	.21		.000
MA	3.55	.34	.55	.000
MS	1.57	. 35	.45	.000
MAI	1.55	. 34	.43	.001

Note: MTS = Mathematics Test Score; MAI = Overall score in metacognition; MA = Metacognitive Awareness; MS = Metacognitive Strategies

N= 260

Results of the Beta standardized coefficients reveal that metacognitive awareness had the greatest significant predictive value on mathematics test performance at ($\beta = .55$, $p = .05$) followed metacognitive strategies at ($\beta = .45$, $p = .05$). The overall predictive value of metacognition was ($\beta = .43$, $p = .05$).

4.4.6 Discussion of the results

From the findings of this study, it can be observed that majority of the respondents registered low metacognition. The findings further illustrate that most of the respondents who registered low metacognition scored poorly in the mathematics test getting less than the set pass mark of 40%. These findings are consistent with prior research that has shown a strong positive correlation between metacognition and test performance. In their study, Stilman (2012) on the effects of metacognition training on problem solving for third year students found out that students who underwent training in metacognition awareness and skills gained higher scores in mathematics problem solving performance compared to the control students. This simply implies that students who are aware of their metacognitive strategies are more likely to perform better in a mathematics test as compared to those who are not. In the current study, the low performance in mathematics test among most of the respondents in the co-educational schools may be explained by their low or lack of awareness of their metacognitive abilities and thus lack of use of them.

As shown by the results of the study, metacognition is a significant predictor of mathematics test performance. These findings corroborate those of Handel, Artelt and Weint (2013). In their correlation study which involved 288 first year male and female college students in America found out that more than half of the respondents reported a spontaneous control of their learning process without them being aware. This spontaneous control was exhibited by the conscious execution of strategies which helped them solve a test question.

The results also determine a significant correlation between the two levels of metacognition (metacognitive awareness and metacognitive strategies) as seen in Table 4.7. These findings are consistent with those of Mwaniki (2015) who studied standard six pupils on the correlation between metacognition and reading comprehension performance. The study found out that a significant correlation existed between metacognitive knowledge and metacognitive strategy use. This correlation may be so because the application of metacognitive strategies depends on a large extent to the level of metacognitive awareness of the individual, thus the respondents were more likely to use metacognitive strategies that they knew. These results upheld the Flavel Metacognition theory which states that metacognition is a higher order thinking process which involves learners' knowledge of their own cognition which helps them to use this knowledge in choosing which strategies to use for effective problem solving.

Learners who are aware of the metacognitive strategies available to them can effectively plan, control and regulate their thinking process during problem solving. This could have been the phenomenon shown among the participants of the current study who reported a significant and strong correlation between metacognitive awareness and metacognitive strategies.

4.5 Relationship between mathematics anxiety and mathematics test performance.

This sub-section presents results of the study in accordance with the relationship between mathematics anxiety and mathematics test performance. The researcher sought to find out how mathematics anxiety among students related to their performance in a mathematics test. The researcher also how students exhibited mathematics anxiety in the three school categories, that is; Boys Boarding Schools, Girls Boarding Schools and Co-Educational Schools.

4.5.2 Relationship between mathematics anxiety and mathematics test score

An analysis of the respondents' score on the Mathematics Anxiety Rating scale (MARS) versus their score on the Mathematics Test was done to find out how the scores in the mathematics test was distributed against the scores in MARS. First, a comparison of the means of mathematics score by the two levels (low and high) of mathematics anxiety was done. The results are tabulated in Table 4.16

Table 4.16

Mathematics test scores by level of mathematics anxiety

	MA	*N*	*M*	*SD*	Std. Error Mean
Mathematics test	High	185	33.99	15.26	1.122
score	Low	75	53.88	15.00	1.732

Note. *N* = 260. MA = mathematics anxiety; *M* = mean; *SD* = standard deviation

Results in Table 4:16 indicate a high mathematics test score mean difference in respondents with low mathematics anxiety (53.88, *SD* = 15.26) and those with high mathematics anxiety (33.99, *SD* = 15.00). Score dispersion around the mean for both groups is approximately the same at (*SD* = 15.26) for those with high mathematics anxiety and (*SD* = 15.00) for those with low mathematics anxiety. An independent-samples *t* test was performed to ascertain whether the differences shown had any statistical significance. The results are reported in Table 4.17

Table 4.17

Independent samples test: Mathematics test score by level of mathematics anxiety

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	*MD*	*StED*	95% CI Lower	95% CI Upper
MTS	EVA	.256	.613	-9.56	258	.000	-19.89	2.08	-23.99	-15.80
	EVnA			-9.63	139.24	.000	-19.89	2.06	-23.97	-15.81

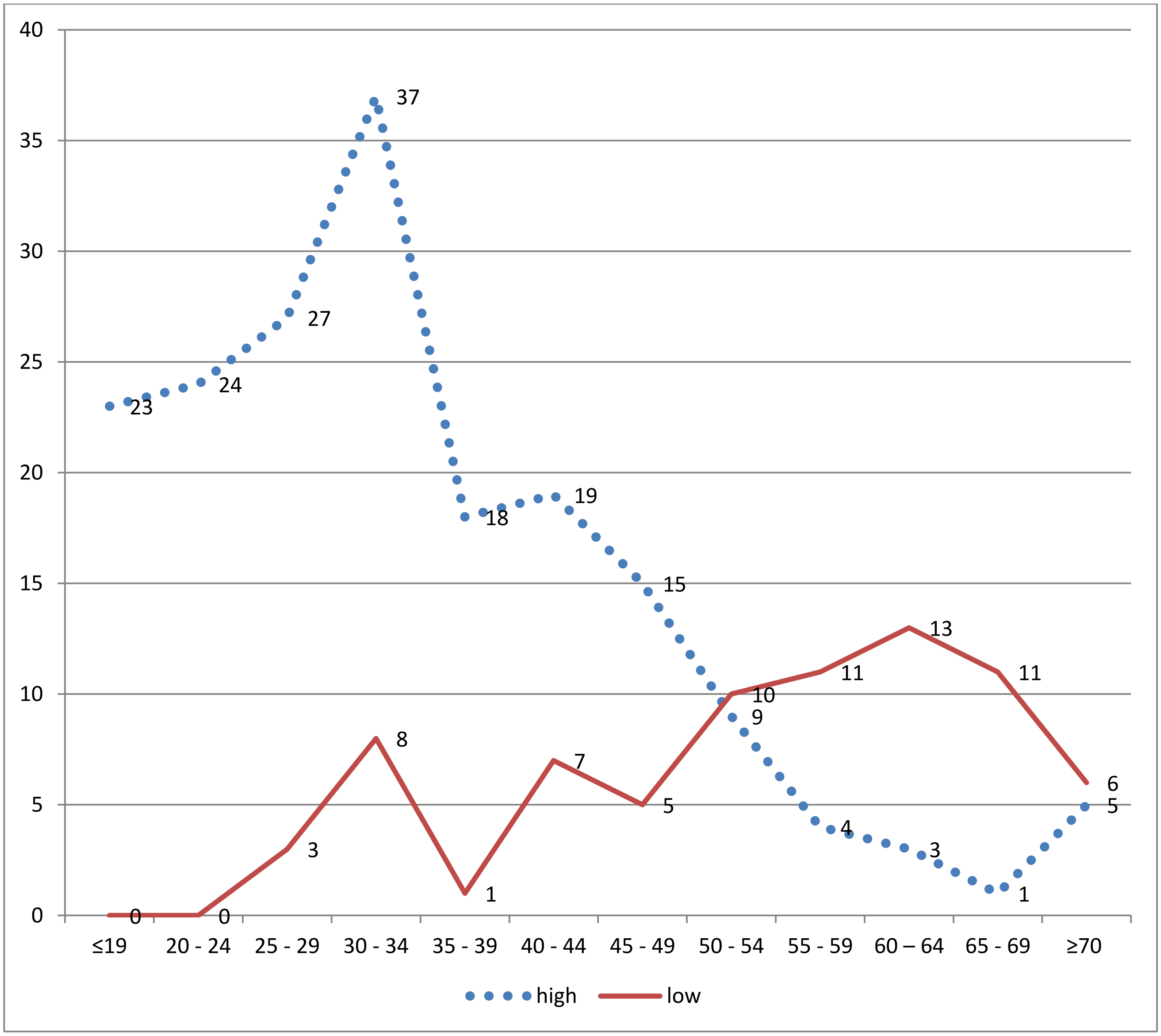
Note. *N* = 260. MTS = mathematics test score; EVA = Equal variances assumed; EVnA = equal variances not assumed; *MD* = mean difference; *StED* = standard error difference

Table 4.17 shows the results of an independent-samples *t* test which indicate that the difference in mean mathematics test score for participants with low mathematics anxiety and those with high mathematics anxiety was statistically significant ($t(258) = -9.56$, $p = 0.001$). The mean mathematics test score for respondents with low mathematics anxiety (53.88,) was significantly higher than the mean mathematics test score for participants with high mathematics anxiety (33.99). The extend of the difference in the means was 19.89 marks with a 95% confidence interval of -23.96 to 15.80.

These results show that mathematics anxiety correlated negatively with mathematics test performance. It further indicates that students who have high mathematics anxiety will most likely perform poorly in mathematics test as compared to those who have low mathematics anxiety. To show the comparison between scores on mathematics anxiety rating scale and performance in mathematics test, the respondents' scores were plotted on a line graph and the following results obtained as seen in Figure 4.1

Figure 4.1

Trend of mathematics test score against scores against mathematics anxiety



Note: N = 260. low = Low score on the Mathematics Anxiety; high = High score on the Mathematics Anxiety; *x* axis = mathematics test score; *y* axis = mathematics anxiety score.

In Figure 4.1, the blue dotted line show respondents who had high scores in the Mathematics Anxiety Rating Scale while the red bold line shows respondents who scored low on the MARS. As it can be observed, the dotted line shows high values at the beginning of the graph with 23 respondents scoring below 19% in the mathematics test. The graph then shoots up through 24 and 27 respondents for mathematics scores of 20-24 and 25-29 marks until it peeks at 37 respondents for 30-34 marks. It then drops sharply through the scores from 35-39 marks till it reached 65-69 marks where it then slightly raises to 5 respondents for above 70 marks. The red line starts with a very low value of 3 respondents at 25-29 marks and zig-zags its way slightly up until the 13 respondents' mark for 60-64 marks. It then drops gradually to 6 respondents for above 70 marks.

This graphical presentation illustrates how majority of students with high mathematics anxiety scored low marks in the mathematics test while majority of those who had low anxiety scored considerably high marks in the mathematics test. The graph also indicates that almost an equal number of students who scored both low and high on mathematics score the highest marks in the mathematics test. For those with high anxiety, they had also scored high in metacognition a factor that may have enabled them apply the right strategies in solving mathematics problems. They may have also given a false report of their anxiety levels during the MARS data collection period.

4.5.2 Relationship between mean score on mathematics anxiety and type of school

An analysis of the respondents' score on the Mathematics Anxiety Rating scale (MARS) versus the type of school was done to find out how the scores in MARS were distributed among the respondents according to their type of schools they attend and their gender for those in Co-Educational schools. The results are tabulated in Table 4.18

Table 4.18

Mathematics anxiety against type of school

		Score in MARS		
		High	Low	Total
ToS	BB	37 (62)	23 (38)	60 (100)
	GB	41 (68)	19 (32)	60 (100)
	Co-Ed B	58 (72)	22 (28)	80 (100)
	Co-Ed G	49 (82)	11 (18)	60 (100)
Total		185 (71)	75 (29)	260 (100)

Note: N = 260. ToS = Type of School; BB = Boys Boarding; GB = Girls Boarding; Co-Ed B= Boys in Co-Educational School; Co-Ed G= Girls in Co-Educational School; MARS= Mathematics Anxiety Rating Scale

Results in Table 4.18 show that majority of the respondents manifested high anxiety towards mathematics test than those who showed low anxiety. Girls in co-educational schools exhibited the highest percentage in being anxious towards a mathematics test. More than three quarters of the girls in co-educational schools reported having high anxiety towards a mathematics test. Almost three quarters of boys in co-educational schools also portrayed high anxiety towards mathematics test. More than half of respondents from boarding schools showed high anxiety towards mathematics test, with more respondents from girls' boarding schools showing high anxiety than those from boys' boarding schools. These results thus show that more girls than boys scored high on mathematics anxiety. The results also show that more respondents from co-educational schools scored high on mathematics anxiety as compared to respondents from boarding schools.

4.5.3 Hypothesis testing

In order to determine the relationship between mathematics anxiety and mathematics test performance was significant or not, the following null hypothesis was advanced;

H_{02} There is no significant relationship between mathematics anxiety and mathematics test performance.

To test this hypothesis, data was analyzed using the Pearson's Product Moment Coefficient and the results presented in Table 4.19.

Table 4.19

Correlations between mathematics anxiety and mathematics test score

		Mathematics test score
Mathematics test score	Pearson Correlation	1
	Sig. (2-tailed)	
Score in Mathematics Anxiety Rating Scale	Pearson Correlation	-.565**
	Sig. (2-tailed)	.000

Note. n = 260

As shown in table 4.19 there was a significant and negative relationship between mathematics anxiety and mathematics test performance (r (258) = -.565, p <.05). The results indicate that when mathematics anxiety score go up, there is a corresponding decrease in mathematics test performance. The results imply that students who have high anxiety towards mathematics test are likely to perform poorly in mathematics test. Based on these results, the null hypothesis which stated that there is no significant relationship between mathematics anxiety and mathematics test performance was hence rejected and the alternative one adopted.

