EFFECTS OF LABORATORY METHOD ON MATHEMATICS PERFORMANCE AND MOTIVATION AMONG SECONDARY SCHOOL STUDENTS IN KAPSERET SUB COUNTY, KENYA

BY

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DECLARATION

Declaration by the Student

This thesis is my original work and has not been submitted for any academic award in any institution and shall not be reproduced in part or whole or any format without prior written permission from the author and the University of Eldoret.

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DEDICATION

The work is dedicated to my mother, Winnie Rono, and my father, Joseph Rono, who has been my biggest inspiration, support sources, and rock-solid pillars throughout my life.

ABSTRACT

According to the Kenya Institute of Curriculum Development's 2010 recommendation, all secondary school students require mathematics. The absence of a Mathematics laboratory is one of the factors contributing to Mathematics' persistence and poor performance. Based on this problem, this study used a quasi-experimental research methodology to investigate the impact of the Laboratory method on Mathematics achievement and motivation. The objectives of this study were to determine the effects of laboratory methods on secondary school students' Mathematical performance, the impact of laboratory techniques on students' motivation to learn Mathematics in secondary schools, and the challenges faced by Teachers of Mathematics when implementing laboratory methods in secondary school Mathematics teaching and learning. Relevant literature was sought regarding performance, motivation, and challenges for students and teachers using the laboratory method. The study tools used were pre-test, post-test non-equivalent group experimental design, questionnaires, and an interview schedule. The study's population was comprised of students from 156 secondary schools in Uasin Gishu County. Twenty six Schools were chosen from 156 schools using stratified random sampling. Participants in the study were selected from Form 2 students. A sample size of 298 students, 26 teachers and ten heads of the mathematics department (HOD) representative of the research population was selected using simple random and purposive sampling. The experimental and control groups were created using the Solomon Four-Group design for the investigation. While the control group used a conventional educational style, the experimental group used a laboratory-based instructional strategy. The respondents were divided into four groups, two of which were observed and two of which were controlled. The identical material regarding reflection and congruence was taught to each group. However, groups 1 and 3 were taught using the laboratory approach, whereas groups 2 and 4 were conducted using the conventional way. Before beginning the laboratory technique treatment, groups 1 and 3 had preliminary testing. Data were gathered using questionnaires, interviews, and the Mathematics Achievement Test 1 and Mathematics Achievement Test 2. SPSS aided the data analysis. Chi-square tests were employed to identify associations, and a t-test was used to compare the results of laboratory and conventional approaches. The study's findings show that the laboratory approach stimulates students' attention, increases their engagement, improves their performance, enables them to gain the skills they need for more advanced study research, and fosters the growth of their scientific thinking. The study suggests that teachers should employ the laboratory method, which guarantees that students are more engaged and involved in Mathematics activities and that teachers should be taught to use the laboratory method.

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LIST OF ACRONYMS

KCSE	Kenya Certificate of Secondary Education
MAT	Mathematics Achievement Test
NACOSTI	National Commission for Science and Innovation
SCDE	Sub County Director of Education
SPSS	Statistical Package for Social Sciences
UG	Uasin Gishu
UoE	University of Eldoret

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CHAPTER ONE

INTRODUCTION

1.1 Introduction

This chapter provides a review of the background of the study, the statement of the problem, the purpose of the study, the objectives of the study, the research question, the hypothesis, significance and justification of the study. The scope of the study will also be addressed together with the limitations of the study, assumptions, theoretical framework, conceptual framework, and the operational definitions of terms used.

1.2 Background of the Study

Maass, Geiger, Ariza, and Goos (2019) believe mathematics is the fundamental building block of science and technology. Sah (2016) states that mathematics studies quantity, structure, and change, including geometry, algebra, and analysis. The Greek term "mthma" (which denotes learning, study, and science) is where the name "mathematics" originates (Sah, 2016). According to Van den Heuvel-Panhuizen and Drijvers (2020), teaching mathematics is the sequential process of imparting and acquiring mathematical information and knowledge. By employing effective teaching techniques and resources, mathematical concepts are transmitted through this process from a more familiar person to a less knowledgeable person, from a teacher to a student and from educators to learners (Van den Heuvel-Panhuizen & Drijvers, 2020).

Learning new mathematical information or knowledge is a process that happens when students (learners) process it in a way that makes sense to them in their frame of reference, which is in their inner worlds of memory, experience and response (Rach & Ufer, 2020). Mathematics is one of those subjects that must be taught through doing rather than reading and reciting; otherwise, it causes problems in teaching and learning. The practice of mathematics necessitates the use of adequate tools and resources. It can be adequately addressed using laboratory techniques and mathematics laboratories (Sah, 2016). There are numerous issues with mathematical education. Such cases may be connected to administration, students, teachers and classroom management (Hoy & Weinstein, 2013). Every branch of science and technology, as well as commercial organizations can succeed with the help of Mathematics. The core of modern science is Mathematics, just like it is for computer science, information technology, computer engineering and other related fields (Nkirote & Thinguri, 2020).

According to Asad, Muhammad, Rasheed, Chethiyar and Ali (2020) and Nkirote & Thinguri (2020), it is a subject that enables a learner to have a proper understanding and interpretation of broad principles in science and technology, which results in technology. According to the 2010 recommendation of the Kenya Institute of Curriculum Development, it is an examinable subject for all students. Nearly all jobs and professions now require the study of Mathematics. According to Asad *et al.* (2020), Mathematics is necessary for all major occupations nowadays. Some specializations include engineering, accounting, drug development, economics, banking, and technology. Mathematics is essential for analyzing, associating, and evaluating the knowledge required to generate fresh opinions in services, diligence, and other mortal setups. A country must pay attention to Mathematics to advance scientifically and technologically (Nkirote & Thinguri, 2020).

Mathematics is a requirement for secondary education in Kenya and it is crucial for careers in the sciences, including Engineering, Pharmacology, Environmental Science and Technology. Both internal exams and the Kenya Certificate of Secondary Education have often shown poor Mathematics performance (Ochieng, Kiplagat & Nyongesa, 2017). According to KNEC (2021), Mathematics scores have historically lagged behind those in other science courses. According to Galadina (2002), students consistently do poorly in internal and external Mathematics tests (Desoete, Baten, Vercaemst, De Busschere, Baudonck, & Vanhaeke, 2019; Njoroge, 2022). The research of Hassler Hallstedt, Klingberg & Ghaderi (2018), which supports these findings, also adds that educational tools like school laboratories are crucial since literacy develops creatively via investigation, discovery and environmental engagement.

In Vision 2030, the Kenyan government has extensively acknowledged the value of Mathematics in STI (science, technology and invention). The Kenyan government has set out to develop Mathematics to attain its science, technology, and invention aim by 2030. The only way to make Mathematics teaching and learning realistic, interesting, and engaging, according to Hwa (2018), is to use instructional aids and enjoyable activities that students love. To promote a learner-centered approach, Mathematics laboratories should also be built in schools and furnished with the necessary and sufficient tools or resources to allow all learners to use them.

Mathematics teaching and learning are intended to be improved by laboratory teaching strategies (Salami, Bello, & Ibrahim, 2021). Teaching science, technology, and mathematics without laboratories and workshops where these disciplines are practiced, in Ihendinihu's opinion (2020), would never provide a complete understanding of the fundamentals of these sciences. It was seen as crucial since it instructs in observation, offers thorough information, and piques students' interests. It is also a better approach for getting students involved in the learning process and somewhat stimulating them than discussions or expository methods, which turn students into passive recipients of knowledge (Salami *et al.*, 2021).

Science and mathematics are the two subjects where the laboratory method is most frequently employed nowadays (Nicolete et al., 2017). In the laboratory technique, students work in small groups to conduct their own hands-on laboratory exercises. This approach enables pupils to gain knowledge of the facts through first-hand experiences. According to Nicolete et al. (2017), a mathematics laboratory is a space with a variety of tools and teaching/learning aids that are necessary to assist students understand the concepts through engaging in practical, meaningful activities. In order to explore the world of mathematics, learn about it, discover it, and grow an interest in it, the teacher or the pupils might engage in these activities.

The mathematics laboratory, as described by Adenegan (2003), is a special room or location, with current and relevant tools known as instructional materials, designated for the teaching and learning of mathematics and other scientific or research work, where a trained and professionally qualified person (mathematics teacher) can easily interact with learners (students) on a predetermined set of instructions.

A proper environment is needed for such a phenomenon change in mathematics teaching, and it is unquestionably a mathematics laboratory (Hattie, Fisher, Frey, Gojak, Moore & Mellman, 2016). Teaching mathematics should focus on processes rather than just transferring knowledge from the teacher's mind to students' notebooks through the tip of a pen. According to the laboratory approach, the experiment's origin in mathematics should be acknowledged. This implies that some material should be provided so the students can experience the value of mathematics. It is also important to note that laboratory experiments in mathematics have two main goals: to apply previously learned material or to create new mathematical puzzles to be studied (Mwila, Mangwatu, Lufungulo, Mugala, Namuchana, Chinemerem & Siampule, 2022). However, the genuine mastering of experiment in the laboratory calls for practice with mathematics.

Science and mathematics are the subjects where the laboratory technique is most commonly utilized. Students use their hands-on laboratory activities to conduct laboratory experiments as part of the laboratory method in small groups (Corter, Esche, Chassapis, Ma & Nickerson, 2011). Hands-on learning enables students to get familiar with the information (Corter *et al.,* 2011). Researchers, students and scholars can experiment and explore patterns and ideas in the mathematics laboratory. Various games, puzzles and other teaching and learning resources can be found there (Maschietto & Trouche, 2010). The resources are designed to be utilized by students independently and in collaboration with their teacher to explore the world of mathematics, learn about it and take an interest in it (Maschietto & Trouche, 2010). The activities stimulate students' or anybody else's curiosity in exploring and testing some of their ideas and views about mathematics.

According to Njoroge (2022), problem-solving methods, such as using a laboratory to teach and learn Chemistry, can help students improve their ability to communicate, work in a team, and access and utilize knowledge. The laboratory is highly helpful in subjects like Biology, Chemistry and Physics since it allows students to engage in practical activities, which inspires them to learn more (Affeldt, Tolppanen, Aksela & Eilks, 2017). Slieman & Camarata (2019) defined five categories of academic objectives that can be met by including the laboratory in science teaching. These objectives were skills in manipulation, enquiring minds, research, planning and communication; concept of mastery, which had thesis, theoretical model and taxonomic; development of cognitive capacities with abilities in problem-solving skills, application, analysis, and synthesis, understanding the nature of science. Also, scientific endeavors, scientists and their methods, the reality of a diversity of scientific approaches, interactions between science and technology, and relationships among the various scientific disciplines and finally development of scientific attitude including a desire to learn, an interest in taking chances, objectivity, perfection, self-assurance, persistence, satisfaction and responsibility.

Slieman & Camarata (2019) provide eight additional components of scientific attitudes that can be fostered in the school's science laboratory. Curiosity, objectivity, intellectual honesty, rationality, willingness to put aside judgment, modesty and reverence for life are some of them. It is therefore predicted that laboratory methods should also be used in the teaching and learning Mathematics.

At the moment, Mathematics students are not taken to laboratories. The majority of learning is theoretical with a few practical components, and it often takes place in classrooms where teachers assign homework that students typically complete at home with the assistance of their parents or guardians. The study suggests employing practical tools to help students learn and grasp concepts better. A laboratory setting is typically used for Physics, Biology, and Chemistry classes. In that case, the benefits of laboratories can be achieved in mathematics as well as described by Slieman & Camarata (2019). According to Njoroge (2022), the Mathematics laboratory exhibits Mathematical data, provides quick access, eliminates abstraction, and fosters more efficient teaching and learning.

Students can learn and explore Mathematical generalities in the Mathematics laboratory, where they can verify various Mathematical facts and theories using a variety of activities and resources (Evans *et al.*, 2022; Njoroge, 2022; Slieman & Camarata, 2019). According to Gamage *et al.* (2020), a laboratory is a physical space for carrying out scientific trials as part of teaching, practice, or research with students. Bellingham says a laboratory room is a unique teaching space created or provided with specialized equipment for students to engage in learning activities, including scientific or practical experimentation. It is a space or building designed for conducting experiments, particularly under controlled conditions.

The laboratory is a corrective environment where students of all socio-economic backgrounds and abilities can engage in active sensory experiences that lead to the emergence of concepts (Katsaros-Molzahn, 2018; Okeke & Okigbo, 2021). It is a location where the necessary Mathematical knowledge and abilities are gained. It draws on the concepts of learning by doing and learning by observation, shifting from concrete to abstract, according to Hassler Hallstedt *et al.* (2018) (Hall-Powell, 2022). Students will develop concepts in Mathematics by practical application of real-world materials in Mathematics laboratory instruction (Okeke & Okigbo, 2021).

The traditional definition of motivation states that it is the act of being moved to act (Hall-Powell, 2022). Motivation is a crucial concept for understanding behavior and the duration and intensity of involvement (Nkirote & Thinguri, 2020; Schiefele & Schaffner, 2015). It is regarded as one of the cornerstones of a learner's willingness (Schiefele & Schaffner, 2015). The premise that engaging in practical tasks boosts motivation is supported by empirical research (Fischer et al., 2019; Wambu & Fisher, 2015). Because learning by doing promotes motivation, Mathematics should be taught practically using a laboratory approach. The laboratory is useful for fostering students' positive attitudes and giving them a platform to hone and show off their practical talents in real-world chemistry projects (Salame & Makki, 2021).

Practical activity will help improve students' scientific knowledge, experience, skills, and enjoyment (Lee & Sulaiman, 2018). All of these will improve students' ability to solve problems and comprehend concepts (Lee & Sulaiman, 2018). Thus, it is necessary to reinforce practical activity in order to alter students' perceptions of learning physics. Additionally, doing practical work gives students a chance to expand their constructivist learning opportunities (Umar, Ubramaniam, & Ukherjee, 2005). By engaging in practical work in a school laboratory, students' knowledge can be expanded to grasp the real world (Millar, 2004). The mastering of concepts is motivated and stimulated by practical practice for students (Johnstone, 1997).

Students' enthusiasm, interest, and academic success are also created and boosted by practical work done using the laboratory technique (Lee & Sulaiman, 2018). As in mathematics, it fosters opportunities for active teaching-learning in chemistry (Okam & Zakari, 2017). Additionally, the laboratory teaching approach puts students in a serious learning setting (Amunga, Amadalo, & Musera, 2011), takes charge of the learning process Musasia *et al.* (2012), and helps them gain a deeper knowledge of the actual tasks required.

Teaching science, technology, and Mathematics without laboratories and workshops where these disciplines are practiced can never give a complete understanding of these subjects' fundamentals, claim Hernández-de-Menéndez *et al.* (2019). According to Evans *et al.* (2022), the Mathematics skills needed by today's young people and adults to function in the job differ from those required by yesterday's youth and adults. According to 21st-century pedagogy, teaching methods prioritizing student engagement are necessary to advance education (Schiefele & Schaffner, 2015).

As a result, the laboratory method promotes student engagement, and students who can interact, exchange and apply information to solve Mathematical problems are more likely to succeed.

According to Hwa (2018), secondary school students hoping to become Mathematicians or continue to technical schools should use the Mathematics laboratory technique. Principal observers in Mathematics for the West Africa Examinations Councils (WAEC) in 2003, 2004, 2005, and 2006 often noted candidates' inability to correctly answer nearly all general Mathematics problems. As a result, reflection and congruence must be taught using a student-centered method to promote effective learning and exemplary performance in Mathematics.

It appears that even teachers do not comprehend the need for Mathematics laboratories, as Menéndez *et al.* (2019) demonstrated. There is a misconception that laboratories are only for (Biology, Chemistry, and Physics). However, Menéndez et al. (2019) and Evans et al. (2022) show that these subjects help students understand the principles, and the skills they learn will be helpful in the workplace of the future. The research has demonstrated the significance of these laboratories in helping students own their communication and teamwork abilities through lesson plans or teaching aids. According to the study, students do better when using laboratory techniques instead of conventional ones.

From the cited literature information on the mathematics laboratories has been outside the Kenyan territory though major finding in Kenyan has been on biology, chemistry and physics. The researcher found no literature on laboratory method of teaching in

Kenya and particularly in the study area. The study area was chosen due to poor performance as indicated by Kapseret Sub-County KCSE performance for the years (2017-2021) as shown in table 3.1. The researcher aims was to demonstrate if laboratory method can help in improving mathematic performance which has been proven in the table 4.10 on the findings.

1.3 Statement of the Problem

According to the Kenya Institute of Curriculum Development (2010), all primary and secondary school pupils must take Mathematics. Most scientific disciplines, including engineering, environmental sciences, and medicine, depend heavily on Mathematics. It is also utilized in other art related courses, such as economics, business management, accountancy, banking and technology. According to Gamage *et al.* (2020), Mathematics is the cornerstone of learning in the sciences and the arts. Science and technology are built on the principles of Mathematics, and Mathematics serves various functions in science and technology that apply to all fields of study and business (Okeke & Okigbo, 2021). Mathematics is an essential subject in the school curriculum and a vital source of knowledge and skills used in daily life, assert Desoete *et al.* (2019).

The persistent low performance in Mathematics-oriented courses, particularly in higher institutions, worries Mathematics educators, researchers and policy makers worldwide (Desoete *et al.*, 2019; Evans *et al.*, 2022; Njoroge, 2022). Students need more practical applications and adequate skill and knowledge acquisition to improve their Mathematics class performance, which demotivates them from continuing their studies (Lave, 2021). Mathematics laboratory instruction can help students create concepts through experience with material things (Okeke & Okigbo, 2021).

The Kenya Certificate of Secondary Education has historically needed improvement in Mathematics performance despite the subject's prominence. In the National Examination this is clear. Poor performance has been contributed by teaching mathematics using conventional methods. Teaching science, technology, and Mathematics without laboratories and workshops where these disciplines are practiced won't ever result in a solid understanding of these subjects' fundamentals, claims Hall-Powell (2022). In secondary schools, where there is no Mathematics laboratory, the laboratory method is not used to teach Mathematics; instead, it is only considered for other science subjects, which is one of the reasons for low achievement in Mathematics (Okeke & Okigbo, 2021).

According to Maass *et al.* (2019), there is plenty of evidence that a lack of a Mathematics laboratory and a lack of usage of laboratory techniques by teachers of Mathematics are essential factors in secondary school students' poor Mathematics performance. In Kapseret Sub-County KCSE performance for the years (2017-2021) has shown poor performance of mathematics among students. The average score for the four years has been a D minus. Teaching of mathematics has been done using convention methods where a teacher provides instruction to students and there no laboratory practical work for the students. Therefore, this study aimed to ascertain how the laboratory approach affected secondary school students' Mathematics performance and motivation in Kapseret Sub County, Kenya.

1.4 Purpose of the Study

This study aimed to ascertain how laboratory method affects students' motivation and performance in Mathematics. The study was conducted in Kapseret Sub County, Kenya

1.5 Objectives of the Study

1.5.1 Main Objectives

Assessing the effects of laboratory method on mathematics performance and motivation among secondary school students in Kapseret Sub County, Kenya

1.5.2 Specific objectives

The study explored the following objectives;

i. To determine the effects of laboratory methods on Mathematics performance among secondary schools students in Kapseret Sub County Kenya.

ii. To establish the effect of laboratory method on students' motivation in Mathematics in Secondary Schools of Kapseret Sub County Kenya.

iii. To establish the challenges faced by teachers of Mathematics in using laboratory methods in teaching and learning Mathematics in Secondary Schools.

1.6 Research Questions

The research questions were used because it was more of a description and not a comparison of it

i. What are the effects of laboratory method on students' motivation in Mathematics in Secondary Schools of Kapseret Sub County, Kenya?

ii. What challenges do teachers face in using the laboratory method in teaching and learning Mathematics in Secondary Schools?

1.7 Null Hypothesis

The study used the null hypothesis because it was testing differences between different groups used and thus the following null hypothesis was used

i. Ho_1. There is no significant difference in performance when the laboratory and conventional methods are used in teaching and learning Mathematics.

The use of both research question and hypothesis was to test significant difference between laboratory method and conventional method for objective one. The research question was used to gauge the level of understanding of the respondents regarding the laboratory method and conventional methods, their views and challenges; it was used for objective two and three.

1.8 Justification and Rationale of the Study

The use of laboratory methods in teaching mathematics is one of a kind in Kenya. The current study has been among pioneer in this field and has provided evidence of the importance of laboratory methods. Previously Mathematics has been taught using conventional methods and most studies have shown a poor trend in performance. Still, few studies have suggested a pedagogy change in teaching the subject. Thus, the laboratory method is essential in comparing findings between the two processes. The experiment aimed to support those who had written on the value of such incorporation for student achievement. The conclusion has demonstrated that such incorporation boosts student performance; hence, school management are advised to invest in such facilities.

1.9 Significance of the Study

The Ministry of Education (MoE) may use the findings to create appropriate efforts to improve secondary school students' Mathematics performance. To generate lesson plans, textbooks, and recommendations for integrating the laboratory method in the Kenyan secondary schools, curriculum designers need to understand the benefits and challenges of employing the technique. This study's findings will aid in this endeavor. The results will be helpful to Mathematics educators who can use the method to train Teachers of Mathematics, who can then use it in different schools to raise Mathematics achievement.

The study's conclusions might improve administrators' and teachers' understanding of how to teach Mathematics using a laboratory approach. Additionally, since they are motivated, students who would have benefited from this method may use it in other areas and subjects, improving their overall performance.

1.10 Assumptions of the Study

The study assumed that the students and teachers provided accurate and honest answers. The data was believed to be measurable and regular; sampled schools followed the Mathematics Syllabus provided by the Kenya Institute of Curriculum Development.

1.11 Scope of the Study

The study was only conducted in secondary schools in the Kapseret Sub County of Uasin Gishu County. The study examined the effects of the laboratory method on secondary school students' motivation to learn Mathematics, their performance in form two classes and on the reflection and congruence topics, and the challenges

Teachers of Mathematics encounter when implementing the laboratory method in those classrooms. Participants in the study were limited to teachers of Mathematics and form two secondary school students.

1.12 Limitations of the Study

The study anticipated that using questionnaires to gauge students' motivation would not accurately reflect students' motivation since they do not allow for probing inquiries or a way to gather non-verbal clues. To overcome this restriction, the researcher interviewed teachers to determine their thoughts on students' interest in Mathematics lessons.

The Quasi Experimental technique is challenging to implement when students share the same environmental settings. This could lead to a possibility of them sharing notes and then failing to answer questions honestly. This limitation was circumvented by using different schools for the treatment group and other schools in each category for the control group.

1.13 Theoretical Framework

Constructivist theory, credited to Swiss psychologist Jean Piaget, describes how learners assimilate knowledge and serve as the foundation for this study (Devi, 2019). The theory holds that accommodation reshapes one's internal perception of the outside world to accommodate new experiences. According to Piaget, people assimilate new experiences into preexisting frameworks without modifying those frameworks through the processes of accommodation and assimilation.

According to Karantalis and Koukopoulos (2022), the foundation of constructivism is the observation and study of how people learn. They argued that experiences are the best way to learn about and understand the world. Consequently, a constructivist approach to learning in the classroom can suggest a variety of different teaching strategies, such as encouraging students to use active learning techniques (experiments, real-world problem solving) to increase their knowledge and then to reflect on and discuss what they are doing and how their understanding is developing..

Suhendi (2018), who argues that a critical premise of Piagetian constructivism is that it presupposes that learners' are exposed to various hands-on experiences where they understand what they do and are fit to construct new knowledge positions, agrees with this. The teacher comprehends the student's lingering generalizations and guides the activity to address and expand upon them. Forming inferences, reflecting on their learning, and observing conflict requires active participation from the students. When this occurs, Suhendi (2018) refers to it as "meta-cognition," where learners become aware of their cognitive processes.

Constructivist theory informs a variety of instructional strategies. They typically argue that a hands-on approach to learning is the most effective. Learners must be taught what will happen when they learn by doing and can conclude by making judgments and findings. This theory's premise will make it possible to investigate how the laboratory approach impacts student achievement and motivation to learn Mathematics.

The result of human interaction with the environment is knowledge. According to Karantalis and Koukopoulos (2022), constructivists concur with this and stress that people derive meaning from their interactions with others and their surroundings. Suhendi (2018), Learners actively engage in Mathematics using the laboratory method. In the laboratory, learners can acquire skills and knowledge. The theory applies to the study since group projects and collaboration encourage peer knowledge sharing more than standard teaching techniques.

According to Karantalis and Koukopoulos (2022), constructivism helps people build their knowledge and understanding of the world through experiences. The theory offers direction on the best approach for information retention. It serves as a solid theoretical underpinning for the current study, which focuses on utilizing the laboratory method to enhance students' performance.

1.14 Conceptual framework

According to this study, the realization of good performance in Mathematics and the Motivation to learn Mathematics is depended upon the independent variables and it is influenced by intervening variables as follows:

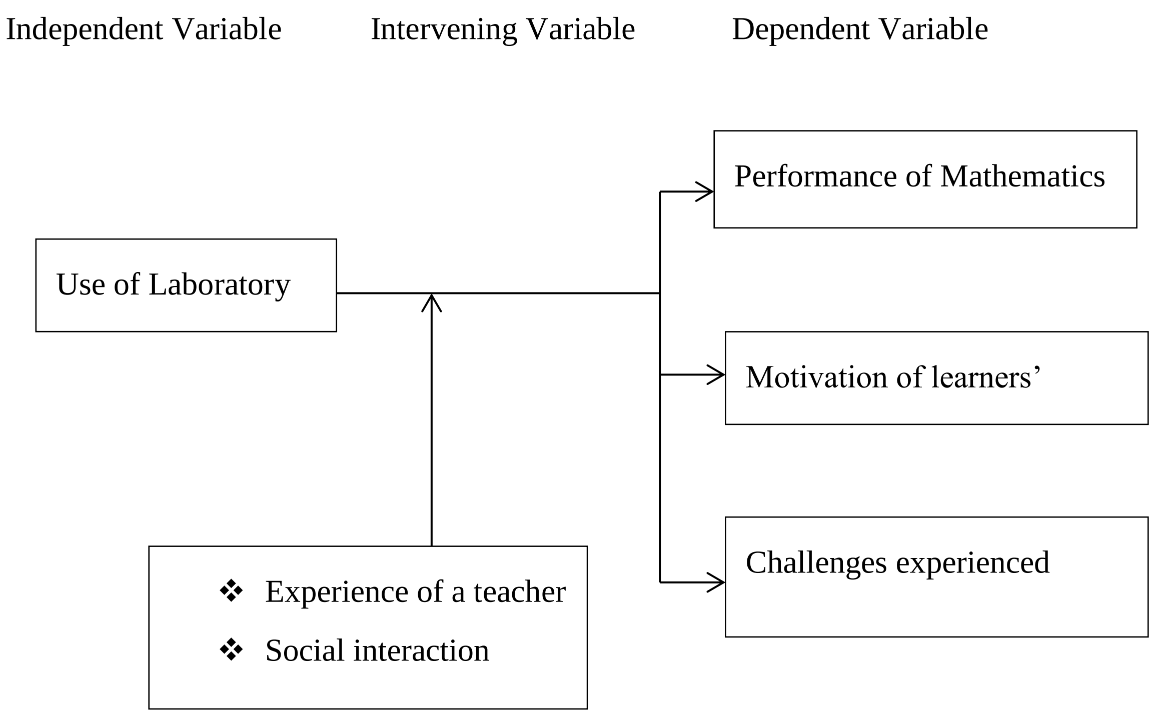

Figure 1.1: Conceptual framework

The effects of adopting the laboratory method refer to students using a practical way to learn Mathematics and their favorable impact on Mathematics performance and learning motivation. Thus, when teaching and understanding Mathematics, the students should have the chance to complete practical. Both students and teachers must be interested in the laboratory methods for them to be successful, and there must be enough teaching aids and physical Mathematics laboratories to make them work.

As a result of their expertise in Mathematics, teachers used teaching aids during laboratory practical after induction. They limited their social connection with students so that they could solve problems and learn from one another. Teachers were needed after that for clarification by students on topics under study. The student's social interaction was controlled using different schools for control and treatment. The experience of a teacher is likely to influence how a teacher presents the concept which in turn affects students' level of understanding and motivation. To control this, the study sought to determine the experience of all the teachers involved. It was determined that the experience of teachers was evenly distributed in control and the experimental groups, therefore canceling the effect of the teachers' experience in the final results of the two groups.

The laboratory method will aid in ensuring improvement in mathematic performance as students can grasp the concept well, discuss it among themselves, and, if a topic is challenging to comprehend, seek further clarification from the teacher. This motivates the student to learn and explore more about mathematics and reduces negative attitudes toward it as a complex subject. Adopting the new teaching method could be easily overcome when students are well motivated, and teachers are willing to teach using the method.

1.15 Operational Definition of Terms

The following terms were used in the study:

The laboratory method - refers to how students learn Mathematics by carrying out Mathematical practicals in a laboratory. This study focused on “reflection and congruence,” The practical activity involved; labeling, drawing, measuring, observation, sketching, recording, and reflecting practically in a room.

Mathematics performance– scores of examinations obtained by learners subjected to lessons in Mathematics theory and practical based on secondary school Mathematics curriculum.

Motivation – According to this study, motivation refers to the characteristic that pushes students' interest levels and willingness to engage and perform Mathematical practicals or activities.

The conventional method- The "chalk and talk" method, which is frequently used, incorporates direct instruction from the teacher, whose primary responsibility is to impart knowledge to students and carry out testing and assessment.

Laboratory challenges- These are hindrances when using a laboratory method

1.16 Chapter Summary

The study aimed to determine how Mathematics laboratory benefit Mathematics in general. Thus, the research questions generated guided the research during the study. In general, chapter one introduces the study problem of the lack of a Mathematics laboratory and its effect on the student's performance and motivation in learning Mathematics in Kapseret Sub-County, Uasin-Gishu County.

A summary of the reasoning, assumptions, conceptual framework, restrictions, and study scope is also provided in this chapter. Additionally, operational explanations of words were delivered to draw the reader in and make it apparent what information was being communicated.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter discusses the research done to ascertain the effect of laboratory procedures on secondary school students' Mathematical aptitude and motivation. It addresses the impact of laboratory methods on Mathematical performance, the development of laboratory methods on secondary school students' basis to learn Mathematics and the difficulties Teachers of Mathematics encounter when implementing laboratory methods in the teaching and learning Mathematics. According to this literature evaluation, the laboratory technique should be considered when assessing students' motivation and proficiency in Mathematics.

2.2 Laboratory Facility

According to Adeoye and Papoola (2011), access to the information and resources learners need is a prerequisite for learning. To ensure some level of performance, they must engage with both material and intangible resources. Therefore, learning sciences must include learner-centered hands-on activities. The student works in a unique space known as the laboratory. This space is always equipped with the scientist's or students' tools. Piaget (1971) observed that students can solve issues they ordinarily cannot answer when they use concrete materials. These resources must be available in sufficient quantities in schools for pupils to excel in science.