4.5.4 Discussion of results

The study's second objective was to determine the relationship between mathematics anxiety and mathematics test performance. Majority of the respondents manifested high anxiety towards mathematics test. Girls in co-educational schools formed the highest percentage of the respondents who were anxious towards a mathematics test. More than three quarters of girls and nearly three quarters of boy in co-educational schools reported having high anxiety towards mathematics test. Slightly more than half of the respondents from boarding schools also reported high anxiety towards mathematics test.

The analysis of results showed a negative and significant relationship between mathematics anxiety and mathematics test performance as in Table 4.19. These findings mean that students with low scores in anxiety towards mathematics test also showed high mathematics test scores. On the contrary, students who had high scores in anxiety towards mathematics test had corresponding low mathematics test scores.

The findings indicate that low anxiety levels towards mathematics test reported by the study participants may have made them carry themselves favorably to solving the mathematics problems in terms of reducing or eliminating any cognitive interference that may have caused them distracting thoughts about their ability to solve the mathematics problems. It may also have made them to consciously and ambitiously face the mathematics problems in terms of utilizing various strategies to solve them (Myers, Solem & Wells, 2019). The opposite may also be valid for participants with high anxiety towards mathematics test and may experience negative distracting thoughts which may hinder them in attempting to solve the mathematics problems successfully.

These results are in line with Irwin Sarason's Cognitive Interference theory (1988) that guided this study. The theory had claimed that task relevant responses arise from anxiety drive and reduce anxiety by leading to successful completion while the task irrelevant responses are not specific to the task thus interfere with the performance of the task at hand.

This may give a justification why participants with low anxiety towards mathematics test performed better than those with high anxiety.

The findings corroborate earlier research done by Mutawah and Ali (2015) and Gina (2018) that reported that a learner's anxiety towards a particular task greatly influences how they perform in it. The results are consistent with those of Melihan, Erhan and Bulet (2017) who found a significant negative relationship between anxiety towards mathematics and performance in mathematics. They also support earlier findings by Guney (2017) who found a negative significant correlation between anxiety towards mathematics test and performance in mathematics test among elementary school students. The findings are also in tandem with those of Skagerlund, *et al* (2019) who found out that high anxiety towards mathematics impairs mathematics problem solving ability.

Based on the above findings and discussions, it can be concluded that the level of anxiety a learner has towards mathematics test determines their mathematics test scores. Therefore, it is imperative that students are helped to be relaxed and reduce their anxiety towards mathematics test in order for them to enhance their performance. In as much as the study shows that anxiety towards mathematics test is an important predictor for performance in mathematics, it is worth to note that there are other factors that also influence how a student performs in a mathematics test either independently or in combination. These include, but not restricted to the learners' metacognition, attitude, and motivation to successfully solve mathematics problems. It is possible that a student who has low anxiety towards mathematics test but has negative attitude towards mathematics may not perform well in mathematics. Comparable o this, a student who has low anxiety towards mathematics test yet is not aware of the metacognitive strategies to use in solving mathematics problems may not perform well.

The researcher opined that learners' self-awareness of their metacognition capabilities helped them to optimize their subject understanding, enhanced their memory and encouraged them to explore independent learning skills in solving specific mathematics problems. This may have further helped the students to learn more efficiently and tolerate through setbacks since they were able to understand and use strategies that gave them success in previous mathematics problem solving situations.

4.6 Difference between metacognition and mathematics anxiety due to gender.

The third objective in this study was to test for differences in metacognition and mathematics' anxiety due to gender. This being a broad objective was split into two supplementary objectives for the purpose of analysis. The first one dealt with gender differences in metacognition and the second one with gender differences in mathematics anxiety.

4.6.1 Difference in metacognition due to gender

The researcher grouped the participants' metacognition scores into three categories of low, medium and high levels of metacognition. After a cross-tabulation of the three levels of metacognition with gender was done and findings tabulated in Table 4.20.

Table 4.20

Metacognition against Gender

			Gender of respondent		
			Male	Female	Total
Score in MAI	Low	*f*	47 (18.15)	53 (20.33)	100 (38.48)
	Medium	*f*	42 (16.24)	28 (10.70)	70 (26.94)
	High	*f*	51 (19.48)	39 (15.10)	90 (34.58)
Total			140 (53.87)	120 (46.13)	260 (100.00)

Note. N =260; f = frequency; () indicates %; MAI = Overall score in metacognition

The results presented in Table 4.20 indicate that almost an equal number of female and male participants were found within the category of low metacognition. This category had the largest number of participants at 38.5%. Girls formed the majority at 20.4% compared to boys at 18.1%. The category that had the least number of participants was that of medium metacognition at 26.9% with boys being the majority a 16.2% compared to girls at 10.7%. More boys than girls were in the high metacognition level representing 19.6%. Chi-square test done to determine if the frequencies in the various categories were significant or not showed that there were no significant differences in the frequencies (χ^2 = .198, *df* = 2, $p>$ 0.05). The results show that more girls recorded low metacognition that boys. This may be mainly due to the typical stereotypic attitude that boys are better in mathematics than girls. This may have influenced their view on mathematics test and helped bring about some confidence among the boys especially in boys' boarding schools and demoralize girls mostly those in co-educational schools whenever they think of or when they are doing a mathematics test. However, a Chi-square test revealed that there was no significant difference in the frequencies which imply that on average, the number of girls who scored low in metacognition is not significantly different from that of the boys.

The researcher went further to compare the scores of both male and female participants in the two sub-scales of metacognition, namely, metacognitive awareness and metacognitive strategies. The results for these comparisons were as follows in Table 4.21.

Table 4.21

Gender Differences in Metacognitive Awareness and Metacognitive Strategies

Gender		*n*	Range	Min	Max	*M*	*SD*	Sk
Male	MA	140	71.00	16.00	96.00	56.00	9.30	-1.32
	MS	140	63.00	31.00	94.00	62.50	11.30	-0.03
Female	MA	120	66.00	20.00	82.00	51.00	9.90	0.15
	MS	120	69.00	24.00	93.00	58.50	10.20	-0.88

Note. *N* = 260; Min – Minimum; Max = Maximum; *M* = Mean; *SD* = Standard Deviation; Sk = Skewness; MA = Metacognition Awareness; MS = Metacognitive Strategies

The results showed in Table 4.21 shows that there were gender differences in the means of metacognitive awareness and metacognitive strategies. The metacognitive awareness (MA) mean scores were 56.0 (*SD* = 9.3) and 51.0 (*SD* = 9.9) for boys and girls respectively. Boys registered relatively higher metacognitive strategies (MS) mean score of 62.5 (*SD*

=11.3) as opposed to that of the girls which was 58.5 (*SD* =10.2). The male respondents rated themselves highly on these two sub-scales of metacognition as shown by the negative skewness in their MA and MS. The females also rated themselves highly in MS as per the negative skewness. There could other variables that may have brought about the differences in metacognition due to gender which were not part of this study. Such variables like but not limited to self-confidence and regular practice in solving mathematics problems by students may have contributed to boys especially in boys' boarding schools to show a higher metacognition score as compared to girls.

4.6.3 Hypothesis Testing

The third null hypothesis stated as follows:

H_{03} There are no significant differences in metacognition and mathematics anxiety of secondary school students due to gender.

Since this hypothesis was in two parts, two supplementary null hypotheses were formulated to test it.

$H_{03.1}$ There are no significant differences in students' metacognition due to gender.

$H_{03.2}$ There are no significant differences in students' mathematics anxiety due to gender.

To test the first supplementary hypothesis, the students' metacognition scores were summarized in terms of means, standard deviations and skewness as reported in Table 4.22

Table 4.22

Summary of Differences in Metacognition due to Gender

	Gender	*n*	*M*	*SD*	Sk
Metacognition Score	Male	140	59.00	21.30	-0.19
	Female	120	52.00	17.80	-0.11

Note. *N* = 260; *M* = Mean; *SD* =Standard Deviation; Sk = Skewness

Table 4.22 indicates that the mean metacognition score was 59.0 (*SD* = 21.31) and 52.0 (*SD* = 17.8) for male and female participants respectively. The boys had a relatively higher metacognition mean score than the girls. The metacognition scores for both the boys and girls were negatively skewed meaning that both rated themselves highly in terms of their metacognition. To test whether the observed differences in metacognition mean scores between boys and girls were significant or not, an independent samples t-test was performed and the findings were shown in Table 4.23.

Table 4.23

Independent Sample t-test for Differences in Metacognition due to Gender

	t	*df*	Sig. (2-tailed)
Metacognition Score	1.367	258	.173

N = 260

Results in Table 4.23 show that even though the male participants had a slightly higher mean score in metacognition than the female participants, the differences in means were not significant (t = 1.367, df = 258, p => .05). The alternate hypothesis was hence rejected and the null hypothesis retained.

4.6.4 Discussion of Results

In line with the third objective of the study which sought to test for differences in metacognition and mathematics' anxiety due to gender. The study found out that differences in metacognition due to gender favored the boys but they were not significant (Table 4.23). This implies that even though boys had a higher mean score in metacognition compared to girls; these differences were not statistically significant. This occurrence may be due to the balanced distribution of trained teachers of mathematics in public secondary schools who have a similar approach to their teaching of the subject. This therefore implies that no gender may be superior in terms of how they are taught which in turn determine the metacognitive abilities they acquired.

Prior research has given inconclusive results in regard to differences in metacognition due to gender, most of the findings report differences in favor of female participants. These findings contradict earlier findings by Salas-Sender *et al.* (2020) who investigated gender differences in response to metacognitive training and revealed a significant difference due to gender in favor of girls. Similarly, Mwaniki (2015) in her study in metacognition, attitudes towards reading and reading comprehension performance among standard six pupils found a slightly higher mean in metacognition among girls than boys. However, the current results corroborate earlier findings by Darmawan, *et al* (2018) who found slight differences due to gender in some aspects of metacognition but these differences were not significant. The findings are also consistent with those of Cakici (2018) who investigated metacognitive awareness and critical thinking abilities of pre-service teachers failed to find significant metacognition differences due to gender.

Findings of the current study have shown differences in metacognition due to gender in favor of the boys even though these differences were not significant. This may be explained by the homogeneity of age between the boys and girls.

4.6. 5 Difference in mathematics anxiety due to gender

The participants were categorized into two categories based on their score on the mathematics anxiety rating scale namely; those with high anxiety towards mathematics test and those with low anxiety towards mathematics test. These two categories were then cross-tabulated with gender and the results were as shown in Table 4.24.

Table 4.24

Cross-tabulation between mathematics anxiety and gender

			Gender of respondent		
			Male	Female	Total
Score in mathematics anxiety	High	*f*	95 (36.52)	90 (34.69)	185 (71.21)
	Low	*f*	45 (17.28)	30 (11.51)	75 (28.79)
Total			140 (53.80)	120 (46.20)	260 (100.00)

Note. *N* =260; *f* = frequency; () indicates %

Table 4.24 indicates that there were slight differences noted between boys and girls in terms of their anxiety towards mathematics test. In the category of high anxiety, boys were slightly more by 1.8% a phenomenon that may be attributed to the higher number of boys who took part in the study than girls. In the category of low anxiety, boys were more by 5.8%. Overall, both boys and girls rated themselves highly in the mathematics anxiety rating scale thus the high percentage of participants with high anxiety towards mathematics test. A Chi square test was run to determine whether the differences in the two categories were significant or not and it showed no statistically significant differences in the frequencies ($\chi 2 = 0.21$, $df = 1$, $p = 0.05$). These results may therefore imply that most students get anxious when they are to do a mathematics related task. Hence, it greatly depends on how individual students handle the anxiety towards mathematics that will determine how they carry out the problem solving. This phenomenon is not specific to gender but affects both boys and girls in a similar way.

4.6.6 Hypothesis testing

The second supplementary hypothesis was

$H_{03.2}$ There are no significant differences in students' mathematics anxiety due to gender.

To test the second supplementary hypothesis, the students' mathematics anxiety scores were summarized in terms of means, standard deviations and skewness as reported in Table 4.25

Table 4.25

Summary of Differences in Mathematics Anxiety due to Gender

	Gender	*n*	*M*	*SD*	Sk.
Anxiety towards mathematics Score	M	140	72.70	26.40	-.48
	F	120	75.10	21.80	-.41

Note. *N* =260; *M* = Mean; *SD* = Standard Deviation; Sk = Skewness

Table 4.25 shows that female participants scored higher in anxiety towards mathematics than male participants. This was shown in the mean scores where the female scored a mean of 75.1 while the males had 72.7. Both female and male participants showed a negative skewness indicating that both rated themselves highly in terms of having anxiety towards mathematics test. To test whether these means had statistically significant difference, they were then analyzed using the independent samples t-test and the results were shown in Table 4.26.

Table 4.26

Independent Samples t-test for Differences in Anxiety towards Mathematics test due to Gender

	t	*df*	Sig. (2-tailed)
Anxiety towards mathematics test score	1.27	258	.21

Source: Researcher, 2020

Results in Table 4.25 indicate that there were no significant gender differences in the participants' anxiety towards mathematics test scores (t = 1.27, df =258, p = .05). These results mean that although the anxiety towards mathematics test was slightly higher in females than in males, the differences were not statistically significant. Based on these findings, the second supplementary hypothesis which had hypothesized that there were no significant differences in students' mathematics anxiety due to gender was retained.