In all nations, the purpose of laboratory education needs to be reevaluated, according to Ogunniyi (2009). Given the inefficient use of laboratory equipment and facilities in many nations, it is a waste of time and resources to support the creation and provision of conventional laboratory facilities without thoroughly analyzing proposed initiatives before funding. The laboratory setting is appropriate for active and collaborative learning (Hass, 2000). Hass adds that active participation in laboratory activities increases comprehension of the concepts covered in lectures. Additionally, by promoting student interaction throughout the completion of practical activities, the lab can be improved even more. Hass continues by saying that laboratory exercises improve students' problem-solving skills while also assisting them in understanding ideas.

School laboratory activities have a unique potential as a medium for learning that can support significant science learning outcomes for children, claims Hofstein (2004). Additionally, laboratory activities offer a distinctive learning environment distinct from those found in classrooms when other teaching methods are used. Hofstein also discovered that the distance between the actual and preferred learning environments was lower for students exposed to a laboratory learning setting, making them more flexible and conceptually integrated.

The science teacher lacks the opportunity to teach and mentor students if the laboratory isn't set up or stocked with the necessary equipment. The lack of these resources could impact students' interest in, enrollment in, and performance in scientific classes. This supports Lunetta's (2007) claim that science performance in Taita, Taveta, Kenya, was negatively impacted by laboratories with insufficient resources. Despite this, researchers discovered a lack of laboratories in Nigerian schools (Speering & Rennie, 2013). They noted that numerous schools lacked the necessary laboratory infrastructure. As a result, students frequently struggle in the laboratory since their teachers cannot conduct practicals as they would like to, which always has an unavoidable impact on students' learning (Tytler, 2010).

These lab facility constraints may seriously impact the quality of educational output. All of these demonstrate the value educators place on science laboratories in classrooms. This significance motivated the researcher to investigate the availability of science laboratories in secondary schools, especially in teaching mathematics, and its influence on student performance, motivation, and challenges in the Kapseret sub-county in Uasin Gishu county Kenya.

According to research, science laboratories are essential for secondary school science teaching (Leithwood, 2004). According to the study, laboratories serve as the scientists' workrooms where practical exercises are carried out to improve their understanding of scientific theories and concepts (Hofstein, 2004). They have also been discovered vital for developing students' formal reasoning abilities and comprehension, improving desired learning outcomes (Kwan & Texley, 2003). Schools with more excellent teaching facilities do better than those with less, according to Aderomu and Obafemi (2015). Aderomu and Obafemi (2015) found that access to a well-equipped laboratory considerably positively impacted students' academic success in chemistry, biology, and physics. However, such facilities do not exist for mathematical subjects, especially in Kenya.

2.3 Laboratory method

Olufunke, Awolowo and Blessing (2014) noted that the teaching method is a significant determinant of achievement in physics, as presentation is critical to content acquisition and retention. According to Joshi (2008), a unique instructional strategy and an essential element of effective science education is the laboratory style of instruction. This approach does not involve lecturing or experiment demonstrations from the teacher in charge. Instead, the students are urged to experiment to extract scientific laws and principles.

The students are provided with all the tools and supplies they'll need in the lab and the proper instructions to conduct their independent experiments. The observations are noted and conclusions are drawn from them. It allows students to participate in the process and develop an appreciation for scientific procedures while assisting them in comprehending complex abstract concepts. He believed that as students learn via experience, observation, testing and verification, the knowledge and skills acquired through the laboratory approach are more durable and permanent.

According to Agwagah (2008), using conventional methods on scientific students results in poor concept creation, decreased attention and retention, and low performance overall. This necessitates the employment of the laboratory teaching approach, one of the modern instructional strategies that might assist students to achieve more and encourage the retention of their psychomotor abilities in biology. Akuto, Aduloju, and Odeh (2012) define the laboratory teaching method as a procedure where students come into close contact with the concepts or processes they are studying. This covers any activity that puts pupils in actual settings with real materials and functional equipment.

According to Pareek (2019), a laboratory is a physical space furnished and equipped to conduct scientific experiments for students' practice, instruction, or study. According to Pareek, a laboratory room is a unique learning environment created or furnished with special equipment enabling students to engage in learning activities, including scientific or practical experimentation. It is a space outfitted for experiments and scientific study, particularly in a controlled environment (Salami, Bello, & Ibrahim, 2021).

The mathematics laboratory is a mainly furnished space in a building where mathematics instruction or activities are regularly held. It can also be a small area of a typical classroom with tables and equipment. Many young brains realize that mathematics is more than just practicing addition and subtraction problems that the teacher provides in Olatunde (2010), which contains a collection of teaching aids for student manipulation (Omere & Ogedengbe, 2022). Simply put, a mathematics lab is where students interact with actual items to make learning easier (Ihendinihu, 2020). Mathematical laboratories should be used for teaching mathematics, according to the researchers Manjunath (2008).

A method of instruction known as the "mathematics laboratory approach" allows students to work informally, move around, engage in discussion, and select their tools and strategies for solving problems. According to Kunwar (2020), an assignment or test, Yeasmin (2016) quoted Aristotle's statement that thinking is complex without images. Due to the potential for students to engage in various hands-on activities, laboratory work is quite significant (Salami *et al.*, 2021). Numerous studies have examined how well students' grasp of scientific topics is improved by laboratory teaching. Additionally, many researchers think that doing laboratory work encourages conceptual shift. It entertains and inspires students (Yeasmin, 2016); Sunday, Akanmu, and Fajemidagba (2017).

Additionally, according to Eshiet (1996), adequate laboratory facilities make teaching chemistry in secondary schools more engaging and entertaining while improving students' academic achievement. Lagoke (1997) adds that for students to comprehend scientific concepts, laws and theories, science education needs to be built on the learner's prior knowledge and skills. Because of this, the quality of the laboratories used for science pedagogy contributes to developing values and abilities that enable the learner to make decisions.

Furthermore, Abuseji (2007) suggests that practicals be included in the study of the subject. This is so that students won't be taken into any existing depilation, if there is any, due to insufficient laboratory infrastructure. Because of this, greatness in science and technology can only be attained by good science instruction, which can be accomplished by fusing theory with practice. The report advises the need for well-furnished laboratories with necessities like power and running water. Sam (2009) concluded that the infrastructure in most public secondary schools, both in urban and rural locations, is frequently under stress due to a lack of or incomplete laboratory equipment.

Although the science laboratory has been assigned a unique position in science education in Israel, Hofstein and Mamlok-Naaman (2007) discovered that research has not been able to establish clear links between activities in the laboratory and students' learning. They concluded that meaningful learning in the lab is feasible, provided students can work with tools and materials to build their understanding of scientific phenomena and related ideas.

The laboratory is a corrective environment where students of all socioeconomic backgrounds and abilities can engage in active sensory experiences that lead to the emergence of concepts (Salami *et al.,* 2021). It serves as a hub of resources for math education. It is founded on the idea that learning occurs best when experiential and emerges through observation (Salami *et al.,* 2021). Students participate in discovering mathematical linkages and properties in laboratory instruction (Sunday *et al.,* 2017). When they gather equipment, play games, do experiments, or measure objects, students using this method must use some thought.

By incorporating experiences and practices in the study of mathematics and its relevant applications, facilities are provided that encourage student participation in the research of mathematical applications (Salami et al., 2021). The lack of a mathematics laboratory is one of the factors contributing to low math achievement (Mwila et al., 2022). Mathematical laboratories can be used strategically and intelligently to address the issue of ineffective instruction (Mwila et al., 2022). Maschietto and Trouche (2010) state that mathematics laboratory instruction helps students build concepts through hands-on interaction with real-world materials. Okigbo and Osuafor (2008) assert that a mathematics laboratory presents mathematical data, provides a means of simple access, eliminates abstraction, and fosters more efficient teaching and learning.

Festus (2007) emphasizes how problem-based learning techniques can help students improve communication, teamwork, knowledge access, and application skills. One example is using a laboratory to teach chemistry. Therefore, Bond-Robinson advises the method's adoption as one of the fundamental approaches to teaching chemistry in secondary schools.

According to Yara (2011), resources, tools, and relevant products are crucial to a practical science curriculum. This observation agrees with Owoeye (2011) and Nwoye (2012), who concur, that fusing theory with practical work boosts learners'' interest as they are forced to engage in beneficial scientific activities and experiments personally. They continue by saying that validating a scientific hypothesis, law, or principle is necessary. Additionally, knowledge gained through laboratory work helps to improve long-term memory. According to Aina (2012), the laboratory has been given a crucial and distinct place in science instruction. The use of laboratory activities as a science laboratory setting in students who can work in small groups to examine scientific occurrences has been suggested by science educators as having rich learning benefits.

To assess the technology of science laboratories and the technology of science instruction in schools, Bello (2012) suggests giving good management and laboratory techniques a high priority. This will allow for the development of a system that improves comprehension, thinking, production, and problem-solving within human and material resource constraints. Ojimba (2013) asserts that pupils learn more from scientific lessons when they can practice what they are learning rather than just being allowed to observe.

2.3.1 The laboratory method in Africa

According to Konyango *et al.* (2018), the existing 8-4-4 educational system mandates that students be appropriately taught the three science topics of Biology, Physics, and Chemistry. The specified subjects' syllabi provide sufficient practical exercises for forms one through four. Similarly, the final exams for the topics also include a thorough practical exam (Mukami, 2009). As a result, the teaching and learning processes require that students become adept at the courses' theoretical and practical aspects. Most valuable work can only be completed in the laboratory; however, some practical tasks can be completed in the classroom or outside. This is so because the activities need equipment, chemicals and other supplies found only in laboratories (Twoli, 2006).

According to Weber and Fukawa-Connelly (2023), the best way to learn mathematics is by practice rather than reading. Students learn Mathematical facts through laboratory or activity methods (Jumayeva *et al.*, 2021). Its foundation is that learning occurs best when it is experiential, observational, and moves from the concrete to the abstract. It merely represents the inductive method's expansion. Students behave practically after hearing the knowledge as well as after listening to it. Most teachers and students do not comprehend the purpose of Mathematics laboratories; they know they are designed for Biology, Chemistry and Physics. Through students' enhanced performance compared to conventional techniques, the study has demonstrated the value of laboratories in Mathematics instruction. It has also helped me learn through peer-to-peer teamwork in problem-solving, enhancing knowledge sharing among students instead of teacher-student knowledge sharing.

According to Edomwonyi-Otu and Avaa's (2011) study in Nigeria, one of the students stated that he was supposed to be a science student but that his school lacked a laboratory and that the only experiment he had completed before the final exam was a short pendulum in Physics, which caused him to fail Chemistry. Furthermore, at the same institution, several students denied the existence of a laboratory, claiming that it was still under construction and that no practical work had ever been done since science was provided. Teachers at the same school reported the presence of a temporary, inadequately equipped laboratory (Hernández-de-Menéndez *et al.*, 2019). Students were, therefore, unable to focus during practical sessions due to the unfavorable environment. Most students believed they would have performed better if they had been exposed to practical learning earlier. The study was more based on assumptions, as students assumed they could have done better when laboratory methods were incorporated into their studies. The study may be biased as there is no empirical evidence to back up the students' claims.

Mathematics laboratory instruction will help students build concepts through hands-on interaction with real-world materials (Okeke & Okigbo, 2021). The importance of laboratory work cannot be overstated because it allows students to engage in various hands-on activities and develop the necessary skills (Hernández-de-Menéndez et al., 2019). Numerous studies have examined the impact of laboratory education on students' comprehension of science concepts in general. Additionally, according to multiple types of research, laboratory work encourages conceptual transformation, motivates students, and is interesting for them (Njoroge, 2022; Okeke & Okigbo, 2021; Prayogi & Yuanita, 2018). Through interaction, when working together, the learners can realize that Mathematics is not as tricky a subject as perceived. Thus, they are motivated to learn Mathematics, which improves their performance.

Omike (2021) assertions that schools without laboratories where students can perform Biology, Chemistry, and Physics practicals will end up producing or graduating students who do not understand the science practicals necessary to pass the senior academy instrument exam set by the West African Examination Council (WAEC) and the National Examination Council (NECO). As a result, these kids would not meet the requirements for professions in science-related fields like engineering, agriculture, or medicine. In this regard, laboratory work in Mathematics should be done to give students the necessary practical skills (Evans *et al.,* 2022; Njoroge, 2022).

Gamage *et al*. (2020), Hwa (2018), and Okeke & Okigbo (2021) all observe the fact that using Mathematics laboratories helps to integrate theory and practical work in Mathematics teaching and learning. According to Desoete et al. (2019), Mathematics laboratories communicate Mathematical content, offer easy access, do away with abstraction, and enhance efficient teaching and learning. Okeke and Okigbo (2021) listed several causes for pupils' poor performance, such as society's belief that Mathematics is difficult, a shortage of qualified teachers, a lack of laboratories, and a lack of incentives.

2.3.2 The use of laboratory method in Kenya

According to Hassler Hallstedt *et al.* (2018), Maass *et al.* 2019, and Nkirote & Thinguri (2020), a Mathematics laboratory is a setting where students can investigate Mathematical objects, forms, and symbols to learn and verify Mathematical truths and theorems through a range of activities utilizing diverse materials. Teachers and students can carry out these activities to study, learn, pique curiosity, and foster a positive attitude toward Mathematics (Eyong et al., 2020). The student's perception of Mathematics will affect their desire to learn. Using audio-visual resources to teach Mathematics will make the class more engaging since it gives students a chance to communicate and exchange ideas with one another, which motivates them.

According to Omike (2021), multimedia allows pupils to express their thoughts to others and comprehend a topic in various ways. Children who love problem-solving and feel accomplishment or enjoyment after completing a challenging problem are considerably more likely to persevere, try again, and even look for new difficulties (Brennan, 2021). According to Donohoo *et al.* (2018), belief in one's capacity to act is linked to that capacity. According to McCulloch et al. (2018), a teacher should prepare the lesson using various tools, including computers, calculators, pictures, and pictorial models and manipulations. The instructor should also use creativity to design environments that will motivate students and teachers throughout the teaching-learning process for Mathematics. Better documentation is required for Kenya's Mathematics laboratory.

2.4 The use of laboratory method on Mathematics performance

Students who learned science utilizing the laboratory instructional strategy did better than those who learned it using the traditional lecture and textbook method, according to research by Okeke and Okigbo (2021). According to Gamage *et al.* (2020), Mathematical laboratory oratories should be moderately equipped. According to Budai & Kuczmann (2018), there are several benefits to using a Mathematics laboratory, including;

- Mathematical data should be displayed.
- Practical work as a platform for exploration
- Mathematical resources are stored in a pool for convenient access.
- Eliminating abstraction and boosting efficient teaching and learning.

A Mathematics laboratory, in the opinion of Hadar and Tirosh (2019) and McCulloch et al. (2018), is a setting where students can learn and explore Mathematical concepts and put theories and facts about Mathematics to the test. Given the advantages of a Mathematics laboratory, it is anticipated that teaching and learning Mathematics in one will help to reduce the abstract nature of the subject and enable students to grasp concepts, which encourages them to view Mathematics as a subject that is not difficult and sparks their interest in learning it. The students will perform better and perform better. It is crucial to consider possible performance-improving tactics considering how they may affect Mathematics education. According to recent studies (Hadar & Tirosh, 2019; Hernández-de-Menéndez et al., 2019; Hwa, 2018), one of these ways is the usage of Mathematics laboratories.

According to Budai and Kuczmann (2018), a Mathematics laboratory is a tool for practicalizing Mathematics education. They note that this is because when you hear something, you forget it, see something, you remember it, and when you do something, you comprehend it. Therefore, teachers of Mathematics must promote "learning by doing" by utilizing the Mathematics laboratory technique, improving instruction during the teaching process, and encouraging student development.

Evans *et al.* (2022) and Hernández-de-Menéndez et al. (2019) demonstrated that the Mathematics Laboratory way of teaching and learning Mathematics was superior to the lecture method regarding student achievement. Similarly, Bastir et al. (2019) defined a Mathematical laboratory as a space where objects might be measured, joined, portioned, packaged, unpackaged, ordered, numbered, ordered, recorded, grouped, ungrouped, organized, re-arranged, mantled, and many other tasks. According to Maass et al. (2019), activities conducted in the Mathematics laboratory encourage students to appreciate and take pleasure in Mathematics, which supports this advocacy. The Mathematics laboratory improves students' capacity to complete their assignments and engage in activities that offer active Mathematical experiences using their senses (Das, 2019; Njoroge, 2022; Okeke & Okigbo, 2021). Hence, the Mathematics laboratory should be a focal point of all school Mathematics work.

According to Das (2019), secondary school teachers teach Mathematics concepts using conventional methods. This approach negatively affects students' academic progress in measurement, which necessitates conceptual mastery before computation. To enhance both the performance of the topic Reflection and Congruence and other Mathematical concepts, the laboratory technique should be used to teach it (Budai & Kuczmann, 2018; Hernández-de-Menéndez et al., 2019).

Understanding Mathematics and describing its value system about real-life problems and the development of the national economy will force students to organize their genuine potential and talents and nurture habits of hard work and high moral and ethical standards. Mathematical concepts should be taught and learned through practical application, investigation, and experimentation in a Mathematics laboratory (Das, 2019). Abstract ideas should be illustrated using concrete examples in the Mathematics laboratory. As a result, pupils may become more interested in arithmetic (Eyong *et al.,* 2020; Katsaros-Molzahn, 2018).

Researchers Evans *et al.* (2022) noted that pupils perform poorly in the topic because they are uninterested. Prayogi & Yuanita (2018) assert that teachers' motivation significantly impacts students' learning outcomes. According to Hwang et al., (2018) and Wambu & Fisher (2015), countries with poor teacher motivation and low teacher performance have resulted in subpar educational results. According to Okeke & Okigbo (2021), the issue of Mathematics students' low achievement can be resolved by using the Mathematics laboratory in a planned and logical way. In light of this, Hwang *et al.* (2018) suggested using the laboratory technique to teach Mathematics. Learning is monotonous and lacks incentive when it is done through drill and verbal recitation.

According to Schiefele and Schaffner (2015), the teacher's instructional strategies dramatically impacts students' ability to learn and engage in meaningful learning. When performing tasks, pupils engage less with one another and become more passive when learning strategies like lectures are used. According to Hwa (2018), the lecture method utilized in schools separates students from one another and contributes to the high failure rate in the sciences and Mathematics. According to Njoroge (2022), good improvements occur when a teacher adapts their teaching style to one that is more student-centered. So using a Mathematical laboratory is the right course of action.

According to Adeyemi (2008), a laboratory is crucial in establishing the caliber of a secondary school's production. Schools with laboratories consequently fare higher on exams. Adeyemi continues by stating that a lack of laboratory space could significantly impact the caliber of educational output. Therefore, secondary schools' lack of science laboratories and equipment significantly affects production quality.

2.5 The use of laboratory method on students' motivation

Another element that is crucial to students' learning in science classes is motivation (Bastir *et al.*, 2019; Das, 2019; Hall-Powell, 2022). According to Hwang et al. (2018), motivation significantly impacts students' learning outcomes. Students can be successful, study more, and learn more in school with the help of reason, which attempts to explain behavior and willingness in various activities (Desoete et al.,

2019) (Nkirote & Thinguri, 2020). The same motivation that plays such a significant role in science is present in Mathematics laboratories.

The teacher's teaching methods and delivery style influence the learner's performance and motivation in studying Mathematics. A lesson presentation is crucial to how well students absorb the material. The learner is more engaged with a lesson when it is provided from application to definition than when presented from description to application. Teachers' structure of studies might influence their pupils' attention and focus. According to Maass *et al.* (2019), a teacher's instructional tactics and approaches impact the pupils' academic achievement. According to McCulloch et al. (2018), Mathematics-phobic students blame their difficulties on how their teachers approach the topic.

Sabel (2006) claims that attitudes include how one feels, thinks, and behaves and upholding an expression of one's identity in the situation. Winston Churchill once stated, "Attitude is a little thing that makes a tremendous difference." Students' Positive or negative attitudes toward learning can affect how they feel about education. According to Hijazi and Naqvi (2006), determining a student's academic achievement can be challenging because it depends on several socioeconomic, psychological, and environmental factors. Since their attitudes about learning impacted how much they learned and desired to study, they needed to alter how they saw their academic success (Assem, Nartey, Appiah & Aidoo, 2023). Two actions must be taken to improve students' unfavorable attitudes toward learning: identifying the origins of those attitudes and employing that information to bring about change (Assem *et al.,* 2023).

Das (2019) contends that good resource management in the classroom keeps dropout rates in check, upholds student behavior, and keeps students engaged for extended periods. The availability of school supplies such as laboratories, classrooms, desks, seats, computers, textbooks, teachers, principals, school operating expenditures, and other teaching aids is essential for effective teaching and learning. Students with interesting, worthwhile, and pertinent activities are less likely to skip class, improving access and educational outcomes. Raw contends that for the teaching-learning process to be successful, these resources must be made available in schools in quality and quantity (Bastir et al., 2019; Das, 2019; Hall-Powell, 2022).

Musasia *et al.* (2012) highlighted practical experience as a determining element in physics learning. Students were split into two groups for the experiment. By offering the girls the chance to perform functional studies, the theoretical implications are made evident, and the girls' opinions of physics are modified. They concluded that the experimental group's attitude toward physics had changed significantly compared to the control group. This group was able to confirm the reported events independently. They had control over how quickly the practical moved along. The issue became understandable as soon as they realized they could negotiate meanings. Throughout the numerous experiments they underwent, this experience was repeatedly reproduced.

The control group wasn't exposed to the experiments in any more depth. Thus, they were still unclear about their purpose. The pace of the practical was under their control. The situation became apparent when they understood that they might conflate their meanings. This experience was repeated multiple times in the various studies they underwent. The control group didn't receive additional information regarding the research, so they were still unsure of their goal.

The new high school Mathematics curriculum, implemented in 2005, was viewed by McCulloch *et al.* (2018) as supporting various teaching methodologies. He asserts that utilizing different teaching strategies improves students' attitudes toward Mathematics. According to Hadar & Tirosh (2019), there is an association between a good attitude toward Mathematics and Mathematical success. Okeke and Okigbo's study from 2021 examines senior secondary schools in southwest Nigeria's Mathematics accomplishment levels and the suitability of the resource materials (Mathematics Laboratory) to be successful (Bastir *et al.*, 2019; Das, 2019; Hall-Powell, 2022).

According to attitude change research by Musasia *et al.* (2012), students' understanding of the subject improved as soon as they understood they could compromise on meanings. This experience was repeated multiple times in the various studies they underwent. Thus, altering one's mindset can affect knowledge of physics at any educational level and improve students' performance. Students must choose the conceptual understanding to apply to each more minor problem and the necessary unknown facts to complete each problem portion to answer a physics problem correctly.

The study found that out of 1750 senior secondary school students and 123 teachers of Mathematics mat chosen from 2 schools in the senatorial districts, (75%) had a positive perception of the need for a Mathematics laboratory, and students who used the laboratory performed better (65%) than those who did not. According to numerous researchers, laboratory work motivates and excites students (Fischer et al., 2019) and aids in conceptual shifts (Hernández-de-Menéndez et al., 2019). The study has found that employing a Mathematics laboratory to teach and learn Mathematics in Kenya produces successful outcomes and significantly inspires pupils to have a positive attitude toward learning arithmetic.

Jufrida *et al.* (2019) assert that their enthusiasm will decline if students hold unfavorable views about how physics influences society. If students don't understand the nature, benefits, beauty, and work that can be done by studying physics, their motivation to learn the subject will suffer. For physics to be more engaging for students, they must know its benefits. If students do not understand the nature of physics, it will not encourage the attitude of learning to study physics. According to Naki (2018), a student's views about physics, ideas about the subject matter, study habits, and propensity to continually put off tasks all significantly impact their performance.

2.6 The challenges faced by teachers of Mathematics in using laboratory methods

As teachers are interested in implementing the use of laboratory methods with the learners', there are some challenges that they encounter, and they include:

Inadequate teaching and learning resources: Most secondary schools in Kenya need more technical help, such as laptops, that could inspire students to learn independently. According to Njoroge (2022), the insufficiency of the tools and equipment used to teach Mathematics and the teachers' lack of expertise are to blame for the students' subpar performance. The development of information and communication technologies must be linked to Mathematics education (Das, 2019).

According to Katsaros-Molzahn (2018), the quality of education is enhanced not just by providing physical resources like textbooks and increasing not only by the amount of time teachers and students spend interacting but also by how they use the tools provided. Making the necessary resources available enhances the effectiveness of Mathematics lessons. These resources could include computers, realia, human resources, and teaching aids like models and wall charts.

Time constraint: As the topics to be covered in Mathematics are comprehensive, and the term dates have been condensed, the teachers are expected to complete the syllabus before they sit for their Kenya Certificate of Secondary Education. This has led to no use of laboratory methods (Field findings).

No Mathematics laboratory technicians in schools: most of our secondary schools have no Mathematics laboratory technicians. In such situations, teachers are forced not to use laboratory methods in teaching Mathematics (Field findings).

The pressure of conflicting parent and learner beliefs: Classroom procedures may be influenced by children's and parents' perceptions of the nature of Mathematics and Mathematics education (Bastir *et al*., 2019; Das, 2019; Hall-Powell, 2022).

> *Many parents have also used the traditional "drill and practice" or "chalk and talk" methods. Therefore, it is reasonable for parents and children to assume that effective Mathematics instruction involves memorizing facts and completing many worksheets. Furthermore, Hadar & Tirosh (2019) point out that, contrary to the reality of Mathematicians' highly collaborative practice, the general public views Mathematics as a solitary and "lonely enterprise."*

The possible influence of colleagues: Colleagues who firmly believe in the merits of traditional Mathematics instruction may dissuade teachers eager to implement the laboratory method in their education. Other problems can include students' perceptions that they are being taught to pass national exams, which prevents them from utilizing the practical approach (Mathematics Laboratory).

Since the approach is primarily considered and used in other science subjects like Physics, Biology, and Chemistry rather than in the teaching and learning of Mathematics in Kenya's educational system, the difficulties facing using the Mathematics laboratory method are rarely documented.

In a study titled "Study of Different Problems Faced by Students and Teachers in Learning and Teaching Mathematics and Their Suggestions Measures," Singha, Goswami, and Bharali (2012) examined these issues. They concluded that most problems are caused by big class sizes, a teachers' manual that is irrelevant to instructors' needs, a lack of instructional resources, insufficient teacher preparation, a lack of supervisory support, and a lack of physical facilities.

Sharma (2001) studied "The availability and use of instructional materials in teaching mathematics at the primary school of Parbat district of Nepal." He concluded that most schools did not find the availability of materials particularly encouraging, except for a few objects like meter scales, compasses, clock models, and abacuses. Poudel (2015) conducted a thesis titled "Problem Faced by mathematics teacher at higher secondary level" and concluded that the majority of teachers exhibited a lack of moral education, an administration-wide economic crisis, a lack of supervision, an inadequate learning environment, a lack of student awareness of mathematics class, a lack of appropriate lesson plans and materials, a lack of student participation, and a lackluster educational background. Teachers who were skilled and trained were not using their knowledge. There was a scarcity of mathematical conferences and seminars.

In a study titled "A study on problem faced by the mathematics students in the existing curriculum" conducted by Bhattarai (2005), the author concluded that there are numerous factors that interfere with secondary-level mathematics instruction, including a lack of adequate instructional materials, poor physical facilities, teachers' disregard for curriculum planning, and students' inadequate prior knowledge of the subject. Financial circumstances and poor academic administration brought on the majority of the issues.

Khanal (2012) conducted a thesis titled "A Study on the Problem Faced by Teachers in Teaching Mathematics at Higher Secondary Level" and concluded that few students were participating in math class, a lack of moral education, a lack of a parents teacher association and a lack of administrative support for the creation of math materials. Students are used in political programs, which presents challenges to teachers in the sense of a result-oriented system that does not well reward participation on the part of both students and teachers in the classroom, lack of amicable relationships between teachers and students, a lack of preparation and teacher confidence, a lack of effective teaching strategies, a lack of diagnostic tests and oral exams, a lack of supervision, a lack of opportunities for students to participate in mathematical conferences and seminars and a lack of political engagement among teachers.

In the sampled schools in the old Oyun LGA, Tytler (2010) found that materials and equipment were either completely absent or woefully inadequate. In the former Okehi LGA, Osaki et al. (2004) looked into the reasons behind students' subpar performance in chemical practicals. According to twenty-eight percent (28%) of pupils and sixty-six point eight percent (66.8%) of teachers, the laboratories were underequipped. In Irepodun LGA, Barchok's (2008) study was carried out. He discovered that many laboratories lacked adequate equipment and that, occasionally, students would do practical work.

According to Omolo and Simatwa (2010), laboratory instruction is a crucial part of science education and appropriate government policies should be in place to guarantee that students gain applicable scientific abilities. Most nations need to think about systemic reform through thoughtful, long-term evolution rather than revolution. Tobin (2007), however, affirms that the education of science teachers—especially their continuing education—should be the first issue addressed in most countries, given the sizable number of inexperienced young teachers currently employed in many systems. Teachers are the key driver of transformation in every classroom; they require assistance, acknowledgment and most importantly, continued respect for their vocation.

2.7 Knowledge Gap

Most secondary school laboratories are used for Biology, Chemistry, and Physics with laboratory specified technicians in each department or science department. Mathematic is not specified as a science so, it is unusual for mathematics student to use science laboratory as known in Kenya. According to Menéndez *et al*. (2019) study, even teachers do not comprehend the need for a laboratory to teach

Mathematics. There is insufficient information on the role of laboratories in teaching Mathematics by teachers and students, especially in Kenya. The current study has filled this gap and provided a baseline for further studies.

2.8 Chapter Summary

The second chapter examined earlier studies on how the laboratory approach affected student performance and motivation. The laboratory is a valuable workshop where practical activities are carried out to enhance a meaningful grasp of scientific concepts and theories, per studies (Bastir *et al.*, 2019; Das, 2019; Hall-Powell, 2022). The three science courses, Biology, Physics, and Chemistry, must be taught to students by the present 8-4-4 educational system (Konyango *et al.*, 2018). The disciplines' curriculums include sufficient practical exercises for grades one through four. Similarly, each subject's final examination consists of a thorough practical test (Mukami, 2009).

As a result, only a laboratory is required for the three science disciplines, and most Teachers of Mathematics only dream of having a Mathematics laboratory. However, Okeke and Okigbo (2021) have noted that Mathematics laboratories are a means of achieving the practice of the study of Mathematics, stating that; Hear something — you forget it, See something — you flashback it and Do something — you understand it (which is the basic idea of Mathematics laboratories).

The majority of scholars, including Edomwonyi-Otu and Avaa (2011) and Hernandez-de-Menendez *et al.* (2019), have lamented the absence of resources in laboratories for practical training, even though Asad et al., (2020) state that the Mathematics subject is made mandatory in practically all fields and professions.