The researcher further sought to find out if there were significant gender differences in the outcome variable since the results in Figure 4.2 showed that more girls performed poorly in mathematics test than boys. The findings were tabulated in Table 4.27

Table 4.27

Differences in Mathematics Test Performance due to Gender

Gender	*n*	*M*	*SD*
Male	140	59.32	19.82
Female	120	48.51	23.24

Note. *N* = 260; *M* = Mean; *SD* = Standard Deviation

Table 4.27 show that boys had a higher mean score in mathematics test performance of 59.32 (*SD* = 19.82) as compared to the girls' 48.51 (*SD* = 23.24). An independent samples t-test for these mean differences was performed to ascertain whether they were significant or not and the findings shown in Table 4.28.

Table 4.28

Independent Samples t-test for Mean Differences in Mathematics Test Performance

	t	*df*	Sig. (2-tailed)
Mathematics test score	-1.63	258	-.043

Note. *N* = 260

Table 4.28 reveals that significant differences (t =-1.63, df = 258, $p < .05$) was found in favour of the boys. These results show that boys scored better in mathematics test than girls. Given that no significant gender differences were found in students' metacognition and anxiety towards mathematics test yet the two variables showed significant correlation with mathematics test performance, the results may thus point to other factors that may singularly and in combination with others influence mathematics test performance. These may include, but are not limited to age of the student, learning environment and many others.

4.6.4 Discussion of results

Although there were differences between boys and girls in their anxieties towards mathematics test, Table 4.27 shows that these differences were not statistically significant. This led to the researcher to accept the study hypothesis which said there is no significant difference in mathematics anxiety due to gender. These findings may be explained by other factors that are not investigated in the current study. Such factors may include but not limited to adequate teachers of mathematics in all the schools or participation in joint mathematics activities by the students as planned by their teachers. These findings are in tandem with those of Mutly (2019) who in his study of mathematics anxiety among students with and without mathematics learning difficulties also failed to find significant differences between averages of mathematics anxiety scores by gender. He however reported a strong and negative correlation between mathematics anxiety and mathematics achievement. Results of the current study also complement findings of Moreno-Garcia, *et al* (2019) who in their study about mathematics anxiety among economics students opined that men and women have different levels of anxiety when it comes to mathematics test and observed that females experienced higher anxiety. However, they attributed the difference to previous mathematical background since they did not find the differences significant to gender. Similarly, Delgado and Kassim (2019) divulged that females become more anxious than males when facing a mathematics test yet the difference is not statistically significant.

The results of the current study however tend to disagree with some previous research that report significant gender differences in mathematics anxiety in favor of ether girls or boys. Akbayir (2019) reported that anxiety of female respondent was lower than that of their male counterparts in his investigation of ninth grade high school students' mathematics level in Turkey. On the other hand, Suren and Kandemir (2020) in their study to find out effects of mathematics anxiety on students' mathematics achievement, reported that boys recorded a lower anxiety which helped them score favourably on mathematics achievement as compared to girls.

The lack of concurrence between the findings of the current study and most of previous studies may be explained by the fact that learning activities, school environment and cultural expectations of the participants among other variables of the current study may be different from those of participants used in previous studies.

4.7 Difference in metacognition and mathematics anxiety due to age.

The study sought to test for differences in metacognition and mathematics anxiety due age in its fourth objective. Since this objective was broad, it was necessary to split it into two objectives for ease of analysis. The first part dealt with differences in metacognition due to age while the second one dealt with differences in mathematics anxiety due to age.

4.7.1 Difference in metacognition due to age

For ease of analysis, the participants' ages had been divided into four categories (≤15.0, 15.1 – 16.5, 16.6 – 18.0 and ≥18.1). These age categories were cross-tabulated with the three levels of metacognition (low, medium and high) as earlier categorized. The results are presented in Table 4.29

Table 4.29

Cross-tabulation of Levels of Metacognition and Age of Respondent

		Age of respondent (Years)				
		≤15.0	15.1-16.5	16.6 – 18.0	≥18.1	Total
Metacognition levels	Low	2 (13.31)	37 (38.63)	44 (40.85)	17 (41.52)	100 (38.40)
	Medium	7 (46.68)	27 (28.08)	28 (25.94)	8 (19.51)	70 (27.00)
	High	6 (40.01)	32 (33.21)	36 (33.21)	16 (38.97)	90 (34.60)
Total		15 (100.00)	96 (100.00)	108 (100.00)	41 (100.00)	260 (100.00)

Note. *N* = 260; () indicates %

Results in Table 4.29 show that generally the participants were almost equally distributed among the three levels of metacognition. Participants with low metacognition took the bulk of the representation (38.4%) while those with high and medium metacognition had 34.6% and (27.0%) respectively. The youngest participants in the age category of ≤ 15.0 years had 40.0% of them in high metacognition level compared to age categories of 15.1 – 16.5 and 16.6 – 18.0 years who both had 33.3%. The ≥ 18.1 years category had 41.5% of them in low metacognition level. To find out whether the frequencies were significant or not, a Chi-square test was carried out and the results showed that there were no significant differences in frequencies between metacognition level and age categories ($\chi 2 = 6.26$, $df = 6$, $p < .05$).

4.7.2 Hypothesis Testing

The fourth objective in this study was to test if there were differences in metacognition and mathematics anxiety due to age. To achieve this goal, the following supplementary hypothesis was stated:

H_{04}: There are no significant differences in metacognition and mathematics anxiety due to age of secondary school students

This hypothesis was very broad consisting of two parts therefore; it was split into two to give way to two supplementary hypotheses as follows;

$H_{04.1}$: There are no significant differences in students' metacognition due to age.

$H_{04.2}$: There are no significant differences in students' mathematics anxiety due to age.

To test for the first supplementary hypothesis, first, the students' mean metacognition scores were summarized and the results presented in Table 4.30.

Table 4.30

Mean Metacognition Scores for Students' Age Categories

Age Category (Years)	*n*	Range	Min	Max	*M*	*SD*	Sk
≤15.0	15	55.50	16.70	72.20	43.90	17.40	0.02
15.1-16.5	96	55.60	22.20	77.80	51.40	25.70	0.08
16.6 – 18.0	108	38.90	27.80	66.70	55.10	12.20	0.1
≥18.1	41	55.60	33.30	88.90	63.20	20.30	0.05

Note. *N*= 260; Min = Minimum; Max = Maximum; *M* = Mean, *SD* = Standard Deviation; Sk = Skewness

Table 4.30 indicates differences in mean metacognition scores among the four age categories with age category ≥18.1 having the highest mean of 63.2 (*SD* = 20.3) and age category ≤15.0 having the lowest score of 43.9 (*SD* = 17.4). To determine if the mean differences in metacognition scores observed were significant across the four age categories, one-way analysis of variance was performed and the findings presented in Table 4.31

Table 4.31

One-Way ANOVA for Age Differences in Metacognition

	Sum of Squares	*df*	Mean Square	*F*	Sig.
Between Groups	2240.00	2	1120.52	6.72	.02
Within Groups	166972.20	257	650.41		
Total	169212.60	259			

Note. *N* = 260; *df* = Degrees of Freedom; *F* = Critical value of F

The findings in Table 4.31 show that there were significant mean differences in the participants' total metacognition scores in regard to their age categories (*F* = 6.7, *df* = 2, *p* = < .05). These results imply that metacognition is influenced to a certain degree by the age of the students. The first supplementary hypothesis was that there were no significant differences in students' metacognition due to age. However, as seen in the results in Table 4.26 the null hypothesis was rejected and the alternative one accepted since significant differences in students' metacognition due to age were found with the age category of ≥18.1 having a higher metacognition compared to the categories.

To ascertain which age category contributed to the significant difference, the researcher carried out a post-hoc analysis using Tukey HSD and the results were tabulated as in Table 4.32.

Table 4.32

Post-hoc Analysis of differences in Students' Metacognition Scores Due to Age

(I) Age Category (Years)	(J) Age Category (Years)	Mean Difference (I-J)	Sig.
≤15.0	15.1 - 16.5	0.319	0.7
	16.6 - 18.0	0.341	0.04
	≥18.1	5.91	0.001
15.1 - 16.5	≤15.0	-0.319	0.7
	16.6 - 18.0	0.022	0.998
	≥18.1	6.8	0.02
16.6 - 18.0	≤15.0	-0.341	0.04
	15.1 - 16.5	-0.022	0.998
	≥18.1	2.4	0.32

Note. The Depended variable is the Total Metacognition Score

From the results in Table 4.32, it is shown that the significant differences in students' metacognition were influenced by the age category ≥18.1 years which had a significantly greater mean in metacognition scores compared to the other three categories. Despite the fact that the students were sampled from the same class (Form three), older students scored higher in metacognition than their counterparts of lower age. This may imply that metacognition improves with age. Therefore, the researcher may conclude that with advancement in age, the students are able to utilize most of their mental faculties more efficiently including becoming aware of the various metacognitive strategies available and being able to use these strategies in solving mathematics problems.

The researcher went further to test for age attributes towards the differences in scores of the two sub-scales of metacognition namely metacognition awareness and metacognition strategies. Mean scores of metacognitive awareness for the four age categories were calculated and results shown in Table 4.33.

Table 4.33

Metacognitive Awareness Mean Scores per Age Category

Age Category (Years)	*N*	Range	Min	Max	*M*	*SD*	Sk
≤15.0	15	39.70	32.70	72.40	55.40	14.90	1.35
15.1-16.5	96	20.70	41.20	61.90	53.80	12.30	-0.20
16.6 – 18.0	108	47.40	29.80	57.20	49.10	11.10	2.00
≥18.1	41	46.80	46.50	93.30	72.90	13.70	-2.10

Note. *N*= 260; Min = Minimum; Max = Maximum; *M* = Mean, *SD* = Standard Deviation; Sk = Skewness

Results in Table 4.33 shows differences in mean metacognitive awareness scores across the age categories. Age category ≥18.1 showed the highest mean of 72.9 (*SD* = 13.7) while age category 16.6 – 18.0 having the lowest mean score of 49.1 (*SD* = 11.1). All categories except category 16.6 – 18.0 years rated themselves highly in terms of their metacognitive awareness as revealed by the negative skewness in their mean scores. The researcher carried out an analysis of variance to determine whether the mean differences observed were significant across the four age categories and results presented in Table 4.34.

Table 4.34

Differences in Metacognitive Awareness Scores due to Age

	Sum of Squares	*df*	Mean Square	*F*	Sig.
Between Groups	1840.00	2	987.53	5.62	.00
Within Groups	33692.20	257	234.41		
Total	36921.60	259			

Note. *N* = 260; *df* = Degrees of Freedom; *F* = Critical value of F

Results in Table 4.34 indicate that there were significant mean differences in metacognitive awareness due to age ($F = 5.6$, $df = 2$, $p = < .05$). To further determine which age categories were better in metacognitive awareness, a post-hoc analysis was performed using Tukey HSD and the results were shown in Table 4.29. The results show that there were significant mean differences in metacognitive awareness due to age. The ≥18.1 years age category showed a significantly higher metacognition score than the other age categories.

Table 4.35

Post-Hoc Analysis for differences in Metacognitive Awareness due to Age

(I) Age Category (Years)	(J) Age Category (Years)	Mean Difference (I-J)	Sig.
≤15.0	15.1 - 16.5	1.7	0.9
	16.6 - 18.0	2.6	0.04
	≥18.1	5.8	0.00
15.1 - 16.5	≤15.0	-1.7	0.9
	16.6 - 18.0	3.2	0.3
	≥18.1	8.8	0.01
16.6 - 18.0	≤15.0	-2.6	0.04
	15.1 - 16.5	-3.2	0.3
	≥18.1	4.2	0.04

Note. N = 260; Dependent Variable = Metacognitive Awareness

The researcher also subjected the metacognitive strategies scores to a One-Way Analysis of Variance to check whether there were significant differences due to age and the results were presented in Table 4.36.

Table 4.36

Differences in Metacognitive Strategies due to Age

	Sum of Squares	*df*	Mean Square	*F*	Sig.
Between Groups	2432.00	2	1233.20	7.24	.00
Within Groups	56446.10	257	745.90		
Total	56987.42	259			

Note. *N* = 260; *df* = Degrees of Freedom; *F* = Critical value of F

Results in Table 4.36 imply that there were significant mean differences in metacognitive strategies due to age ($F = 7.2$, $df = 2$, $p = < .05$). This shows that the age of the student has some influence in their metacognitive strategies. This may be attributed to maturation of the brain thus allowing it to compute more complex cognitive processes. To determine the age group that strongly contributed to the significant differences observed, the researcher did a post-hoc analysis using Tukey HSD and the results were as shown in Table 4.37.

Table 4.37

Post-Hoc Analysis of Differences in Metacognitive Strategies due to Age

(I) Age Category (Years)	(J) Age Category (Years)	Mean Difference (I-J)	Sig.
≤15.0	15.1 - 16.5	0.9	0.41
	16.6 - 18.0	1.1	0.56
	≥18.1	9.5	0.01
15.1 - 16.5	≤15.0	-0.9	0.41
	16.6 - 18.0	3.8	0.05
	≥18.1	7.3	0.00
16.6 - 18.0	≤15.0	-1.1	0.56
	15.1 - 16.5	-3.8	0.05
	≥18.1	4.1	0.04

Note. *N* = 260; The Depended variable is the Total Metacognition Score

Table 4.37 illustrates that the ≥18.1year category showed significant higher scores in metacognitive strategies than the other age categories. This may have been expected given that older students are expected to have acquired a gamut of metacognitive strategies which they can apply to carry out mathematics problem solving. This however, may not be a sure implication that being older equips one with metacognitive strategies to solve mathematics problems. It is through deliberate efforts and motivation from the student as one learns how to solve different mathematics problems that he or she is able to acquire these strategies.