Studies by Omike, Okeke, and Okeke & Okigbo (2021) are focused on the sciences. There are attempts to demonstrate the significance of laboratory methods in teaching Mathematics. However, there need to be more empirical examples in the literature, primarily based on the three sciences of Biology, Chemistry and Physics. Results from the current study on laboratory practices in a few schools in the Kapseret Sub County of Uasin Gishu County will be helpful to Mathematics researchers.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The methods employed to conduct the study were covered in this chapter. The study area, research design, population of interest, sampling techniques, sample size, research instruments, their validity and reliability, methods of data collecting and data analysis are all included in the subsections.

3.2 Study Area

The study was carried out in Uasin Gishu County's Kapseret Sub County. The old Rift Valley Province now contains Uasin Gishu County, one of Kenya's 47 counties. The county's commercial and administrative centers are located in Eldoret town. Kapseret Sub County has five wards, which are as follows: Simat, Kipkenyo, Ngeria, Megun, and Langas. Kapseret Sub County has 26 secondary schools and a student population of about 4680. Moreover, it was picked because of poor performance in Mathematics (Shulezote.com).

The choice of Kapseret Sub County was based on poor performance in Mathematics in KCSE, as indicated in the evidence in Table 3.1. Kapseret is predominantly made up of the Nandi sub-clan of the Kalenjin tribe, though other communities like the Kikuyus, Luos, and Luhyas also reside there. It has five wards, an estimated surface area of about 451 square kilometers and approximately 121,178 individuals (Kenyacradle.com). Main economic activities include; maize farming, wheat farming, dairy farming, horticulture, and trade. The schools are distributed evenly within the sub-county. Attached is a map of the study area (Appendix 1).

Table 3.1: Kapseret Sub-County KCSE performance for the past years (2017-2021.)

Year	Very good	Good	Average	Poor	Entry	Mean Score	Grade
2018	73	124	129	1477	1803	2.332	D-
2019	68	173	350	1367	1958	2.126	D-
2020	25	206	386	1409	2026	2.006	D-
2021	12	128	222	1101	1463	2.2372	D-

(Source: SCDE, 2021

3.3 Research Design

According to McCombes (2019), a research design is a framework for collecting and analyzing data. The study used Quasi-experimental design. The study design was employed because laboratory method was not being used in mathematics instruction. It therefore necessitated the introduction of the method in instruction which is allowed instruction as well as controlling the effect of pre-testing on both control and experimental group. All these could only be achieved by employing Solomon Four Group Design. The design has four groups, two experimental groups where one is pre-tested and the other one is not and two control groups where one is pre-tested and the other one is not. The groups not pre-tested are for the purposes of controlling the effect of pre- testing on the final results. The design is summarized in table 3.2. It was easy to use the format because some classes and schools could be easily used during the experiment. Entire groups of the selected schools were split up and then randomly assigned to the treatment and control conditions. The pre-test-post-test technique helped to assess the initial differences between the experimental and control groups (Bolarinwa, 2015).

Table 3. 2: Solomon's four groups

Group	Pre-test	Treatment	Post-test
Experimental 1	Yes	Laboratory Method	Yes
Experimental 2	No	Laboratory Method	Yes
Control 1	Yes	Conventional Method	Yes
Control 2	No	Conventional Method	Yes

Those in experimental one and two were subjected to treatment involving use of laboratory method on form two learners'. The treatment involved learning materials such as the marking ash, large protractor, peak cons, meter rule, and objects in reflection and congruence. Control group one and two were subjected to Conventional methods where the teachers of Mathematics used chalk and talk method where students did theory work in class and class assignments. Students were not allowed to go for practical lessons in the laboratory.

3.4 Target Population

According to Mugenda and Mugenda (2003), the target population comprises organizations with the information. The target population included all the Form Two students where reflection and congruence are taught. There are one hundred and fifty-six secondary schools (156) in Uasin Gishu County. Kapseret Sub County has approximately 26 secondary schools, comprising Extra County, sub-county, and private secondary schools. The study targeted 1170 form two students and 54 teachers of mathematics in 26 secondary schools within the sub-county.

The students are important because they provided evidence that laboratory methods enhance good performance among students when compared to conventional methods.

Also, the experiments were meant for secondary school students. The teachers are needed to guide the students during the practical lessons and for the researcher to observe the teachers' skills and competence on the subject matter.

3.5 Sample Size and Sampling Techniques

The sample size was relative to the target audience; Stratified random sample, simple random sampling and purposive sampling were all used to choose the respondents. Schools from each stratum were randomly chosen to participate in the study. The total number of schools selected for the study was 20; students and teachers sampled from the selected schools were 298 and 26, respectively.

Simple random sampling was used to select the sample size, which comprised of one stream in each school. One school was used for experimental and another different school for control. The selection of HOD’s (Mathematics) and Teachers of mathematics was done using purposive sampling because they were considered to have adequate information needed by the researcher. Yamane’s (1967) in McGrath (2020) formula for finite population was used to generate the sample size for schools as described below:

nh = n (Nh/N)

Where nh = sample size in stratum h,

Nh = population size in stratum h,

h = stratum number,

where h= 1,2, 3,.....,

N= total population size, and n is the overall sample size.

n = $\boldsymbol{N} / \boldsymbol{1 + N\ (e)^2}$

n = $\boldsymbol{1170} / \boldsymbol{1 + 1170(0.05)^2}$ = 298 learners……………… Equation 3.1

Table 3. 3: Sampling frame

Category	**Extra County**	**County**	**Private**	**Total**
Number of schools in each category	8	17	1	26
Number of schools selected	7	12	1	20
Teachers of mathematics in each category	18	34	2	54
Teachers of mathematics selected	8	16	2	26
Number of HOD in each category	11	14	1	26
Number of HOD selected	4	5	1	10
Number of students in each category	582	393	195	1170
Number of students selected	154	106	38	298

3.6 Research Instruments

A research instrument is a device that you can use to gather, quantify, and evaluate information on your research interests. These instruments are most frequently employed in the social sciences, health sciences, and education to evaluate patients, clients, students, teachers, and employees. A research tool may be an interview guide, a test, a poll, or a checklist. Interview schedules and questionnaires were employed for this investigation. According to Collis (2013), a questionnaire is a collection of well-prepared questions selected to elicit reliable responses from a group.

The fact that the data can be obtained quickly and accurately at a minimal cost is its most significant benefit. The interview schedule let participants elaborate on their meanings, providing a deeper understanding. This approach explores the questions that can be revealed more deeply. The close supervision of university supervisors developed the questionnaire and interview schedule. Before being utilized, it was piloted to test its effectiveness before data collection in the field. Questionnaires were meant for both students and Teachers of Mathematics, and the interview schedule was for the head of the Mathematics department in the school.

Data was gathered using the Mathematics Achievement Tests 1 and 2 to investigate the effect of laboratory procedures on Mathematical performance. Before the study was conducted, they were created and put through a pilot test. The pre-test consisted of reflection and unity-related questions from MAT 1. Its goal was to determine the pupils' entrance behavior before treatment. After the treatment, when all the lessons had been taught, MAT 2 was given as a post-test to evaluate how well the students had improved in Reflection and Congruence. Interview schedules and questionnaires were other research instruments used in this study to gather data.

3.6.1 Teacher of Mathematics Questionnaire

The targeted respondents must complete a questionnaire to respond to similar questions in a preset order (Rahi *et al.*, 2019). There were two portions to the survey, which was created for teachers of Mathematics. Background data was requested in Section A. Closed-ended questions in Sections B, C, and D evaluated the goals of the instruction method's effects on Mathematics performance, the instructional process' impact on student motivation, and the challenges that teachers have when implementing the laboratory approach.

3.6.2 Students Questionnaire

This questionnaire comprised Sections A, B and C. Section A sought background information. Sections B and C consisted of closed questions which assessed the effect of the instructional method on Mathematics Performance and the result of the instructional process on students' motivation.

3.6.3 Interview Schedule

A conversation that the interviewer starts with the express goal of gathering data for a study is known as an interview. Interview schedules typically consist of a series of questions compiled to help the interviewer guide the interviewee in providing the necessary information on a particular subject or topic (Mann, 2016). It is a simple and uncomplicated method of learning information when one person speaks, and another listens. The researcher got in-depth information about the challenges associated with using laboratory methods by speaking one-on-one with the Teachers of Mathematics directly during the interview. In addition to helping to standardize the interview so that the interviewer could ask the same questions in the same way, the interview schedules made it possible to collect the data needed to achieve the study's specific objectives. The interviewer learned more details and extra information as a result.

3.7 Pilot Study

In a research project, a pilot test is carried out before the beginning of data collection to evaluate the accuracy of the research instruments, specifically the questionnaires and interviews used for data collection (Yoo & Bai, 2013). Improvements can be made before the start of the inquiry by pre-testing the equipment and the overall research design.

Pilot testing offers proxy data for sample selection and identifies design and equipment problems. A pilot test of the questionnaire was conducted to ensure its clarity, consistency, and readability. The pilot test adheres to the widely praised standard range of 5% to 10%. Outside of the research area, at two schools in Soy Sub-County, the questionnaires for this study were pilot tested. By doing this, it was made sure that the respondents were clean.

The goals of the pilot study included determining the clarity, meaning, and understandability of each tool's item, validating the instruments by comparing their validity and reliability and gaining the necessary administrative experience in conducting the study in advance of the primary research. The study's findings were reliable, and a correlation of 0.89 was discovered.

3.8 Validity and Reliability of Instruments

In subheadings 3.8.1 and 3.8.2, respectively, the researcher evaluated the instruments' reliability and validity.

3.8.1 Validity of the Instruments

According to Bolarinwa (2015), the validity of a research instrument is how well it will capture the data for which it was built. It speaks to how convincing a conclusion, deduction, or argument is. Data analysis results accurately depict the topic under investigation to the extent. Internal validity and external validity are two types of validity. External validity is the capacity for generalized effects beyond the specific research context (Taherdoost, 2016). To ensure that external validity is realized, there was a selection of study sample that was the most representative group and had no problem with external validity (Scott *et al*., 2016).

By experienced secondary school Teachers of Mathematics and one of the Mathematics educators from the Department of Mathematics Education at the University of Eldoret, MAT 1 and MAT 2 were evaluated for content and face validity to establish the degree of difficulty. Before heading to the field, the researcher addressed the questionnaire's range with the experts in the School of Education at the University of Eldoret to maintain content validity. The researcher might then ensure that any confusing questions were changed or removed.

3.8.2 Reliability of instruments

According to Bolarinwa (2015), an instrument's reliability is determined by consistently producing the same results across various applications. The unbiasedness of a measure determines how accurate measurements will be throughout time and among the different parts of the instrument (Heale & Twycross, 2015). Additionally, he described reliability as the consistency that the device is measuring. Reliability is the tendency toward character observed in repeated measurements. The test-retest method was used to determine the reliabilities of MAT 1 and MAT 2. The Cronbach's

Coefficient Alpha technique by Bolarinwa (2015) was used to examine and test the reliability of the pilot study results, and it produced a coefficient of 0.89. This suggested that the reliability was sufficient.

Furthermore, the internal consistency dependability may be calculated with just one sample of data (Kothari, 2004). Cronbach's alpha is commonly used to describe this dependability statistic. This assesses the consistency with which respondents reply to questions. A Cronbach's alpha coefficient of at least 0.70 is advised by (Scott *et al*., 2016).

3.9 Data collection procedure

This study employed stratified random sampling, simple random sampling, and purposive sampling methods. The researcher divided the schools into three strata using stratified sampling. Each school's name and category were written on a little sheet of paper, and then folded into smaller sizes. Schools belonging to the same strata were combined. Simple random sampling was employed to choose schools from each stratum except for a private category. After mixing the chosen schools from each stratum in a tiny box, simple random sampling was employed to select the schools which led to 20 schools.

Folded papers were given the colors blue and red; the researcher chose blue for the experimental group and red for the control group. The researcher chose the head of the mathematics department and teachers of mathematics using purposive sampling in each sampled school. The overall number of Form 2 students in the 20 participating schools was 298, and the total number of teachers of mathematics was 26. A total of 298 students, with 160 for the control group and 138 for the experimental group made up the sample size. All the 324 questionnaires issued were returned, making 100% return rate. This was possible because students and teachers were located in one place and reduced the chances of missing questionnaire.

In the first week of data collection, a pretest was done. A post-test was given after the teachers had covered the topic for three weeks of instruction. The researcher was in-charge of marking both the pre-test and the post- test. At the end of the fourth week the questionnaires and interview schedules were administered.

3.10 Ethical Considerations

According to Minja (2009), ethics are rules of conduct that significantly impact people's welfare. As required by legislation for research conducted in Kenya, the researcher requested approval from the National Commission for Science, Technology, and Innovation (NACOSTI) via the Department of Technology Education in the School of Education at the University of Eldoret and a letter from the County Commissioner for research authorization. The goal of paying attention to ethical considerations in research is to help the researcher maintain the respondents' dignity by keeping their identities secret (Fouka & Mantzorou, 2011).

The respondents gave their informed consent after being fully informed of the study's goal and the researcher followed the following ethical guidelines. The researcher made sure that the respondents' cooperation was voluntarily given. The researcher presented authorization letters to the responders and introduced themselves. The study's goal was then outlined. Consequently, there was no coercion of those who participated. Due to the strategic importance of the material relevant to the study, secrecy was a concern. The responders' names were kept confidential in this regard. Everyone who took part in the survey was under duress.

3.11 Data Analysis

Data analysis is the theoretical clarification of the real data, using exact analytic approaches to change the raw data into logical information (Kothari, 2004). Statistical Package for Social Science (SPSS) software (version 21) was used to analyze the data obtained. In descriptive statistics; Frequencies and percentages were used and in inferential statistics; chi-square test and t-test were employed. Chi- square test was to assess whether expected and actual frequencies varied. Cross-tabulation was used to determine the correlations between the variables from the questionnaire data that had been coded and examined. Tables, graphs, qualitative statements, and descriptions were used to present the results.

Further analysis of the difference in performance between the control and experimental group was assessed using a student t-test for Mathematical assessment test (MAT) performance. Correlation statistics were utilized to determine whether the research variables had a meaningful relationship.

3.12 Chapter Summary

The chapter discussed research methodology as a mixed method since it involved qualitative and quantitative approaches. The study area was Kapseret sub-county within Uasin Gishu County. The research design used was quasi-experimental, pretest, and posttest. The sample size comprised 298 Form Two students and 26 teachers of mathematics; simple random sampling and purposive sampling techniques were used to select the study sample. Reliability and validity determination was also highlighted in this chapter. Lastly, ethical issues that were adhered to during the study are discussed.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS, INTERPRETATION, AND DISCUSSION OF RESULTS

4.1 Introduction

This chapter has analyzed, interpreted and discussed responses from learners and teachers. Both descriptive as well as inferential statistics were used. There were three objectives that this chapter intended to fulfill, which include; Effects of laboratory methods on Mathematics performance among secondary school students in Kapseret Sub County Kenya for the topic reflection and congruence, which has been dealt with using Survey responses and the Standardized Mathematics Achievement test (MAT); Effects of instructional method on students' motivation for the topic reflection and congruence on Mathematics among students and challenges faced by Teachers of Mathematics in using the instructional process in teaching and learning Mathematics in secondary schools. Tables and figures were used to portray and illustrate the findings. Chi-square goodness of fit and contingency tables were some of the descriptive analyses used, while student t-test, correlation and regression analysis were used as parametric statistics.

4.2 Demographic characteristics of the respondents

Kapseret sub-county has twenty-six (26) schools, though the researcher only sampled 20 schools for the study. The total number of students who participated in the study was 298; in the case of teachers, 26 participated and 10 Head of Mathematics department teachers participated.

Table 4. 1: Demographic characteristics

Respondents	Sampled
Teachers	26
Head of Mathematics Department teachers	10
Students	298

Two hundred and ninety-eight learners participated in this research study. Regarding gender, 154 male (51.92%) and 144 female (48.08%) learners had almost equal proportions hence very low gender disparity. This shows that both genders participated; hence findings can be generalized to all learners regardless of gender.

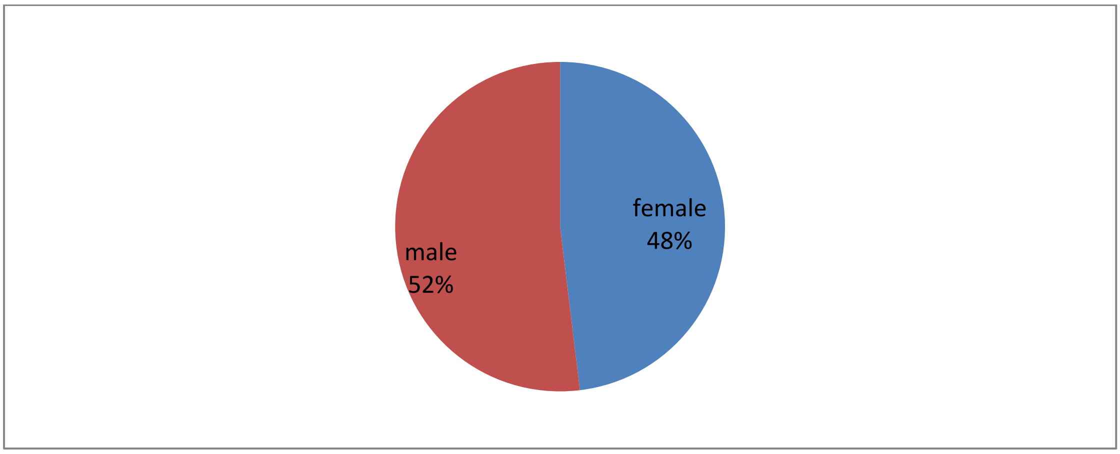

Figure 4. 1: Learners' gender

A large proportion of learners' 206 (69.13%), were aged between 13 and 15 years, while a small proportion, 7 (2.35%), represented those who were between the age of 19 to 21 years, as illustrated in Table 4.2. These findings can be generalized to students of high school age. For ages 18-21 which are not high school age bracket may due to late entry to primary school level, cases of class repetition and due to school fees issues involving drops out for some years and student coming back.

Table 4.2: Learners' demographic characteristics

Parameters	Attribute	Frequency	Percentage
Age	Between 13 - 15 years	206	69.13
	Between 16 - 18 years	85	28.52
	Between 19 - 21 years	7	2.35
	Total	298	100.00

For the teachers, most of those who took part in the survey were female 14 (53.85%), while males represented 12 (46.15%). Previously it has been reported that most females don't take science-based courses; the current finding has indicated that gender is involved in the science courses, as illustrated in Figure 4.2.

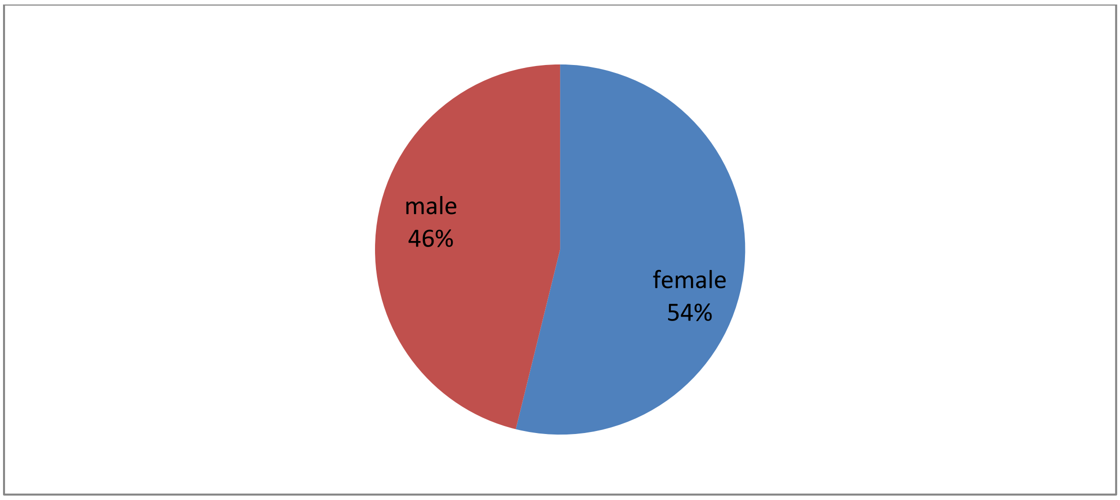

Figure 4.2: Teachers gender

The majority were in the age bracket of 20 to 40 years (65.38%), with a small proportion of them being over 50 years old (3.85%). This meant that the education profession was attracting a youthful generation with a continuous inflow of human resources. Regarding the highest education level attained, the majority had a degree 23 (88.46%), with the rest having a diploma certificate.

This showed the implementation of the government policy of degree holders to teach at the secondary level and diploma teachers at the secondary level. The few seen were those who were already recruited before the policy. Years of experience in teaching varied, with most respondents having between 5 to 14 years of experience (73.08%), which means the respondents were quite experienced and could provide adequate information. The experience was evenly distributed between the experimental and control group. Therefore, there was no bias in advantage or disadvantage to either group. Lecture and demonstration teaching methods were commonly cited as the primary teaching methods the teachers had been trained to use. This showed that teachers are most familiar with the conventional lecture and demonstration methods, as illustrated in Table 4.3.

Table 4.3: Teachers' demographic

Parameter	Attribute	Frequency	Percentage
Age	Between 20-30 years	8	30.77
	Between 31-40 years	12	46.15
	Between 41-50 years	5	19.23
	Over 50 years	1	3.85
	Total	26	100.00
Level of education	University	23	88.46
	College	3	11.54
	Secondary	0	0.00
	Total	26	100.00
Teachers experience	Below five years	3	11.54
	Between 5-9 years	8	30.77
	Between 10-14 years	11	42.31
	Between 15-24 years	3	11.54
	More than 24 years	1	3.85
	Total	26	100.00
Methods trained	Lecture method	9	34.62
	Demonstration method	10	38.46
	Laboratory method	5	19.23
	Problem-solving method	1	3.85
	Discovery method	1	3.85
	Others	0	0.00
	Total	26	100.00

4.3 Effects of a laboratory method for the topic reflection and congruence on mathematics performance among students

4.3.1 Responses on the effects of the laboratory method

In the survey to establish the effects of the laboratory method for the topic reflection and congruence on mathematics performance among students, both learners and teachers were asked to rate various statements as provided in Table 4.3. On the statement that the method used to teach the topic made the students retain the learned concept longer, both learners 163 (78.37%) and teachers 19 (73.08%) agreed with the statement. Only a small proportion of learners' 1(0.48%) were undecided. There was a significant difference in response for learners χ^2 = 218.45, d.f.=4, p<0.0001) and teachers (χ^2 = 125.36, d.f.=3, p < 0.0001) respectively with a positive correlation (p<0.0001)

Both learners 196(62.02%) and teachers 16(61.54%) agreed with the statement that the method enabled the learners to understand the concept better than before with a significant difference (learners χ^2 = 144.3, d.f.=4, p < 0.0001 and teachers χ^2 = 91.47, d.f.=3, p < 0.0001) as illustrated in Table 4.4. There was a positive correlation between teachers' and learners' responses to the statement (p<0.0001).

On the statement that the method helped remove abstractness, 174 learners (83.65%) and teachers 16(61.54%) strongly agreed with the information. Only a small proportion of learners' 3(1.44%) and teachers who were undecided and disagreed respectively with a significant difference (learners χ^2 = 97.5404, d.f.=4, p < 0.0001; teachers χ^2 = 81.44, d.f.=4, p < 0.0001). There was a positive correlation between teachers' and learners' responses to the statement (p<0.0001).

Both Learners' 190(91.35%) and Teachers 24(92.31%) strongly agreed with the statement that the method Boosted performance. Only a tiny fraction of respondents who were undecided (Learners' 1(0.48%) and Teachers 1 (3.85%)) with a significant difference (learners, χ^2 = 161.23, d.f.=4, p < 0.0001; teachers, χ^2 = 112.86, d.f.= 3, p < 0.0001). There was a positive correlation between teachers' and learners' responses to the statement (p<0.0001).

On the statement that the method enabled the use of complex equipment and allowed students to develop skills, both Learners 186(89.42%) and Teachers 24(92.31%) strongly agreed with a significant difference from those undecided and disagreed, as illustrated in Table 4.4.

In addition, both Learners 158(75.96%) and Teachers 16 (61.54%) strongly agreed with the statement that the method is often cheaper and less time-consuming than other methods. In comparison, a small proportion of them were undecided (learners 6(2.88%) and teachers 5 (19.23%)) with a significant difference (learners, $\chi^2 = 106.30$, d.f.= 4, $p < 0.0001$; Teachers, $\chi^2 = 99.10$, d.f.= 4, $p < 0.0001$) but with a positive correlation ($p<0.0001$).

Teachers, as well as learners, strongly agreed with the statement that the method helps the students to build an interest in learning the subject, Provides the opportunity to exhibit the relatedness of Mathematical concepts in everyday life, It provides greater scope for individual participation in the process of learning, Builds confidence in learning subject as well as it enables the learners' develop skills necessary for more advanced study of research with a significant difference. There was a positive correlation between teachers' and learners' responses to the statement ($p<0.0001$).

On the statement that the method promoted the development of scientific thinking in students, all teachers agreed with the word (100.0%) majority of students also strongly agreed with the statement but were undecided 12(46.15%) on the statement that the method enabled the students to answer the given questions correctly as summarized in Table 4.4.

In addition the responses from various teachers during the interview schedules were as follows; most students scored quality grades and they were very happy and excited in using the laboratory method. Few teachers gave out their comments on the interest to apply the same method in other subjects.

Table 4.4: Survey responses on the effects of a laboratory method for the topic reflection and congruence on mathematics performance among students

Statement	Respondents	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Chi-Square (χ^2)
Made the students retain the learned concept longer	Learners'	32 (15.38%)	163 (78.37%)	1 (0.48%)	8 (3.85%)	4 (1.92%)	χ^2 = 218.45 d.f.=4 p= 0.0000
	Teachers	4 (15.38%)	19 (73.08%)	2 (7.69%)	1 (3.85%)	-	χ^2 = 125.36 d.f.=3 p = 0.0000
Enabled the learners to understand the concept better than before	Learners'	67 (32.21%)	129 (62.02%)	2 (0.96%)	8(3.85%)	2(0.96%)	χ^2 = 144.3 d.f.=4 p = 0.0000
	Teachers	8 (30.77%)	16 (61.54%)	1 (3.85%)	1 (3.85%)	-	χ^2 = 91.47 d.f.=3 d.f. p = 0.0000
Helped in removing abstractness	Learners'	61 (29.33%)	113 (54.33%)	3 (1.44%)	24 (11.54%)	7(3.37%)	χ^2 = 97.5404 d.f.=4 p = 0.0000
	Teachers	2(7.69%)	14(53.85%)	6(23.08%)	3(11.54%)	1(3.85%)	χ^2 = 81.44 d.f.=4 d.f. p = 0.0000
Boosted the performance	Learners'	48(23.08%)	142(68.27%)	1(0.48%)	8(3.85%)	9(4.33%)	χ^2 = 161.23 d.f.=4 p = 0.0000
	Teachers	6(23.08%)	18(69.23%)	1(3.85%)	1(3.85%)	-	χ^2 = 112.86 d.f.= 3 p = 0.0000
Enabled the use of complex equipment and allowed students to develop skills	Learners'	75(36.06%)	111(53.37%)	3(1.44%)	8(3.85%)	11(5.29)	χ^2 = 109.33 d.f.= 4 p = 0.0000
	Teachers	11(42.31%)	13(50.00%)	1(3.85%)	1(3.85%)	-	χ^2 = 71.83 d.f.= 3 p = 0.0000
Often cheaper and less time-consuming than other methods	Learners'	34(16. 35%)	124(59. 62%)	6(2.8(8%)	32(15.38%)	12(5.77%)	χ^2 = 106.30 d.f.= 4 p = 0.0000
	Teachers	1(3.85%)	15(57.69%)	5(19.23%)	4(15.38%)	1(3.85%)	χ^2 = 99.10 d.f.= 4 d.f. p = 0.0000
Increased effective teaching and learning	Learners'	52(25.00%)	112(53.85%)	6(2.88%)	24(11.54%)	14(6.73%)	χ^2 = 85.15 d.f.= 4 d.f. p = 0.0000
	Teachers	7(26.92%)	14(53.85%)	1(3.85%)	3(11.54%)	1(3.85%)	χ^2 = 89.04 d.f.= 4 d.f. p = 0.0000
It helps the students to build an interest in learning the subject	Learners'	76(36.54%)	110(52.88%)	6(2.88%)	11(5.29%)	5(2.40%)	χ^2 = 110.81 d.f.= 4 d.f. p = 0.0000
	Teachers	14(53.85%)	12(46.15%)	-	-	-	χ^2 = 0.64 d.f.= 1 d.f. p = 0.4237
Provided the opportunity to exhibit the relatedness of mathematical concepts in everyday life	Learners'	49(23.56%)	132(63.46%)	5(2.40%)	8(3.85%)	14(6.73%)	χ^2 = 130.70 d.f.= 4 d.f. p = 0.0000
	Teachers	18(69.23%)	7(26.92%)	1 (3.85%)	-	-	χ^2 = 65.18 d.f.= 2 d.f. p = 0.0000
It provides greater scope for individual	Learners'	79(37.98%)	109(52.40%)	6(2.88%)	7(3.37%)	7(3.37%)	χ^2 = 110.75 d.f.= 4 d.f. p = 0.0000

participation in the process of learning	Teachers	13(50.00%)	12(46.15%)	1(3.85%)	-	-	χ^2 = 38.96 d.f.= 2 d.f. p = 0.0000
Builds confidence in learning subject	Learners’	63(30.29%)	104(50.00%)	8(3.85%)	18(8.65%)	15(7.21%)	χ^2 = 77.30 d.f.= 4 d.f. p = 0.0000
	Teachers	8(30.77%)	13(50.00%)	1(3.85%)	4(15.38%)	-	χ^2 = 48.08 d.f.= 3 d.f. p = 0.0000
Enables the learners to develop skills necessary for more advanced study of research	Learners’	52(25.00%)	124(59.62%)	8(3.85%)	8(3.85%)	16(7.69%)	χ^2 = 114.03 d.f.= 4 d.f. p = 0.0000
	Teachers	6(23.08%)	18(69.23%)	1(3.85%)	1(3.85%)	-	χ^2 = 112.86 d.f.= 3 d.f. p = 0.0000
Promoted the development of scientific thinking in students	Learners’	53(25.48%)	137(65.87%)	2(0.96%)	5(2.40%)	11(5.29%)	χ^2 = 152.55 d.f.= 4 d.f. p = 0.0000
	Teachers	8 (30.77%)	18(69.23%)	-	-	-	χ^2 = 14.44 d.f.= 1 d.f. p = 0.0001
Enabled the students to answer the given questions correctly	Learners’	32 (15.38%)	45 (21.63%)	43 (20.67%)	33 (15.87%)	55 (26.44%)	χ^2 = 4.100 d.f.= 4 d.f. p = 0.3926
	Teachers	3 (11.54%)	6 (23.08%)	12 (46.15%)	5 (19.23%)	-	χ^2 = 26.00 d.f.= 3 d.f. p = 0.0000

Respondents (both learners and teachers) also added that there were other ways the method of teaching influenced mathematics performance by ensuring high academic achievement (learners’=35.31% and teachers 61.53%), improving student understanding of the concept (learners’ =25.17% and teachers 46.15%), made the subject enjoyable (learners’ =18.18% and teachers 42.31%) as well as fear that the issue is complex is long gone (learners’ =21.33% and teachers 23.08%) with no significant difference between learners and teachers responses (χ^2 = 3.548, df.=3, p= 0.3146) as portrayed in Figure 4.3.