4.7.3 Discussion of Results

From the quantitative analysis, the findings of the study show that older students had demonstrated a better utilization of their metacognitive strategies as compared to the younger age categories. Given that the recommended enrolment age for pupils in standard one is six years old, then it is expected that a form three student to be 16 years or 17 years of age. As observed in Table 4.34, a high number of participants (41.5%) were in the age category 16.6 to 18 years. This was the ideal age that would have been expected to have the best results, however, the age category above them (≥ 18.1 years) showed a better performance in the utilization of their metacognition in order to solve complex mathematics problems. This may be attributed to the brain development that triggers other changes such as behavior regulation (Schneider, 2008).

These findings may imply that older participants have had a longer exposure to mathematics problem solving experiences thus being more likely to have interacted with a variety of problems and strategies therefore making them better mathematics problem solvers as compared to the younger participants.

Various studies have shown that older participants demonstrate better metacognitive functioning as compared to their younger counterparts. For example, studies of memory performance on a value-directed remembering (VDR) task (Ariel *et al*, 2015; & Hayes *et al*, 2013) reported that when adult participants were given a series of words with each word assigned a point of importance to study, the older adults recalled fewer words compared to the younger adults, however, they remembered a greater proportion of high-value words unlike their younger counterparts. These findings illustrate better metacognitive abilities in older adults given they are able to selectively concentrate to and recall high-value words to make the most of their score.

The results of the current study also corroborate findings from a study by Siegel and Castel (2019) in an experiment to find out the level of memory capacity and selectivity predictions differ between young and older adults found out that though both groups showed high selectivity towards high-valued words, the older adults were seen to be more selective than younger adults in the information that they remembered. With increased task experience and being more confident that the younger adults, the study found out that the older adults were more metacognitively accurate in their responses.

Other studies have reported contrary to the findings of the current study. Various studies report findings that by and large concur with the hypothesis that metacognitive processes may be largely spared from age-related influence (Klencklen *et al*, 2012; Ariel & Moffat, 2018; Serra & Ariel, 2014; Thomas *et al*, 2012; Techentin *et al*, 2014). In their experiment, Ariel and Moffat (2018) found out that younger adults showed more confidence in their memory for spatial patterns than were older adults. They found out that when given eight (8) tasks to complete in 2 hours the younger adults showed more cognitive accuracy in performing most of the tasks than were older adults. Across the tasks, older adults presented poorer performance and exhibited lower confidence in their cognitive abilities. Mwaniki (2015) found out that general metacognition does not necessarily increase with age. She reported younger children aged 10-11 years obtaining significantly higher scores in metacognition than older students. Ariel and Moffat (2018) reported that older participants in their study exhibited poor overall performance in metacognition domains and recorded a much lower competence in metacognitive judgement than their younger counterparts. The current study however did not agree with their assertions as the older participants in the ≥ 18.1 years age category obtained higher scores in metacognition and its two sub-scales as compared to the younger age categories.

4.7.4 Difference in mathematics test anxiety due to age.

The researcher cross-tabulated the participants' age categories and mathematics anxiety mean scores as shown in Table 4.38.

Table 4.38

Mean Description of Age Categories and Mathematics Anxiety

Age Category (Years)	*n*	Range	Min	Max	*M*	*SD*	Sk
≤15.0	15	46.50	42.20	88.70	65.50	18.50	2.90
15.1-16.5	96	26.80	43.90	70.70	57.30	11.80	2.50
16.6 – 18.0	108	45.80	37.40	83.20	60.30	21.30	1.30
≥18.1	41	45.40	26.20	71.60	48.90	17.50	-0.60

Note. *N* = 260; Min = Minimum; Max = Maximum; *M* = Mean; *SD* = Standard Deviation; Sk = Skewness

Results in Table 4.38 show that the oldest participants in age category ≥18.1 years had highest mean score of anxiety towards mathematics test of 48.9 (*SD* = 17.5) while the youngest participants in the age category ≤15.0 years had the lowest mean score of anxiety towards mathematics test of 65.5 (*SD* = 18.5). The mathematics anxiety mean scores for all the age categories apart from that of age category ≥18.1 years were positively skewed indicating that all the age categories apart from age category ≥18.1 years rated themselves as having high anxiety towards mathematics test.

In this study, the mathematics anxiety was used to categorize the participants into two categories, these were, participants with high anxiety towards mathematics and those with low anxiety. The researcher performed a cross tabulation of these two types of anxiety against the age categories and the results were tabulated in Table 4.39.

The results in Table 4.39 show that more participants with low mathematics anxiety was reported among the ≥18.1 years age category (51.2%) followed by the 16.6 - 18.0 years age category (36.1%). Age category ≤15.0 years reported the least number of participants who had low anxiety towards mathematics (13.3%). This could have the case because students aged 18.1 years and above had earned better metacognitive scores than the younger ones, which may imply that they are adequately prepared to sit for the mathematics test hence do not experience high anxiety.

Table 4.39

Cross-tabulation of Age Categories and Anxiety

		Age of respondent (Years)				
		≤15.0	15.1 - 16.5	16.6 - 18.0	≥18.1	Total
Score in Mathematics Anxiety	High	13 (86.70)	64 (66.70)	69 (63.90)	20 (48.80)	185 (71.20)
	Low	2 (13.30)	32 (33.30)	39 (36.10)	21 (51.20)	75 (28.80)
Total		15 (100.00)	96 (100.00)	108 (100.00)	41 (100.00)	260 (100.00)

Note. N = 260; () indicates %

When a Chi-square test was performed, it revealed there being significant differences in the type of anxiety towards mathematics test across the age categories ($\chi^2 = 7.44$, $df = 2$, $p < .05$). These results indicate that older students in public secondary schools are more likely to have lower anxiety towards mathematics test perform. Therefore, they are more likely to have a better use of their metacognitive strategies in solving mathematical problems.

4.7.5 Hypothesis Testing

The second supplementary hypothesis for the fourth objective was;

$H_{04.2}$: There are no significant differences in students' mathematics anxiety due to age.

To test for the first supplementary hypothesis, One-Way analysis of Variance was performed on the participants' mean difference in mathematics anxiety scores in comparison with their ages and the results presented in Table 4.40.

Table 4.40

Differences in Mathematics Anxiety due to Age

	Sum of Squares	*df*	Mean Square	*F*	Sig.
Between Groups	2051.10	2	997.67	8.44	.00
Within Groups	28692.70	257	249.40		
Total	31922.30	259			

Note. N = 260; df = Degrees of Freedom; F = Critical value of F

Table 4.40 shows that there were significant mean differences in anxiety towards mathematics scores due to age ($F = 8.4$, $df = 2$, $p < .05$). The researcher further performed a post-hoc analysis using Turkey HSD in order to determine which age group (s) significantly contributed to the differences and the outcomes reported in Table 4.41.

The results shown in Table 4.41 reveal that there were significant differences in anxiety towards mathematics test due to age. The results favoured the older participants especially those in the ≥18.1 years age category. These results may imply that older students may be possessing better anxiety handling mechanisms than the younger ones thus being able to be less anxious when faced with a mathematics test. This may be due to the fact that because of their older age, they are able to rationalize situations when it comes to sitting for a test as compared to the younger students. Eventually, this is more likely to be seen in their mathematics test performance of these different age categories with older students anticipated to perform better.

Table 4.41

Post-hoc Analysis of Mathematics Differences due to Age

(I) Age Category (Years)	(J) Age Category (Years)	Mean Difference (I-J)	Sig.
≤15.0	15.1 - 16.5	2.71	2.20
	16.6 - 18.0	5.48	0.05
	≥18.1	7.86*	0.00
15.1 - 16.5	≤15.0	-2.71	2.20
	16.6 - 18.0	1.00	1.90
	≥18.1	6.80*	0.03
16.6 - 18.0	≤15.0	-5.48	0.05
	15.1 - 16.5	-1.00	1.90
	≥18.1	4.60	0.86

Note. N = 260; Depended variable = Anxiety towards Mathematics Test

A higher percentage of the younger students reported significantly poor results in terms of their anxiety towards mathematics test scores whereas the older students showed significantly better metacognition and anxiety towards mathematics test. This prompted the researcher to be inquisitive whether the same translated into positive outcomes in relation to mathematics test performance. He thus subjected the obtained data to one-way ANOVA and the results shown in Table 4.42

Table 4.42

Differences in Mathematics Test Performance due to Age

	Sum of Squares	*df*	Mean Square	*F*	Sig.
Between Groups	2971.7	2	1433.8	13.4	.00
Within Groups	31672.5	257	154.4		
Total	32212.4	259			

Note. *N* = 260; *df* = Degrees of Freedom; *F* = Critical value of F

The results in Table 4.42 indicate that there were significant mean differences in anxiety towards mathematics test T-score due to age (F = 13.4, df = 2, p = < .05). This, however, does not show the specific age category that was better. To get this, a post-hoc analysis using Tukey HSD was performed and the results shown in Table 4.43.

Table 4.43

Post-Hoc Analysis of Differences in Mathematics Test Performance due to Age

(I) Age Category (Years)	(J) Age Category (Years)	Mean Difference (I-J)	Sig.
≤15.0	15.1 - 16.5	1.17	3.65
	16.6 - 18.0	6.53*	0.04
	≥18.1	9.16*	0.00
15.1 - 16.5	≤15.0	-1.17	3.65
	16.6 - 18.0	3.50	0.57
	≥18.1	7.80*	0.02
16.6 - 18.0	≤15.0	-6.53	0.04
	15.1 - 16.5	-3.50	0.57
	≥18.1	4.33	0.72

Note. *N* = 260; Depended variable = Mathematics Test Performance

Results in Table 4.43 show that the differences in mathematics performance mean scores were significant with a great bias towards ≥18.1 years age category. This implies that participants in this age category were able to perform better in the mathematics test than the younger age categories because of their higher metacognition and low anxiety towards mathematics test.

4.7.6 Discussion of Results

The results attained from the fourth objective appear to support the concept that metacognition and mathematics test anxiety are related as already stated in chapter one. It also supports the idea that metacognition improves with age. From the results, it can be observed that the oldest participants in the ≥18.1year age category obtained significantly low mathematics test anxiety scores than the other age categories. They were also reported to have higher metacognition scores. These participants proceeded to report higher scores in the mathematics test compared to the other younger age categories. The higher performance in mathematics test may be attributed to the fact that the older group had better metacognitive awareness and strategies to use before, during and after solving mathematics problems. Previous research findings support the idea that effective use of metacognitive strategies result in increased learning and achievement (Mwaniki, 2015). This may have reduced their anxiety towards mathematics test and enhanced their motivation and confidence towards the mathematics test. This may be contrary to students who lack a collection of metacognitive strategies and awareness to use while solving mathematical problems. When faced with difficult mathematical tasks, they are more likely to encounter frustration and feel helpless towards their abilities of working the tasks.

The findings of the current study are in tandem with those of Puteh, and Khalin (2016) who found out that lowering ones' anxiety during a mathematics test may lead to better performance in the test. On the contrary, students who report high anxiety during a mathematics test perform poorer than they would have performed in similar mathematics problems when not sitting for a test. Gina (2018) has reported that there is a noticeable incline of metacognitive strategy use among high school students as they progress to upper classes but did not report any effect on mathematics anxiety as the students move to upper classes. In his study, he found out that most of the high school students become more interested in solving mathematics problems as they advance in upper classes. However, as the complexity of the content increases, approximately half of them lose interest and their performance start to palmate.

This may explain why the metacognition of the older students was higher compared to the younger students. This is because the older students may have developed more metacognitive strategies over time as compared to the younger students. This compounded with other constructs such as confidence, motivation and determination may have seen the older students put up a better performance in mathematics test.

The results were however inconsistence with those of Luttenberger, *et al* (2018) who reported no significant differences in anxiety towards mathematics test due to age among 225 undergraduate statistics students in Austria. This contrast from results of the current study may be due to the fact that undergraduate students have already established their potential in mathematics performance, whether low or high, hence they don’t get anxious of poor performance.

4.8 Predictive weights of metacognition and mathematics anxiety on mathematics test performance

The fifth objective of this study sought to determine the predictive weights of metacognition and mathematics anxiety on the performance of mathematics test. To achieve this, the researcher carried out a combined descriptive analysis of the metacognition and anxiety towards mathematics test scores. This then led to the hypothesis testing.

4.8.1 Descriptive Analysis of the Extent to which Metacognition and Mathematics Anxiety Predict Mathematics Test Performance

To determine the extent to which students' metacognition and anxiety towards mathematics predict performance in mathematics test a descriptive analysis of respondents' scores was done. The range, mean mark, standard deviation and skewness of metacognition and anxiety towards mathematics were done as shown in Table 4.44.

Table 4.44

Descriptive Analysis of Metacognition and Anxiety towards Mathematics

	N	Range	Min	Max	*M*	*SD*	Sk
SMS	260	72.20	16.70	88.90	59.80	32.10	-0.23
MAS	260	62.50	26.20	88.70	58.50	27.30	-0.39

Note. *N* = 260; Min = Minimum; Max = Maximum; *M* = Mean; *SD* = Standard Deviation; Sk = Skewness; SMS = Students' Metacognition Score; MAS = Mathematics Anxiety Score.

Findings in Table 4.44 show the minimum scores for SMS and MAS were 16.7 and 26.2 respectively whereas the maximum scores for the same variables were 88.9 and 88.7 respectively. The mean scores for SMS and MAS were 59.8 (*SD* = 32.1) and 58.5 (*SD* = 27.3) respectively. Majority of the participants reported having considerably high levels of metacognition as well as high mathematics anxiety, this was shown by the score distribution for both SMS and MAS which were negatively skewed (-0.23 and -0.39 respectively).

4.8.2 Hypothesis testing

In order to determine the extent to which students' metacognition and anxiety towards mathematics predict performance in mathematics, the researcher hypothesized that:

H_{05}: Metacognition and mathematics anxiety do not significantly predict mathematics test performance among secondary school students.

Therefore, the metacognition and anxiety towards mathematics scores as well as the mathematics test performance T- scores were subjected to multiple regression analysis in order to test whether the interaction effect of the two predictor variables was significant or not. The results were then presented in Table 4.45

Table 4.45

Regression Analysis for Interaction Effect of Metacognition and Mathematics Anxiety towards Mathematics Test Performance

Model		*SS*	*df*	*MS*	*F*	Sig.
1	Regression	867.09	2	433.54	65.88	.00
	Residual	1691.26	257	6.58		
	Total	2558.35	259			

Note. *N* = 260; *SS* = Sum of Squares; *df* = Degrees of Freedom; *MS* = Mean Squares; *F* = Critical value of F

Results presented in Table 4.45 show that there was significant interaction effect between metacognition and mathematics test anxiety in predicting mathematics test performance, $F(2, 257) = 65.88$, $p < .05$. In separation, metacognition showed a positive and significant correlation with the outcome variable while mathematics anxiety showed a negative and significant correlation. This strongly affirms the observation that when acted together, the two predictor variables had a significant interaction effect on mathematics test performance. On the basis of these results, the null hypothesis was rejected and the alternative one accepted.

The metacognition and mathematics anxiety scores were individually subjected to regression analysis to find out their predictive values on the outcome variable. The results were presented in Table 4.46 and 4.47.

Table 4.46

Predictive Value of Metacognition towards Mathematics Test Performance

Model		Standardized Coefficient B	*T*	Sig.
1	(Constant)	10.82		
	Score in Metacognition	1.72	8.50	.00

Note. *N* = 260; R^2 = .22; Adjusted R^2 = .22; *SE* = 2.78

Table 4.46 shows that metacognition had a significant predictive value towards mathematics test performance. From these results, a model of prediction was formulated and presented in equation 1.

Equation 1

$\hat{y} = 10.82 + 1.72(SMS)$ ($R^2 = .22$, $p < .05$)

Where ŷ is the predicted mathematics test performance score and SMS is the participants' metacognition score. For every standard deviation change in metacognition scores, mathematics test performance scores increased by 1.72 points. This model hence indicated that metacognition score, on its own, accounted for a 22% variance in mathematics test performance scores. This means that if all other variables are held constant, then the use of metacognition will contribute 22% of the score a student will get in a mathematics test.

Table 4.47

Predictive Value of Mathematics Anxiety towards Mathematics Test Performance

Model		Standardized Coefficient B	*T*	Sig.
1	(Constant)	8.56		
	Score in Mathematics Anxiety	-3.91	-11.00	.00

Note. N = 260; R^2 = .32; Adjusted R^2 = .32; SE = 2.60

Table 4.47 shows that mathematics anxiety had a significant predictive value towards mathematics test performance. A model of prediction was then formulated from these results and presented in equation 2.

Equation 2

$\hat{y} = 8.56 - 3.91(\text{MAS})$ ($R^2 = .32$) $p < .05$

In the equation, ŷ is the predicted mathematics test performance score and MAS is the participants' mathematics anxiety score. For every standard deviation change in mathematics anxiety scores, mathematics test performance scores decreased by 3.91 points. Therefore, this model indicated that mathematics anxiety score, independently, accounted for a 32% variance in mathematics test performance scores.

The researcher further sought to determine whether, when combined, the two predictor variables had a significant interaction effect on mathematics test performance. Thus, a further regression analysis was conducted on the data and the results were presented in Table 4.48.

Table 4.48

Predictive Weights of Metacognition and Mathematics Anxiety on Mathematics Test Performance

Model		Standardized Coefficient B	*T*	Sig.
1	(Constant)	9.65	22.30	.00
	Score in Metacognition	.67	2.77	.00
	Score in Mathematics Anxiety	-3.11	-6.85	.00

Note. N = 260; R^2 = .34; Adjusted R^2 = .33; SE = 2.57

Table 4.48 shows that both metacognition and anxiety towards mathematics test have a significant predictive value for mathematics test performance. Metacognition has a significantly positive predictive value while anxiety towards mathematics has a negatively predictive value for mathematics test performance. The results in Table 4.48 were used to identify a resultant model of prediction as represented in equations 3.

Equation 3

$\hat{y} = 9.65 + .67(SMS) - 3.11(MAS)$ ($R^2 = .34$) $p < .05$

Where $\hat{y}$ is the predicted mathematics test performance score, SMS is the participants' metacognition score and MAS is the participants' anxiety towards mathematics score. For every standard deviation change in metacognition scores, mathematics test performance scores increased by 0.67 points while for anxiety towards mathematics scores, mathematics test performance scores reduced by 3.11 points. This model indicates that metacognition and mathematics anxiety scores jointly accounted for a 34% variance in mathematics test performance scores.

The researcher further subjected the levels of metacognition and mathematics anxiety to a further regression analysis to find out their respective predictive weights on mathematics test performance. There were two levels for metacognition namely metacognitive awareness and metacognitive strategies. Similarly for mathematics anxiety, there were two levels which were low and high. The results of this analysis are tabulated in Table 4.49.

Table 4.49

Regression Analysis for Levels of Metacognition and Mathematics Anxiety towards Mathematics Test Performance

Level of Anxiety	Model	*SS*	*df*	*MS*	*F*	Sig.
	Regression[a]	1065.06	2	355.02	60.86	.00
Low	Residual	1493.29	51			
	Total	2258.35	53			
	Regression[a]	900.90	2	450.44	69.84	.01
High	Residual	1657.46	203	6.5		
	Total	2558.35	205			

Note. *N* = 260; *SS* Sum of Squares; *df* = Degrees of Freedom; *MS* = Mean Squares; *F* = Critical Value of F

[a] Predictors: (Constant), Metacognitive Awareness Scores, Metacognitive Strategy Scores.

The findings in Table 4.49 reveal a significant interactive effect between low mathematics anxiety and the two levels of metacognition. Similarly, there was a significant interactive effect between high mathematics anxiety and the two levels of metacognition. A further regression analysis was done to determine the relative predictive values of the levels of metacognition and mathematics anxiety on mathematics test performance. The findings were presented in Table 4.50.

Table 4.50

Predictive Values of Metacognition and Mathematics Anxiety on Mathematics Test Performance

Level of Anxiety	Model		Standardized Coefficients β	*t*	Sig.
		(Constant)	13.54	9.62	.00
Low	1^a	Metacognitive Awareness Score	.58	4.01	.1
		Metacognitive Strategies Score	2.49	7.23	.00
		Constant	5.38	4.24	.00
High	1^b	Metacognitive Awareness Score	.67	1.73	.07
		Metacognitive Strategies Score	.94	3.66	.02

Note. N = 260; $^aR^2$ = .42; Adjusted R^2 = .40; SE = 2.41

$^bR^2$ = .35; Adjusted R^2 = .35; SE = 2.54

Results presented in Table 4.50 imply that when low and high mathematics anxiety are interacted with metacognitive strategies, they significantly predict mathematics test performance. On the contrary, when the two levels of anxiety, that is, low and high are combined with metacognitive awareness, they do not show a significant prediction of mathematics test performance. The researcher used the results of Table 4.50 to model a prediction for low mathematics anxiety as represented in equation 4.

Equation 4

$\hat{y} = 13.54 + 2.49(MSS)$ ($R^2 = .40$) $p < .05$

Where ŷ refer to the predicted score in a mathematics test and MSS in the metacognitive strategies use. Equation 4 reveals that metacognitive strategies had a significant predictive value for mathematics test performance when combined with low anxiety towards mathematics test ($\beta = 2.49$, $p < .05$). When low mathematics anxiety is combined with metacognitive awareness, the predictive values for mathematics test performance is lower ($\beta = .58$, $p > .05$). The researcher identified a resultant model of prediction for high mathematics anxiety towards mathematics test performance from the same Table 4.50 and represented it in equation 5.

Equation 5

$\hat{y} = 5.38 + .94(MSS)$ ($R^2 = .35$) $p < .05$

In equation 5, ŷ refers to the predicted score in mathematics test and MSS is metacognitive strategy score. This equation shows that metacognitive strategy score had a significant predictive value for mathematics test performance score when combined with high mathematics anxiety ($\beta = .94$, $p < .05$). On the contrary, combining high mathematics anxiety with metacognitive awareness, the predictive values were lower and insignificant ($\beta = .67$, $p > .05$).

4.8.3 Discussion of results

The results show that majority of the participants reported high level of mathematics anxiety, their performance in the mathematics test notwithstanding. Further, the results indicated that participants with low anxiety towards mathematics test solved more mathematical problems successfully compared to those whose anxiety was high. Participants who reported high on metacognitive strategy and had low anxiety towards mathematics test scored the highest marks in the mathematics test. This implies that a learner may be able to apply a problem-solving strategy without having planned on it. This also shows that not every learner who knows of the different metacognitive strategies is able to apply them when trying to solve a mathematics problem.

Having low mathematics anxiety helps a learner to effectively think of and use metacognitive strategies and in result achieve a higher mathematics test score. This use of metacognitive strategies can be attributed to the fact that with low anxiety, learners tend to feel relaxed and not under pressure to solve mathematics problems. High mathematics test anxiety, on the other hand, impedes the effective use of metacognitive strategies by the learner thus leading them to perform poorly in mathematics test. Learners who have high anxiety during mathematics test may experience feelings of anger, fear, helplessness and levels of disappointments which may make them to experience difficulty in concentrating and have negative thoughts about their capability of performance in the particular test. This would definitely reduce their performance. However, if they are able to apply the various strategies, then they gain some level of confidence and are able to attempt solving mathematical problems successfully.

These findings are consistent with those of Guzman (2018) who found out that significant positive correlations existed between metacognitive strategy use and learners' performance in mathematics test. He also found significant relationship between metacognition and mathematics test performance of senior college students. In their study, Herawaty, *et al* (2018) concluded that low mathematics anxiety contributed to the high school students in thinking of an appropriate strategy to use while solving a mathematics question. This in turn helps them to increase the chances of them remembering the correct formula and thus getting the correct answers to most of the problems.

Results of the current study corroborate what Stephanou and Mpiontini (2017) had earlier opined that metacognitive awareness can improve the confidence of a learner during a test, but what mattered the most was for that learner to be able to apply the metacognitive strategies they know so that they can correctly solve the problem. In their findings, they reported that the learner's use of metacognitive strategies played a bigger role in helping a learner achieve a higher score as opposed to when they were just aware of the strategies and did not apply them in trying to solve the problems. In another study, Erdogan and Sengul (2017) reported that the ability of the learner to apply various strategies when attempting to solve a mathematics problem makes them feel motivated thus reducing their anxiety towards the test. This in turn gives them the confidence to face the challenging problems repeatedly until they successfully solve it.

Other studies (Baliram & Ellis, 2019; Knox 2017; Tian, Fang & Li, 2019) showed that the use of metacognitive strategies when solving mathematical problems often leads to positive outcomes. This may mean that despite learners having low anxiety towards mathematics and high metacognitive awareness, they may fail to solve the problems successfully due to their ineffective utilization of the metacognitive strategies.

The findings of the current study further showed that even when mathematics anxiety was high and was combined with metacognitive strategies, the participants still scored highly in mathematics test. This may simply indicate that as long as a learner is able to apply a strategy in solving a problem, the level of their anxiety towards mathematics test may not hinder them from successfully solving the mathematics problems at hand. On the contrary, when low anxiety towards mathematics was combined with metacognitive awareness, the prediction of mathematics test performance was found to be insignificant. These results thus may imply that learners experiencing high levels of anxiety may be able to effectively use metacognitive strategies to solve a mathematics problem successfully. This therefore, shows that metacognitive strategy use is very paramount in solving mathematics problems. It would then be much easier for a learner to use a strategy that they are aware of rather than spontaneously implement a strategy they may not be aware of. Therefore, this makes metacognitive awareness as the prerequisite to the intentional use of the metacognitive strategies by a learner.

These findings may mean that for some students, the use of metacognitive strategies is unconscious or automated therefore they do not become consciously aware when they are using them thus failure on their part to report the metacognitive awareness of the strategies they used. Such learners may have had a challenge in reporting their awareness of the metacognitive strategies they used thus its insignificant predictive values on performance of a mathematics test.

In the case of this study, the findings may also mean that there could be other factors that affected the learners while solving the mathematics test. These factors may include but not limited to the students' individual ability or IQ in mathematics problem solving, their interest in the subject, academic and self-motivation, students' learning environment and cultural surroundings from which the students live, lack of regular practice in mathematics problem solving and mathematics stereotyping among the genders.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter summarizes the study findings in three sections. The first section presents a summary of the study's major findings and shows the implications of the study to various stakeholders. In the second part, conclusions based on the research findings are drawn while the last section gives recommendations for policy and further research.