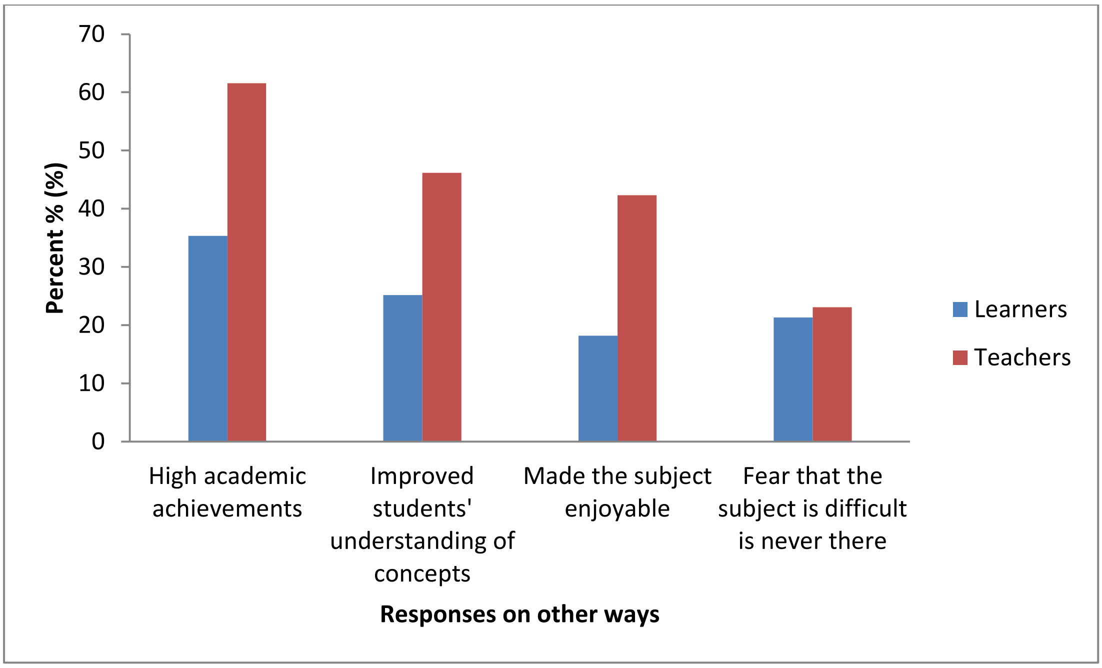

Figure 4.3: Other ways the method used in teaching influenced mathematics performance

4.3.2 Standardized Mathematics Achievement test (MAT) pre-test control and experimental for the topic reflection and congruence

4.3.2.1 Pre-test Scores

Performance by students of Standardized Mathematics Achievement test (MAT) pre-test control and pretest experimental for the topic reflection and congruence for the three categories of school was determined after the researcher, being assisted by research assistants, administered a pre-test to both experimental and control groups at the beginning of the research period. There were three categories of schools involved in this research. These were Extra County, County, and Private secondary schools. Performance for pretest control was as follows. Extra county schools scored a mean mark of 11.09% with a standard deviation 1.21. County Secondary school's mean mark was 7.24% with a standard deviation of 0.83, while private schools' mean mark was 9.0% with a standard deviation 1.31, as illustrated in Table 4.5.

Table 4.5: Pre-test control mean mark and standard deviation

School category	Mean	SD
Extra County	11.09	1.21
County	7.24	0.83
Private	9.00	1.31

For the Pre-test experimental mean mark, Extra county schools scored a mean mark of 11.91% with a standard deviation of 1.31. County Secondary school's mean mark was 8.1% with a standard deviation of 1.08, while private schools' mean mark was 10.44% with a standard deviation of 1.27, as illustrated in Table 4.6.

Table 4. 6: Pre-test experimental mean mark and standard deviation

School category	Mean	SD
Extra County	11.91	1.35
County	8.1	1.08
Private	10.44	1.27

Mean pre-test scores for the school were evaluated. Table 4.7 shows the means and standard deviations of the control and experimental group during the pre-test. The norm recorded by students instructed through the lecture method during the pre-test was 9.11%, with a standard deviation of 1.12. In comparison, that of the students taught through the experimental approach was 10.15% with a standard deviation of 1.20. The mean difference between the two groups was 1.04%. The researcher subjected the pre-test scores of both the experimental and control groups to a t-test to determine the equality of their means, which showed no significant difference between the two groups (t=2.07, df=296, p=0.2732). This indicated that the two groups had similar abilities, therefore any difference in post-test was not attributed to entry behavior of the students.

Table 4.7: Mean pre-test scores for the school

	Type of group	Mean	SD	t-test
Pretest score	Control group	9.11	1.12	t=2.07, df=296, p=0.2732
	Experimental group	10.15	1.2	

4.3.2.2 Treatment

The pre-test involved control groups taught through lecture methods in all categories of schools, focusing on reflection and congruence in Mathematics. The experimental group was instructed through practical methods involving experiments. The week-long instruction covered reflection and congruence concepts, with 40-80 minutes for single and double lessons. Teachers taught experimental groups to explore reflection and congruence concepts, with students manipulating materials and discussing results in all categories of schools. Posttests were conducted after a week across all types of schools.

4.3.2.3 Post-test scores

For the three types of schools, learners'' performance on the Standardized Mathematics Achievement Test (MAT) post-test experimental and post-test control for the theme reflection and congruence was assessed. Extra county schools got a mean grade of 54.45% with a 1.74 standard deviation. As shown in Table 4.8, the mean grade for county secondary schools was 27.38% with a standard deviation of 1.38, and the mean grade for private schools was 27.94% with a standard deviation of 1.22.

Table 4. 8: Post-test control mean mark and standard deviation

School category	Mean	SD
Extra County	54.45	1.74
County	27.38	1.38
Private	27.94	1.22

Extra county schools got a mean score of 92.08% with a standard deviation of 1.96 for the post-test experimental mean mark. As shown in Table 4.9, the mean grade for county secondary schools was 52.13% with a standard deviation of 1.22, while the mean grade for private schools was 48.99% with a standard deviation of 1.29.

Table 4. 9: Post-test experimental mean mark and standard deviation

School category	Mean	SD
Extra County	92.08	1.96
County	52.13	1.22
Private	48.99	1.29

The school's average post-test results were analyzed. The means and standard deviations of the control and experimental groups during the post-test are displayed in Table 4.10. The post-test compromise for students who had received lecture instruction was 36.59%, with a standard deviation of 1.45. In contrast, the mean for students who had received experimental education was 64.44%, with a standard deviation of 1.49. 27.85% was the average difference between the two groups. The post-test results from both the experimental and control groups were put through a t-test to see if their means were equal, and the results revealed a significant difference between the two groups ($t=-26.08$, $df=296$, $p=0.0049$). This indicated that the two groups did not have similar abilities.

Table 4. 10: Mean post-test scores for the school

	Type of group	Mean	SD	t-test
Post-test score	Control group	36.59	1.45	$t=26.08$, $df=296$, $p=0.0049$
	Experimental group	64.44	1.49	

4.3.2.4 Hypothesis Testing

The null hypothesis of this objective was that the laboratory teaching method did not affect mathematics performance for the topic of reflection and congruence among students. This hypothesis was tested by conducting a t-test on the post-test retention scores. The analysis showed a significant difference between the post-test retention scores ($t=9.676$, $df=296$, $p<0.0001$). From the study, the null hypothesis (H_{01}) was rejected, meaning that the laboratory method of teaching affected performance.

4.3.2.5 Discussions

The difference in mathematics performance between Extra County, County, and Private secondary schools can be influenced by several factors, including Resources and Infrastructure; private and extra county schools may have more financial resources, better infrastructure, and access to modern teaching aids and technology. These resources can create a more conducive learning environment for mathematics education, with well-equipped laboratories, libraries, and classrooms. County schools, on the other hand, may face resource constraints, which can impact the quality of mathematics instruction and student outcomes. The findings agree with those of Wang & Degol (2016) that school resources matter in learners' academic performance.

However, they added that translating resources to higher student academic performance depends on how schools and teachers can use those resources to improve performance.

This finding shows that secondary school learners from the experimental group using the laboratory method solved more problems correctly than the control group in this research. The result depicts an instructional material that significantly impacted achievement and performance compared to traditional mathematics learning methods.

There can be several reasons why secondary school learners in the experimental group using a laboratory method solve more problems correctly than the control group, including Effective Teaching Strategies that enhance students' understanding and problem-solving skills. It could involve clear explanations, demonstrations, scaffolding techniques, or guided practice, which help students grasp mathematical concepts more efficiently and apply them accurately to problem-solving tasks. This is supported by Ebele *et al.* (2006), who depicted that the method promotes active student engagement by encouraging collaborative learning, hands-on activities, interactive discussions, or educational technology tools. These approaches can foster student participation, critical thinking, and a deeper understanding of mathematical concepts, leading to improved problem-solving abilities.

In line with the findings of Smith, Rayfield & McKim (2015), the laboratory method in the experimental group may incorporate motivational strategies that stimulate student interest and intrinsic motivation in mathematics. It could include real-world applications, relevant and meaningful problem-solving tasks, or recognition of student achievements.

4.4 Effects of laboratory method on students' motivation for the topic reflection and congruence on mathematics among students

To assess the effects of the laboratory method on students’ motivation for the topic reflection and congruence on mathematics among students, both learners and teachers were asked to rate the statements provided. The majority of both learners and teachers agreed that the method used to teach the topic enabled the students to build confidence (learners’ (58.65%), teachers' (53.85%), $p<0.05$). They also both strongly agreed that the method increased the learners’’ participation in the process of learning (learners’ (53.85%) and teachers (53.85%), while only teachers strongly indicated that it made the students think and understand things and the world around them rather than making them memorize the facts 18(69.23%) (χ^2 = 65.18, d.f.= 2, p = 0.0000), and made the learning of the subject to be enjoyable 14(53.85%) as illustrated in Table 4.11.

Table 4.11: Effects of laboratory method on students' motivation for the topic reflection and congruence on mathematics among students

Statement	Respondents	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Chi-Square (χ^2)
Enabled the students to like the subject	Learners'	16(7.69%)	89(42.79%)	51(24.52%)	32(15.38%)	20(9.62%)	$\chi^2 = 41.15$ d.f.= 4 $p < 0.0001$
	Teachers	2(7.69%)	13(50.0%)0	6(23.08%)	4(15.38%)	1(3.85%)	$\chi^2 = 66.7\ 0$ d.f.= 4 $p < 0.0001$
Build the students' confidence	Learners'	71(34.13%)	122(58.65%)	9(4.33%)	1(0.48%)	5(2.40%)	$\chi^2 = 134.86$ d.f.= 4 $p < 0.0001$
	Teachers	11(42.31%)	14(53.85%)	1(3.85%)	-	-	$\chi^2 = 40.87$ d.f.=2 $p < 0.0001$
Increased the learners' participation in the process of learning	Learners'	112(53.85%)	77(37.02%)	8(3.85%)	2(0.96%)	9(4.33%)	$\chi^2 = 115.8$ d.f.= 4 $p < 0.0001$
	Teachers	14(53.85%)	11(42.31%)	1(3.85%)	-	-	$\chi^2 =0.87$ d.f.= 2 $p < 0.0001$
Made the students to think and understand things and the world around them rather than making them memorize the facts	Learners'	67(32.21%)	154(74.04%)	21(10.10%)	14(6.73%)	19(9.13%)	$\chi^2 = 122.72$ d.f.=4 $p < 0.0001$
	Teachers	18(69.23%)	7(26.92%)	1(3.85%)	-	-	$\chi^2 = 65.18$ d.f.= 2 $p < 0.0001$

Made the students develop an interest in learning the subject	Learners'	68(32.69%)	98(47.12%)	30(14.42%)	7(3.37%)	5(2.40%)	χ^2 = 77.35 with d.f.= 4 p < 0.0001
	Teachers	11(42.31%)	15(57.69%)				χ^2 = 2.56 d.f.= 1 p = 0.1096
Increased learners' attention	Learners'	64(30.77%)	86(41.35%)	4(1.92%)	22(10.58%)	32(15.38 %)	χ^2 = 49.6 d.f.= 4 p < 0.0001
	Teachers	8(30.77%)	8(30.77%)	2(7.69%)	4(15.38%)	3(11.54%)	χ^2 = 24.61 d.f.= 4 p < 0.0001
Made the learning of the subject to be enjoyable	Learners'	94(45.19	98(47.12%)	7(3.37%)	4(1.92%)	5(2.40%)	χ^2 = 114.55 d.f.= 4 p < 0.0001
	Teachers	14(53.85%)	11(42.31%)	1(3.85%)			χ^2 = 40.87 d.f.= 2 p < 0.0001
Made the learners do mathematics willingly	Learners'	39(18.75%)	56(26.92%)	7(3.37%)	80(38.46%)	26(12.50 %)	χ^2 = 35.60 d.f.= 4 p < 0.0001
	Teachers	5(19.23%)	7(26.92%)	1(3.85%)	10(38.46%)	2(7.69%)	χ^2 = 40.08 d.f.= 4 p < 0.0001

Both learners and teachers had varied reasons in addition to the statements provided, which included that students love the subject (36.63%), assignments are completed on time (33.33%), students form group discussions by themselves (7.47%) as well as students develop positive attitudes (23.56%) according to learners' with a significant difference (χ^2 = 20.4, d.f.=3, p= 0.0001). In contrast, teachers pointed out that the method led to students loving the subject (53.85%) and that assignments are completed in time (38.46%) with significant difference (χ^2 = 32.72, d.f.=2, p=0.0000) as illustrated in Figure 4.4.