5.2 Summary

This study sought to determine the extent to which metacognition and mathematics anxiety predicts mathematics test performance of secondary school students in Kakamega County. The study was conducted on a sample size of 260 students, 120 girls and 140 boys from 6 public secondary schools, one boys boarding, 1 girls' boarding and 4 co-educational schools in Kakamega County, Kakamega County, Kenya.

The first objective of the study was to establish the relationship between metacognition and mathematics test performance. The findings showed that there was a positive and significant relationship between metacognition and mathematics test performance. In combination, metacognitive awareness and metacognitive strategies jointly accounted for more than a third of variance in mathematics test performance. Further analysis showed that the two sub-scales of metacognition which are metacognitive awareness and metacognitive strategies had a positive and significant correlation with mathematics test performance. Comparing these two sub-scales, students with high metacognitive knowledge exhibited high metacognitive strategy use whereas those with high metacognitive strategy use did not necessarily show having high metacognitive knowledge. Most students who reported low metacognition score also scored low marks in the mathematics test. The overall predictive value of metacognition on mathematics test performance was slightly over 40%. These findings may imply that students need to acquire metacognitive knowledge of the various metacognitive strategies available in order for them to be able to apply the strategies effectively while solving mathematics problems.

The second objective of the study sought to determine the relationship between mathematics anxiety and mathematics test performance. The findings showed a negative and significant relationship between mathematics anxiety and mathematics test performance. It revealed that high anxiety towards mathematics test often leads to low scores in mathematics test and vice versa. Most students showed some anxiety towards mathematics test where most of them showed high anxiety. Girls in co-educational schools were found to have the highest anxiety levels towards mathematics test. These results may imply that there is need for students to remain relaxed in order to eliminate or reduce their anxiety whenever they are about to sit for a mathematics test.

The third objective of the study was to test if there were any differences due to gender in metacognition and mathematics' anxiety. The study found out that the differences in metacognition favored boys but these differences were not significant. In as much as there were more boys than girls who exhibited higher metacognition, this was not a strong determinant for boys to perform better than girls in mathematics test. This may imply that students need to learn how to apply the metacognitive strategies that they know in order for them to improve their performance in mathematics test. On the other hand, significant differences were noted between boys and girls in terms of their anxiety towards mathematics test. Girls scored higher than boys on the mathematics anxiety rating scale.

The fourth objective of the study was to find out differences in students' metacognition and mathematics' anxiety due to age. Findings of the study revealed that older students demonstrated a better utilization of their metacognition compared to the younger students. This may be attributed to higher brain development among the older students which could be responsible for other changes such as behavior regulation which in turn could lower mathematics anxiety levels. These findings thus imply that older students may be better at mathematics problem solving since they have a better developed metacognition ability and are able to regulate their behavior hence being less anxious while performing a mathematics test. The findings also imply that metacognition and mathematics test anxiety are correlated and that metacognition improves with age.

The fifth objective of the study was to determine the relative predictive weights of metacognition and mathematics anxiety on mathematics test performance. A significant positive relationship was found between metacognition and mathematics test performance while a significant negative correlation was found between mathematics anxiety and mathematics test performance. The following five equations were generated using the Multiple Regression Analysis;

$\hat{y} = 10.82 + 1.72(SMS)$ ($R^2 = .22$, $p < .05$) .... (1).

$\hat{y} = 8.56 – 3.91(MAS)$ ($R^2 = .32$) $p < .05$ ………………….…………….. (2).

$\hat{y} = 9.65 + .67(SMS) – 3.11(MAS)$ ($R^2 = .34$) $p < .05$ ………….…… (3).

$\hat{y} = 13.54 + 2.49(MSS)$ ($R^2 = .40$) $p < .05$ …………….……………..…... (4).

$\hat{y} = 5.38 + .94(MSS)$ ($R^2 = .35$) $p < .05$ ……………….…….……...…. (5).

Where ŷ = predicted score of mathematics test, SMS is the participants' metacognition score, MAS is the participants' mathematics anxiety score, and MSS is the metacognitive strategies use.

In equation (1), mathematics test performance was predicted from participants' metacognition score which showed an increase of 1.72 points for every deviation change in metacognition scores. Equation (2) involved predicting mathematics test performance from mathematics anxiety scores. This showed that for every deviation increase in mathematics anxiety score, mathematics test performance decreased by 3.91 points. Equation (3) involved predicting mathematics test performance from a combination of metacognition score and mathematics anxiety score. It showed that when these two were combined, for every positive deviation change in metacognition score, mathematics test performance increased by 0.67 points and for a similar change in mathematics anxiety score, mathematics test scores reduced by 3.11 point.

In equation (4), mathematics test performance scores were predicted from metacognitive awareness, metacognitive strategies and low anxiety towards mathematics test. However, when metacognitive awareness was combined with low mathematics anxiety, the predictive values were not statistically significant at p-value of 0.05. In equation (5), high metacognitive strategies significantly predicted high values for mathematics test performance when combined with either low or high mathematics anxiety. On the contrary, combining high mathematics anxiety with metacognitive awareness showed insignificant predictive values for mathematics test performance. These findings thus imply that metacognition has a positive effect on mathematics test performance while mathematics anxiety has a negative effect. Metacognitive strategy use affects mathematics test performance positively whether the student's anxiety towards mathematics is high or low while metacognitive awareness tends to show no effect on mathematics test performance when combined with mathematics anxiety.

5.3 Conclusions

This study sought to address gaps in the work on mathematics test performance among secondary school students. Supported by John Flavell's Metacognition theory and Irwin Sarason's Cognitive Interference theory, the study hypothesizes how mathematics test performance is predicted by metacognition and mathematics anxiety. It further delves into developing a further understanding of mathematics test performance among secondary school students in Kenya.

Findings of the study revealed that boys recorded better performance in mathematics test than girls. It further indicated that students in Boarding Schools performed better than those in Co-educational Schools, where those in Boys Boarding scored higher than those in Girls Boarding Schools. Girls in Co-educational Schools scored the least marks. Older students scored higher marks as compared to younger ones while more than half of all the respondents scored below the pass mark.

The first objective sought to establish if there was a relationship between metacognition and mathematics test performance among secondary school students in Kakamega County. It was found out that there exists of a significant positive relationship between metacognition and mathematics test performance. When the two sub-scales of metacognition were analyzed, both were found to be positively related to mathematics test performance. Metacognitive strategy significantly predicted mathematics test performance. It can be concluded that students who use metacognitive strategies while solving mathematical problems are more likely to score highly. Artelt and Weint (2013) asserted that most students experience a spontaneous control of their learning process when sitting for a test without them being aware of it. This, however, does not downplay the role of metacognitive awareness because it is only logical for one to use a strategy that they are aware of. Learners therefore need to have an awareness of the various strategies available for use in order for them to apply them effectively. Using bar modeling representations to decode word problems may help students to understand the underlying structure of the mathematics problem and make it easier for them to interpret a complex word problem and choose an appropriate operation to solve it. Students taking part in regular practice and being taught mnemonics are other simple and reliable ways of helping the students to recall the appropriate strategy to use when problem solving. In addition to teaching metacognition, these approaches may as well help the teacher identify weak and struggling students who can be given further assistance.

The second objective sought to determine the relationship between mathematics anxiety and mathematics test performance among secondary school students in Kakamega County. The results revealed that increase in mathematics anxiety significantly impacted mathematics test performance negatively. This means that students who experience high mathematics anxiety before or during the test are more likely to perform poorly as compared to their counterparts who experience low anxiety. As Gina (2018) reported, a learner's performance in a task is greatly influenced by their level of anxiety towards that task. Students therefore need to remain relaxed as they take their mathematics test so as to keep their anxiety levels down. This may be achieved by the teacher helping them to adequately prepare during their study time. Good and timely preparation instills proper confidence among the students. Encouraging students to have positive self-talk can also boost their positive mental attitude towards mathematics. A student who has low anxiety but harbors a negative attitude towards mathematics may not perform favorably in a mathematics test.

The third objective sought to test for differences in metacognition and mathematics anxiety due to gender among secondary school students in Kakamega County. The results suggested that although there were differences in anxiety due to gender, these differences were not statistically significant. More boys reported lower anxiety towards mathematics than girls did. As previous studies have shown, Delgado and Kassim (2019) and Suren and Kandemir (2020) reported that females experience more anxiety when facing a mathematics test than males. However, their studies did not find these differences statistically significant. It may be concluded that incorporating teaching of metacognition in mathematics lessons could help improve students' ability to solve mathematics problems, which in return may reduce their anxiety during a mathematics test. A program such as bar modeling helps to simplify complex contextual word problems to the easy comprehension of the learner. These programs should be designed should then be designed in a way to improve the student visualize what the mathematics problem is asking thus putting the student in a better position to decide on the best strategy to use in solving it. Such interventions may motivate more students to shed off the fear for mathematics which brings about anxiety when they are sitting for a mathematics test.

The fourth objective sought to find out if there were differences in students' metacognition and mathematics anxiety due to age among secondary school students in Kakamega County. The findings indicated that metacognition improves with age and that older students showed lower anxiety towards mathematics as compared to their younger counterparts. This may be explained by the thinking that older students may have achieved a higher brain development capacity which enables them effectively handle other intervening factors better than their young counterparts. Such factors may include but not limited to behavior regulation and positive self-talk which eventually helps them lower their anxiety when facing a difficult task. The expected age for a form three student is 16 – 17 years. Students above this age could have either started school late or repeated classes. This may have given them an opportunity to have a longer exposure in mathematics classes and solving mathematics problems hence giving them a wider interaction with the strategies used. Wanting to avoid the embarrassment of being outshined by the younger students may also be a reason for them to be motivated in working hard and scoring better marks than the younger students.

The fifth objective sought to determine the relative predictive weights of metacognition and mathematics anxiety on mathematics test performance among secondary school students in Kakamega County. The findings showed that these two variables strongly predicted mathematics test performance among secondary school students. The interaction between the two predictor variables (metacognition and mathematics anxiety) revealed that in addition to being aware of the various strategies and using them effectively to solve mathematical problems, students also need to have a low anxiety towards mathematics in order for them to perform favorably in the tests. It can be concluded that when students are relaxed during a test, they exude a desirable confidence in themselves which helps them initiate their thinking capabilities to recall various strategies and be able to utilize them in problem solving. Highly anxious students however, have their thoughts thrown into disarray thus making them unable to think properly and experience difficulty in trying to recall the best strategies that may be appropriate for different mathematics problems. This in turn brings a sense of helplessness, fear and disappointment which further makes their problem-solving experience more difficult and unsuccessful. This elevates their anxiety levels and enhances the vicious cycle.

The researcher therefore concludes that gender of students does not have a significant influence in their performance in mathematics. From the findings, it is also concluded that children starting school earlier than the recommended start age may have a detriment on their performance especially in mathematics. This has been shown by the results from the study where older students, both in the co-educational schools and either the boys only or girls only schools scored higher in mathematics test as compared to their younger counterparts.

5.4 Recommendations

The findings of this study carry a varied number of implications for students, educators and education policy makers for secondary schools in Kenya on how metacognition and mathematics anxiety play a role in determining students' performance in mathematics test. The research thus made the following recommendations for policy and further studies.

5.4.1 Policy Recommendations

i. The first objective of the study was to establish the relationship between metacognition and mathematics test performance. Findings revealed that there was indeed a positive and significant relationship between the two variables. It is therefore recommended that the teaching of metacognition may be included in mathematics curriculum. Training materials may be developed to assist the teachers train their students on metacognition and how to apply it in solving mathematics problems.

ii. There is need to train teachers on metacognition. The study may therefore recommend for an in-service course on metacognition for secondary school teachers and a course for teachers in training to equip them with necessary skills to teach their students.

iii. Female students in co-educational schools had lowest metacognition and highest anxiety towards mathematics levels than their male counterparts in same schools. However, female students in girls only schools showed higher metacognition and low anxiety levels than those in co-educational schools. This may suggest that female students can perform better when they are in girls only schools, being cognizant of the fact that other variables not investigated in this study may have played a role. The study therefore recommends that students in co-educational school could be assisted in building up their confidence towards mathematics so that they can reduce the level of anxiety they feel whenever solving mathematics problems.

iv. Students are able to handle anxiety and fear that may arise while sitting for a mathematics test may also better their chances of performing better in the tests. This study thus recommends that schools may have scheduled group and individual academic counseling sessions to help all students to inculcate in themselves positive views about mathematics and other subjects. During such sessions, students will be guided on how to use different strategies when responding to mathematics problems and questions of other subjects advancing their attitudes towards mathematics and in turn reducing their anxiety. This will call for employing more guidance and counseling teachers to be able to offer professional educational counseling services to the students.

5.4.2 Recommendations for further research

The study makes the following recommendations for further research.

i. The current study used self-report questionnaires to investigate the relationship between metacognition and mathematics anxiety towards mathematics test performance. Further research could use different research design such as experimental or quasi experimental so as to allow for the researcher to determine cause and effect patterns of the independent and dependent variables.

ii. The current study drew its sample from the public secondary schools only. Further research may consider drawing a sample from both public and private schools and also from different systems of education.

iii. The findings of the study showed that metacognition improves with age. Further research may be done using a longitudinal cohort survey to investigate how a group of students advances in metacognition as they advance in age.

iv. Results of this study were based on a sample drawn from secondary school students. Further studies with samples from primary schools, mid-level colleges and universities could be used to interrogate metacognition and mathematics anxiety among students.

v. The study investigated metacognition and mathematics anxiety among students. Further research may be done to investigate the same variables among school teachers of mathematics.

vi. The current study used only two sub-scales of metacognition in its investigation. It is therefore recommended that further study be done using all the three sub-scales of metacognition (metacognitive awareness, metacognitive strategies and metacognitive experiences) and how their different components and characteristics influence the performance of a student.

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APPENDICES

APPENDIX A: Consent to Participate in the Study

LETTER SEEKING CONSENT FOR STUDENTS' PARTICIPATION

Vincent M. Andaya
Department of Educational Psychology
Kenyatta University
P/O Box 43844-00100
Nairobi
16th June, 2019

Dear Student,

I am a student in the Department of educational Psychology at Kenyatta University. Currently I am undertaking a study on mathematics test performance among secondary school students. The findings of this study will help improve mathematics performance of students and thus boost their overall academic performance. You are one of the schools that I have identified for this study. The purpose of this letter is to request you to participate in the study which will involve solving mathematical questions and answering some questions on mathematics problem solving. All these will be done during the normal lesson time.

Kindly sign in the space below if you accept to participate in the study. Thank you for your kind consideration.

Yours faithfully,

Vincent M. Andaya

I …………………………..…………………………….. agree to take part in the study.

APPENDIX B: Mathematics Test

Part I

1. Gender: Male ☐ Female ☐
2. Age: 13-14yrs ☐ 15-16yrs ☐ 17-18yrs ☐ Above 18yrs ☐
3. School: Boys boarding ☐ Girls boarding ☐ Mixed day ☐

Part II

School: ………………………………………………………………………… Date: …………………

TIME: 30 Min

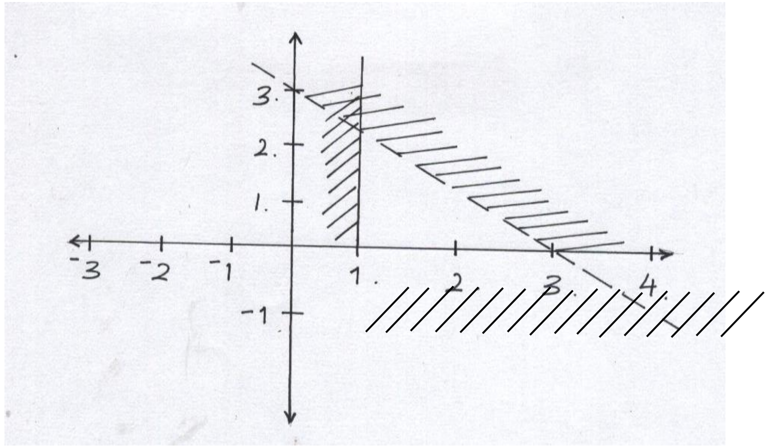
<u>INSTRUCTIONS</u>

1. Write your details in the spaces provided
2. Show all your working in the provide spaces
3. Marks will be awarded for the correct method even if the answer is wrong
4. Answer all questions in the spaces provided

1. Use logarithm tables to evaluate:- (4 marks)

$$\sqrt[3]{\frac{12.3 \times 0.089}{7.654}}$$

2. Determine the inequalities that represent and satisfies the unshaded region (3mks)



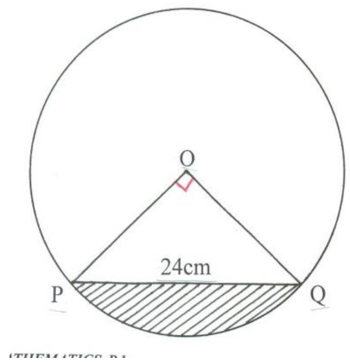
3. The interior angle of a regular polygon is 9 times the exterior angle. How many sides does the polygon have? (3mks)

4. Simplify the expression $\frac{x^2 + 3x+2}{x^2- 1}$ (4mks)

5. Find the equation of the line in the form y = mx + c that passes through the point (4, 6) and is perpendicular to the given line.

(2 marks)

6. In the figure below O is the centre of the circle. ∠ POQ = 90^0 and PO = 24cm.



(a) The area of sector POQ . (3 marks)

(b) The area of the shaded region. (2 marks)

7. During a certain ceremony, goats and chicken were slaughtered. The number of heads for both goats and chicken was 45. The total number of legs was 100. Determine the exact number of goats and chicken slaughtered. (4mks)

8. The table below shows the marks scored by 40 students in a test.

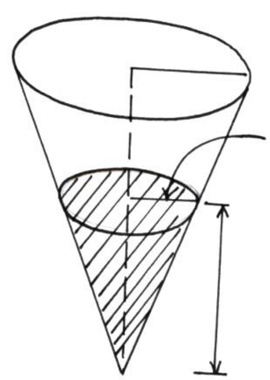
Marks	10-19	20-24	25-29	30-34	35-39	40-49
Frequency	3	4	7	10	9	7

(a) State the modal class (1mk)

(b) Calculate the mean mark. (5mks)

(c) Calculate the median mark (4mks)

9. The figure below shows a cone with water filled as shown.



21cm

30cm

(a) Calculate the volume of water in the vessel. (2mks)

(b) When a metal hemisphere is completely submerged in the water, the water level rose by 6cm.

Calculate:

(i) the radius of the new water surface. (2mks)

(ii) the volume of the metalic hemisphere leaving your answer to 4sf.

(4mks)

10. Momanyi bought a second hand car and later sold it through a sales agent who charged 7 ½ % commission on the price of the car, He received sh. 222,000 from the agent after the latter had deducted his commission. Momanyi incurred a loss of 25% on the price at which he had bought the car.

a) If the amount Momanyi paid for the car was 26 % less that the price of the new car, calculate the price of the new car. (3mks)

d) Express as percentage the amount Momanyi received for his car to its price when New. (2mks)

APPENDIX C: Metacognitive Awareness Inventory **(**MAI**)**

INSTRUCTIONS: This is a questionnaire to find out how different people approach their learning and study habits. Each item consists two responses either True or False. Please tick the one you strongly believe to be the case as far as your personal feelings are concerned. This is not an examination hence there is no right or wrong answer.

No.	**Item**	**TRUE**	**FALSE**
1	I am a good judge of how well I understand something		
2	I find it difficult to motivate myself to learn when I need to		
3	I try to use strategies that have worked in the past		
4	I am not sure what the teacher expects me to learn		
5	I learn best when I know something about the topic		
6	I rarely draw pictures or diagrams to help me understand while learning		
7	I ask myself if I learned as much as I could have once I finish a task		
8	I ask myself if I have considered all options when solving a problem		
9	I rarely think about what I really need to learn before I begin a task		
10	I seldom ask myself questions about how well I am doing while I am learning something new		
11	I find it difficult to focus on the meaning and significance of new information		
12	I learn more when I am interested in the topic		
13	I use my intellectual strengths to compensate for my weaknesses		
14	I do not have control over how well I learn		
15	I rarely ask myself periodically if I am meeting my goals		
16	I find myself using helpful learning strategies automatically		
17	I ask myself if there was an easier way to do thing after I finish a task		
18	I rarely set specific goals before I begin a task		

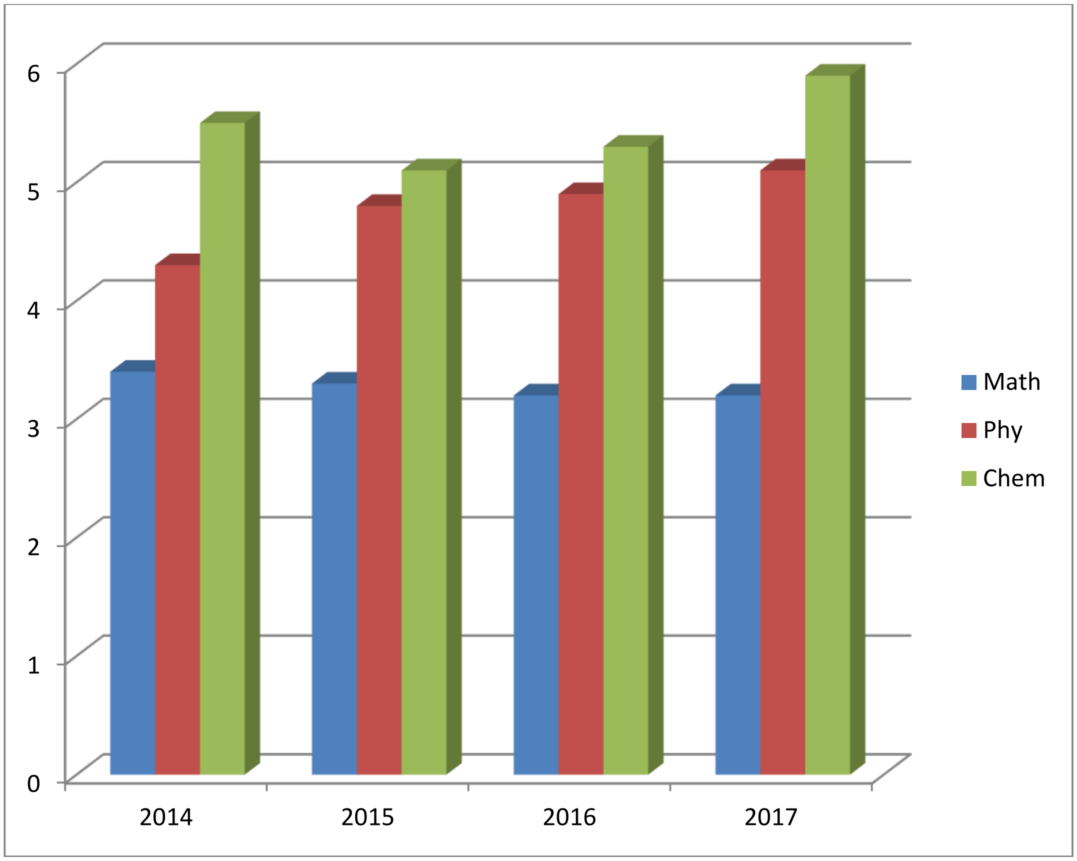
APPENDIX D: Mathematics Anxiety Questionnaire **(**MARS**)**

INSTRUCTIONS: This is a questionnaire attempts to find out how mathematics test may have affected you. Each item consists five responses from Strongly Disagree (SD) Disagree (D) Neutral (N) Agree (A) and Strongly Agree (SA). Please tick the one you strongly believe to be the case as far as your personal feelings are concerned. This is not an examination hence there is no right or wrong answer.

No.	Item	SD	D	N	A	SD
1	While taking an important math exam I find myself thinking of how much brighter the other students are than I am					
2	If I were to take a math test I would worry a great deal before taking it					
3	If I knew I was going to take a math test I would feel confident and relaxed beforehand					
4	While taking an important math exam I sweat a lot					
5	During math examination I find myself thinking of things unrelated to the actual course material					
6	I panic when I have to take a surprise math exam					
7	During math tests I find myself thinking of consequences of failing					
8	After important math test I am frequently so tense that my stomach get upset					
9	I freeze up on math test especially for final exams					
10	Getting good marks on one test doesn't seem to increase my confidence on the following test					
11	I sometimes feel my heart beating very fast during important math tests					
12	After a math test I always feel I could have done better than I did					
13	I usually get depressed after a math test					
14	I experience an uneasy upsetting feeling before taking a math exam					
15	When taking a math test my feelings do not interfere with my performance					
16	During a math exam I frequently feel so nervous that I forget facts I really know					
17	The harder I work at taking a math test or studying for one the more confused I get					
18	As soon as a math exam is over I try to stop worrying but I just cant					
19	I wish math exams did not bother me so much					
20	I think I could do much better in math if I could take them alone and not feel pressure by a time limit					
21	If math exams could be done away with I think I would actually learn more					

22	During math exam I decide that if I don't know it now there is no point worrying about it					
23	I really don't see why some people get so upset about math tests					
24	Thoughts of doing poorly interfere with my math performance					
25	I don't study any harder for final math exams than for the rest of other math tests					
26	Even when I'm well prepared for a math test I feel very anxious about it					
27	Before an important math exam I find my hands or arms trembling					
28	I less often feel the need of cramming before a math exam					
29	The schools should know that some students are more nervous than others about math tests and this affects their performance					
30	Math exams are tense situations					

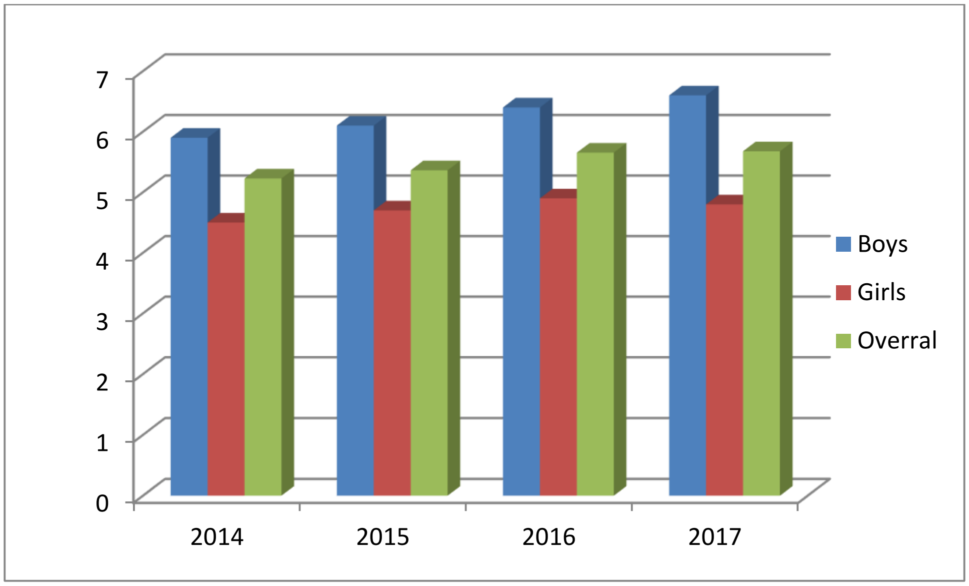
APPENDIX E: Mean Score of Common Subjects



Graph showing mean score for 3 common subjects done by KCSE students for the recent 4 years in Kakamega County

Ministry of Education Science & Technology, MOEST, (2014; 2015; 2016; 2017)

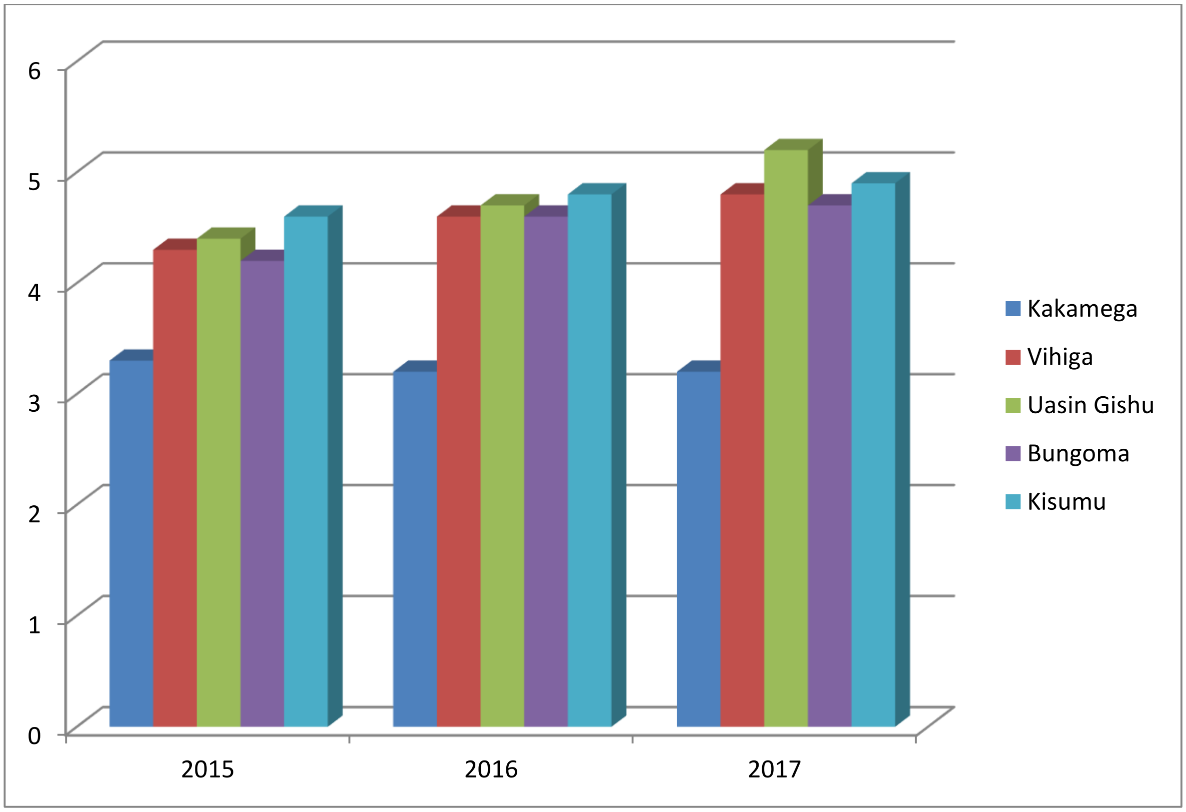
APPENDIX F: Comparison between Boys And Girls Performance



Graph showing a comparison of girls versus boys' performance of mathematics in Kakamega County for the recent 4 years.

MOEST (2014; 2015; 2016; 2017)

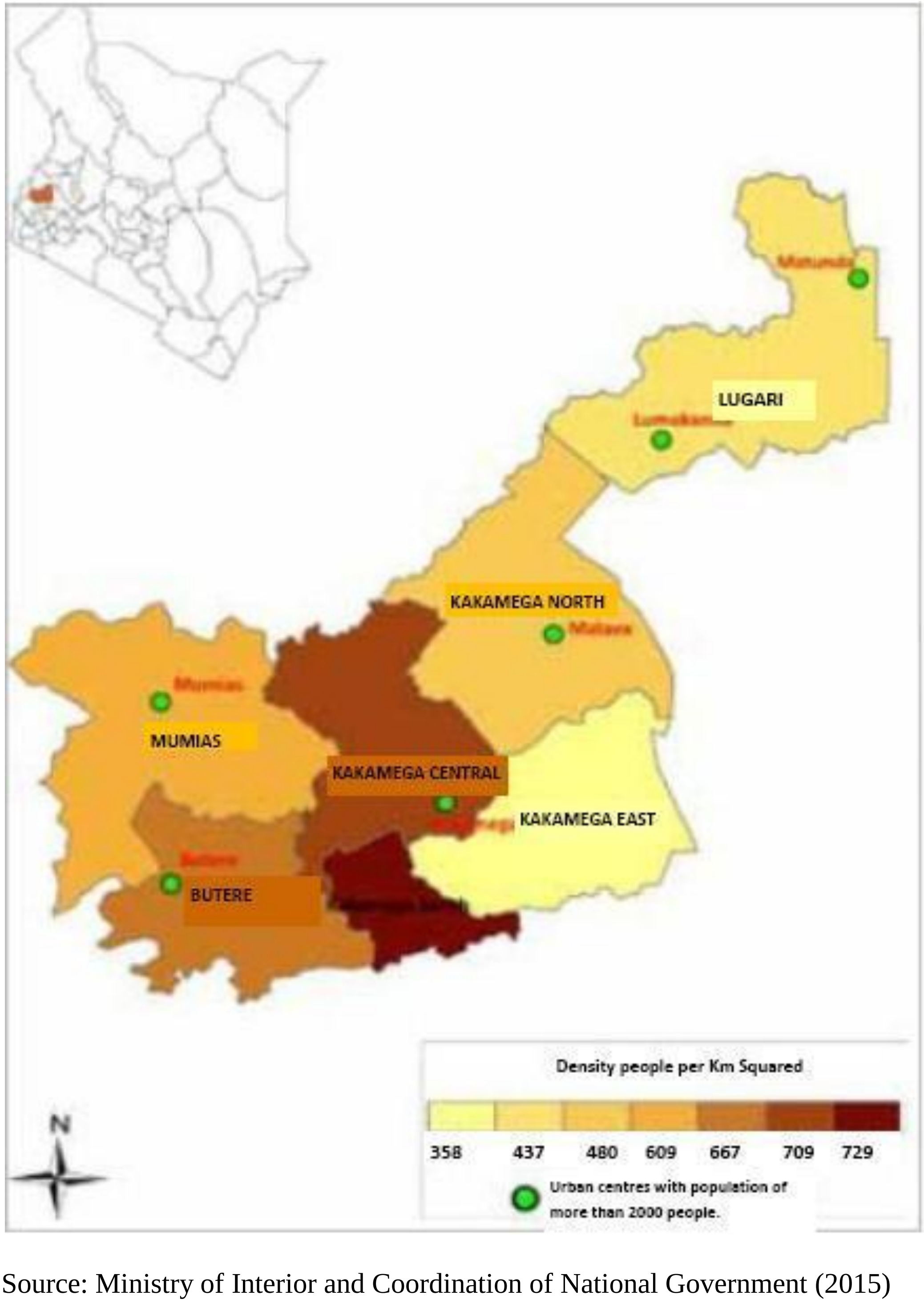
APPENDIX G: Comparison of Performance In Mathematics Among Several Counties



Graph showing a comparison of performance in mathematics in between Kakamega County and other counties for the recent 3 years.

MOEST (2015; 2016; 2017)

APPENDIX H: Map of Kakamega County



Source: Ministry of Interior and Coordination of National Government (2015)

APENDIX I: Research Authorization

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

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

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

Ref: No. **NACOSTI/P/19/9796/29426**

Date: **24th April, 2019**

Vincent Maganga Andaya
Kenyatta University
P. O Box 43844-00100
NAIROBI

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Metacognition and Mathematics anxiety as predictors of Mathematics test performance among Secondary school students in Kakamega County, Kenya)"*** I am pleased to inform you that you have been authorized to undertake research in **Kakamega County** for the period ending **23rd April, 2020.**

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

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

GODFREY P. KALERWA MSc., MBA, MKIM
FOR: DIRECTOR-GENERAL/CEO

Copy to:

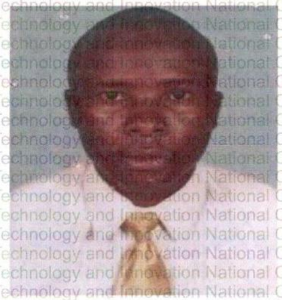
The County Commissioner
Kakamega County.

The County Director of Education
Kakamega County.

APPENDIX J: Research Clearance Permit

THIS IS TO CERTIFY THAT:
MR. VINCENT MAGANGA ANDAYA
of KENYATTA UNIVERSITY, 0-100
Nairobi,has been permitted to conduct
research in *Kakamega County*

Permit No : NACOSTI/P/19/9796/29426
Date Of Issue : 24th April,2019
Fee Recieved :Ksh 2000



on the topic: *METACOGNITION AND MATHEMATICS ANXIETY AS PREDICTORS OF MATHEMATICS TEST PERFORMANCE AMONG SECONDARY SCHOOL STUDENTS IN KAKAMEGA COUNTY, KENYA*

for the period ending:
23rd April,2020

....
Applicant's Signature

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

THE SCIENCE, TECHNOLOGY AND INNOVATION ACT, 2013

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

CONDITIONS

1. **The License is valid for the proposed research, location and specified period.**
2. **The License and any rights thereunder are non-transferable.**
3. **The Licensee shall inform the County Governor before commencement of the research.**
4. **Excavation, filming and collection of specimens are subject to further necessary clearance from relevant Government Agencies.**
5. **The License does not give authority to transfer research materials.**
6. **NACOSTI may monitor and evaluate the licensed research project.**
7. **The Licensee shall submit one hard copy and upload a soft copy of their final report within one year of completion of the research.**
8. **NACOSTI reserves the right to modify the conditions of the License including cancellation without prior notice.**

National Commission for Science, Technology and innovation
P.O. Box 30623 - 00100, Nairobi, Kenya
TEL: 020 400 7000, 0713 788787, 0735 404245
Email: dg@nacosti.go.ke, registry@nacosti.go.ke
Website: www.nacosti.go.ke

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEARCH LICENSE

Serial No.A 24244

CONDITIONS: see back page

+

APPENDIX K: Clearance to Conduct Research by Ministry of Education

MINISTRY OF EDUCATION

STATE DEPARTMENT OF EARLY LEARNING AND BASIC EDUCATION

Telephone: 056 – 30411
Fax : 056 – 31307
E-mail : wespropde@yahoo.com
When replying please quote

COUNTY DIRECTOR OF EDUCATION
KAKAMEGA COUNTY
P. O. BOX 137 - 50100
KAKAMEGA

REF: KAK/C/GA/29/17 V/23

19th June, .2019

Vincent Maganga Andaya
Kenyatta University
P. O. Box 43844 - 00100
NAIROBI

RE: RESEARCH AUTHORIZATION

The above has been granted permission by National Commission for Science, Technology and Innovation vide their letter Ref: NACOSTI/P/19/9796/29426 dated 24th April, 2019, to carry out research on "**Metacognition and Mathematics anxiety as predictors of Mathematics test performance among Secondary school students in Kakamega County, Kenya**", for a period ending **23rd April, 2020.**

Please accord him any necessary assistance he may require.

COUNTY DIRECTOR OF EDUCATION
KAKAMEGA COUNTY

DICKSON O. OGONYA
CDE/CEB – SECRETARY
KAKAMEGA COUNTY

CC
The Regional Director of Education
WESTERN REGION

APPENDIX N: Authority to Conduct Research in Kakamega County

REPUBLIC OF KENYA

THE PRESIDENCY

MINISTRY OF INTERIOR & CO-ORDINATION OF NATIONAL GOVERNMENT

Office Mobile No: 0707 085260
Email-cckakamega12@yahoo.com

When replying please quote

Ref No: ED/12/1/VOL.IV/156

COUNTY COMMISSIONER
KAKAMEGA COUNTY
P O BOX 43-50100
KAKAMEGA.

Date: 19th June, 2019

VICENT MAGANGA ANDAYA
KENYATTA UNIVERSITY
P O BOX 43844-00100
NAIROBI

RE: RESEARCH AUTHORIZATION

Following your authorization vide letter Ref: NACOSTI/P/19/9796/29426 dated 24th April, 2019 by NACOSTI to undertake research on ***"Metacognition and Mathematics anxiety as predictors of Mathematics test performance among Secondary school students in Kakamega county, Kenya ."*** I am pleased to inform you that you have been authorized to carry out the research on the same.

S. WANJALA
FOR: COUNTY COMMISSIONER
KAKAMEGA COUNTY