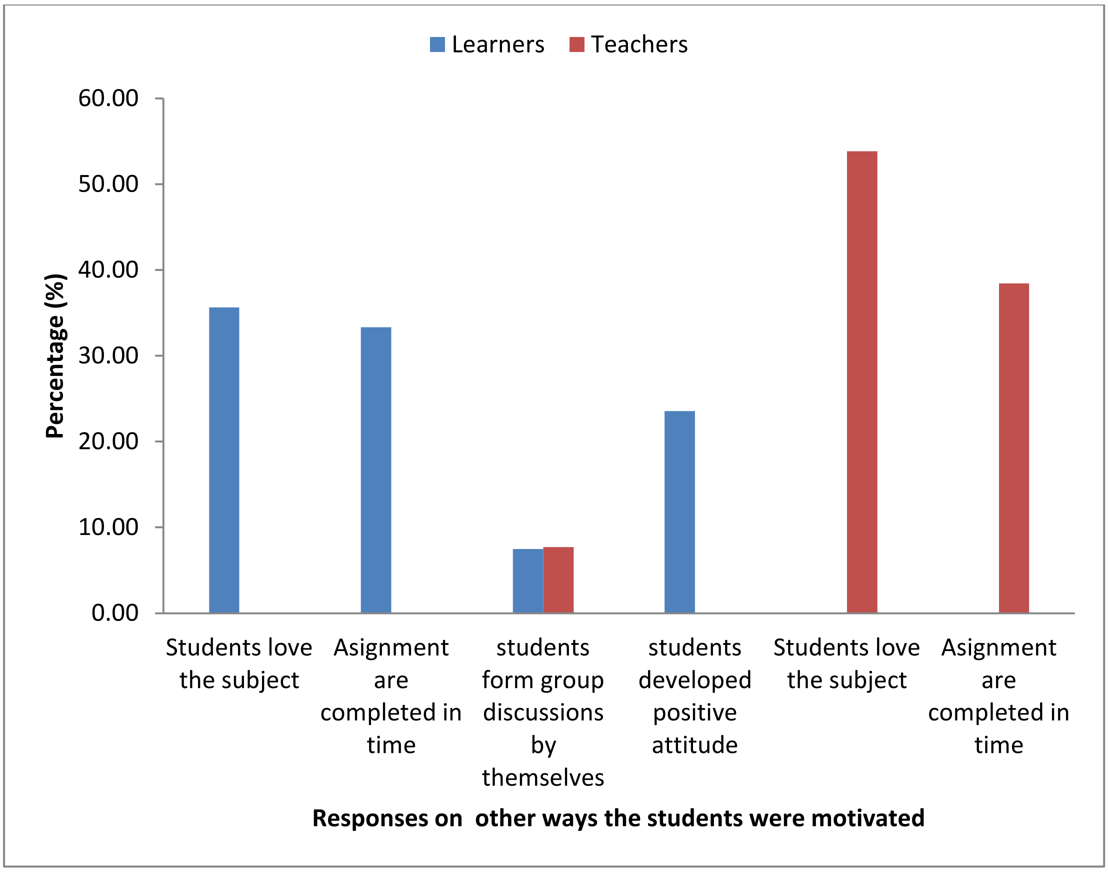

Figure 4.4: Other ways the students were motivated

4.4.1 Discussion

The analysis of motivation indicated that the laboratory method boosted student engagement and confidence in Mathematics learning more than the conventional method. This explains why they preferred the unconventional technique and tended to engage with it more. This is in line with the results of empirical studies that demonstrate that participating in worthwhile activities increases motivation (Fischer *et al.*, 2019; Wambu & Fisher, 2015).

Also, the findings demonstrated how the laboratory approach affected students' enthusiasm to study reflection and Mathematical congruence. According to the research, the laboratory instruction approach inspired students to enjoy the subject, and they successfully finished the assigned tasks on time. The results concur with those of Hall-Powell (2022), who asserted that motivation is the act of being moved to action, and Fischer *et al.* (2019) and Wambu & Fisher (2015), who found that engaging in valuable activities boosts motivation. This is because, as stated by Nkirote & Thinguri (2020) & Schiefele & Schaffner (2015), motivation is crucial in explaining behavior and the length and level of involvement. This supports the findings that Mathematics should be taught practically using a laboratory approach since learning by doing increases the learner’s motivation.

4.5 Challenges faced by teachers of mathematics in using laboratory methods in teaching and learning Mathematics in secondary schools

Various statements were provided to the respondents so they could rate them to answer the objective on challenges faced by teachers of mathematics in using instructional methods in teaching and learning Mathematics in secondary schools. From the survey majority of teachers agreed that the classrooms were not equipped with graph boards (53.85%, $p<0.05$) and that the administration often supported both economic and physical use of instructional materials in teaching (53.85%, $p<0.05$). Teachers disagreed that it was not easy to complete the whole course in time using instructional materials (14(53.85%)) while strongly opposing that instructional resources are unavailable in their school schools (61.54%). Teachers disagreed with the statement that they did not have the skills to select appropriate and innovative instructional materials to use 131(62.98%). They also disagreed with the information that the administration is unwilling to financially support to purchase of instructional material ($p<0.05$), as illustrated in Table 4.12.

Table 4.12: Challenges faced by teachers of mathematics in using laboratory methods in teaching and learning mathematics in secondary schools

Statement	Strongly agree	Agree	Undecid ed	Disagree	Strongly disagree	Chi-square (χ^2)
The instructional resources are unavailable in our school	1 (3.85%)	3 (11.54%)	1 (3.85%)	16 (61.54%)	5 (19.23%)	χ^2= 117.03 d.f.= 4 p<0.0001
I do not have the skills to select appropriate and innovative instructional materials to use	2 (7.69%)	6 (23.08%)	-	14 (53.85%)	4 (15.38%)	χ^2 = 86.7 d.f.= 4 p<0.0001
Made it difficult to complete the whole course in time since it is time-consuming	1 (3.85%)	1 (3.85%)	-	18 (69.23%)	6 (23.08%)	χ^2= 166.08 d.f.= 4 p<0.0001
There are no sufficient leisure periods even to think about the construction and use of instructional materials	1 (3.85%)	3 (11.54%)	1 (3.85%)	11 (42.31%)	10(38.46 %)	χ^2= 69.19 d.f.= 4 p<0.0001
The administration is not willing to support in terms of finance to purchase the instructional materials	1 (3.85%)	11 (0.48%)	1 (3.85%)	15 (57.69%)	9 (34.62%)	χ^2= 129.03 d.f.= 4 p<0.0001
The classroom is not equipped with a graph board	7 (26.92%)	14 (53.85%)	-	4 (15.38%)	1 (3.85%)	χ^2 = 94.30 d.f.= 4 p<0.0001
It is easy to complete the whole course in time using instructional materials	14 (53.85%)	11 (42.31%)	1 (3.85%)	-	-	χ^2 = 134.78 d.f.= 4 p<0.0001
The administration often supports both economically and physically to use of instructional materials in teaching	6 (23.08%)	14 (53.85%)	1 (3.85%)	4 (15.38%)	1 (3.85%)	χ^2 = 85.09 d.f.= 4 p<0.0001
It is compulsory for me to take extra period due to insufficient mathematics teacher	-	-	1 (3.85%)	13 (50.00%)	12 (46.15%)	χ^2 = 131.60 d.f.= 4 p<0.0001

Respondents also added that there were other challenges faced in using the laboratory method, which included a large number of students per class (53.99%), inadequate material to teach students (22.52%) as well as Time spared for the subject is not enough (29.26%) as illustrated in Figure 4.5. There was no significant difference in response from learners and teachers ($\chi^2 = 5.87$, d.f.= 2, p = 0.0000).

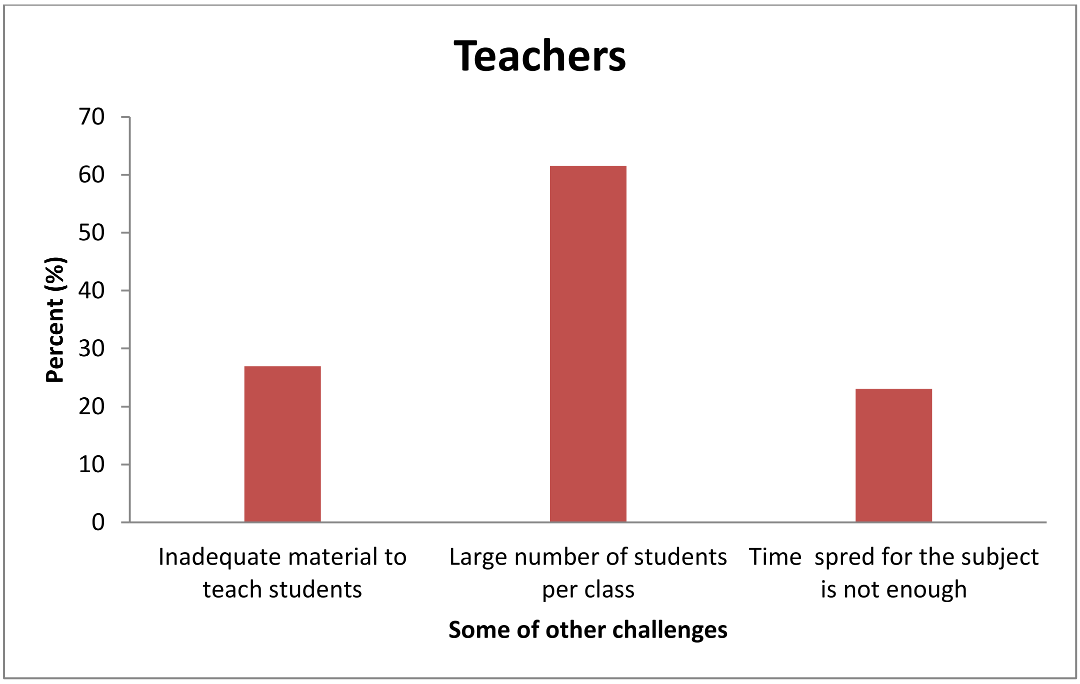

Figure 4.5: Other challenges faced in using this method

4.5.1 Discussion

From the findings, teachers disagreed that the instructional resources were unavailable in their school. This could be due to a perception of availability where teachers may have a different perception of what constitutes "instructional resources" and believe they have access to adequate materials and tools within their school. The finding aligns with Victor's (2017) finding that sometimes teachers may consider textbooks, workbooks, and basic classroom supplies as sufficient resources for instruction, even if more specialized or supplementary resources are lacking. Another reason could be adaptation and creativity, where they may find ways to adapt and make the best use of the available resources, as supported by König et al. 2020). This leads to teachers modifying existing materials, developing their teaching aids, or leveraging technology to compensate for resource limitations. These strategies can help mitigate the perceived unavailability of instructional resources.

The findings established that teachers disagreed that they did not have the skills to select appropriate and innovative instructional materials. This was because they would not have shown incompetence in handling the subject. Keeping up with advancements in mathematical content, teaching strategies and educational technology requires ongoing professional development. However, teachers may face challenges in accessing relevant and high-quality professional development opportunities, which can hinder their ability to implement effective instructional methods, as Wynants & Dennis (2018) indicated.

The study findings established that there were challenges faced in using laboratory methods, including inadequate teaching materials, many students per class, and insufficient time spent. This agrees with Ngala (1997), who argued that scarcity of teachers and resources leads to poor academic performance. Furthermore, Obwocha (2005) noted that a lack of school resources contributes to poor performance across the country. He said that most schools that performed dismally in the national examinations had inadequate teaching and learning resources, including insufficient teachers.

The findings indicated that teachers disagreed with the statement that the instructional method of teaching made it challenging to complete the whole course in time since it is time-consuming. This is due to the nature of the learning, as effective instructional methods can lead to deeper student understanding and retention of the material. According to Morrison et al. (2019), teachers can facilitate meaningful engagement with the content by using strategies that promote active learning, critical thinking, and problem-solving. This can result in students grasping concepts more thoroughly and requiring less time for repetitive drilling or re-teaching.

Teachers also disagree with the statement that the administration is not willing to support in terms of finance to purchase instructional materials. This can be explained by the fact that teachers may have experienced a supportive administration that recognizes the importance of instructional materials and is willing to allocate funds to purchase them. Administrators who understand the value of quality resources and their impact on student learning are more likely to prioritize giving financial resources to support teachers' needs.

Regarding the statement that the classroom is not equipped with a graph board, some schools, especially those with budget constraints or in disadvantaged areas, may lack the necessary resources to provide every classroom with specialized equipment like graph boards. In such cases, teachers may acknowledge the limited resources and agree that their classroom lacks a graph board (Shabiralyani *et al.*, 2015).

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The essential findings, as provided in chapter four, are summarized in this chapter. Based on the research findings, it makes judgments and suggestions. The chapter concluded with several recommendations for future research topics.

5.2 Summary of the Findings

5.2.1 Demographic characteristics of the respondents

The study analyzed the gender distribution of learners in the Kapseret sub-county, involving 298 students who participated, with 26 teachers participating. The majority of learners were between 13 and 15. The majority of teachers were female, and most teachers had a degree. Lecture and demonstration methods were the most commonly used teaching methods.

5.2.2 Effects of a laboratory method for the topic reflection and congruence on mathematics performance among students

The survey aimed to ascertain how laboratory procedures affected students' math abilities; both learners and teachers agreed that the method improved the retaining of learned concepts, improved understanding, removed abstractness and boosted performance. It was also found to be cheaper and less time-consuming. The method also fostered interest, individual participation, confidence and advanced research skills. It also promoted scientific thinking and improved mathematical performance by ensuring high academic achievement, improving understanding, making the subject enjoyable, and reducing fear of difficulty. No significant difference was found between learners' and teachers' responses.

The lecture method was used to teach reflection and congruence concepts. The pre-test scores were evaluated, with the experimental group instructed through practical strategies. The analysis showed a significant difference in post-test retention scores, indicating that the instructional method significantly affected performance. The null hypothesis (H_{01}) was rejected, indicating that the laboratory method significantly affected performance.

5.2.3 Effects of Laboratory method on students' motivation for the topic reflection and congruence on mathematics among students

Both learners' and teachers agreed that the technique helped build confidence, increased participation in the learning process, and made the subject enjoyable. Teachers believed the form encouraged critical thinking and understanding rather than memorizing facts. Overall, the method positively impacted students' motivation for mathematics.

5.2.4 Challenges faced by teachers of mathematics in using laboratory method in teaching and learning Mathematics in secondary schools

. Most teachers agreed that classrooms were not equipped with graph boards and that the administration supported using instructional materials. They also disagreed that it was challenging to complete the course in time using instructional materials, that instructional resources were unavailable, that teachers did not have the skills to select appropriate and innovative materials, and that the administration was unwilling to support purchasing materials. Other challenges faced included many students per class, inadequate material, and insufficient time for the subject. No significant difference was found between learners and teachers in their responses.

5.3 Conclusions of the Study

The themes obtained from the study objectives served as the foundation for the study's conclusion.

5.3.1 Effects of laboratory method on Mathematics performance

The study shows that students' total mean Mathematical achievement was considerably impacted by the laboratory method of instruction. The experimental group outperformed the control group, which got traditional Mathematics instruction, regarding mean achievement. According to teachers and students, the laboratory teaching method considerably impacted students' Mathematical performance on reflection and congruence. This is attributable to the method's ability to assist students in retaining new information for more extended periods, help them understand it more thoroughly than before, help eliminate abstractness, improve performance, allow for sophisticated tools, and let students practice new abilities. Additionally, compared to the conventional instructional approach, the method was frequently less expensive and time-consuming, increased the effectiveness of teaching and learning, helped students develop the skills needed for more advanced research studies, and encouraged the growth of scientific thinking.

The Standardized Mathematics Achievement Test (MAT) pre-test experimental group showed significantly superior performance than the control group in the theme of reflection and congruence, according to the assessment of student performance for the three types of schools.

5.3.2 Effects of laboratory method on Students' Motivation

Motivated students were used in the laboratory approach to teaching Mathematics. This is because the system allowed students to develop their self-esteem, engage in Mathematical activities willingly, develop an interest in learning Mathematics, increase their participation in the learning process, and think critically about and understand their surroundings rather than memorize facts.

5.3.3 Challenges faced by teachers of Mathematics in using a laboratory method

For the challenges that came with the use of the laboratory method, the researcher found that the classrooms were not equipped with graph board, inadequate material to teach students, and the time spared for teaching the Mathematics subject was insufficient.

5.4 Recommendations

Based on the findings and conclusions, the researcher makes the following recommendations:

5.4.1 The Effects of laboratory method on Mathematics Performance

i. Teachers of Mathematics should include the laboratory method as one of the methods used in reflection and congruence and other Mathematics-related topics.

5.4.2 The Effect of laboratory method on Students’ Motivation of Mathematics

i. Teachers of Mathematics should also use the laboratory teaching method to enhance motivation to study Mathematics, especially on reflection and congruence, as well as in other related sub-topics in Mathematics.

5.4.3 The challenges faced by teachers of Mathematics in using a laboratory method

i. Teaching resources such as graph boards should be provided in all classes by the administration to ensure that smooth and effective teaching and learning take place.

5.5 Suggestions for Further Research

The present study highlights the following areas for further research:

i. An investigation should evaluate the impact of gender on Mathematical performance, a topic that the current study could not cover.

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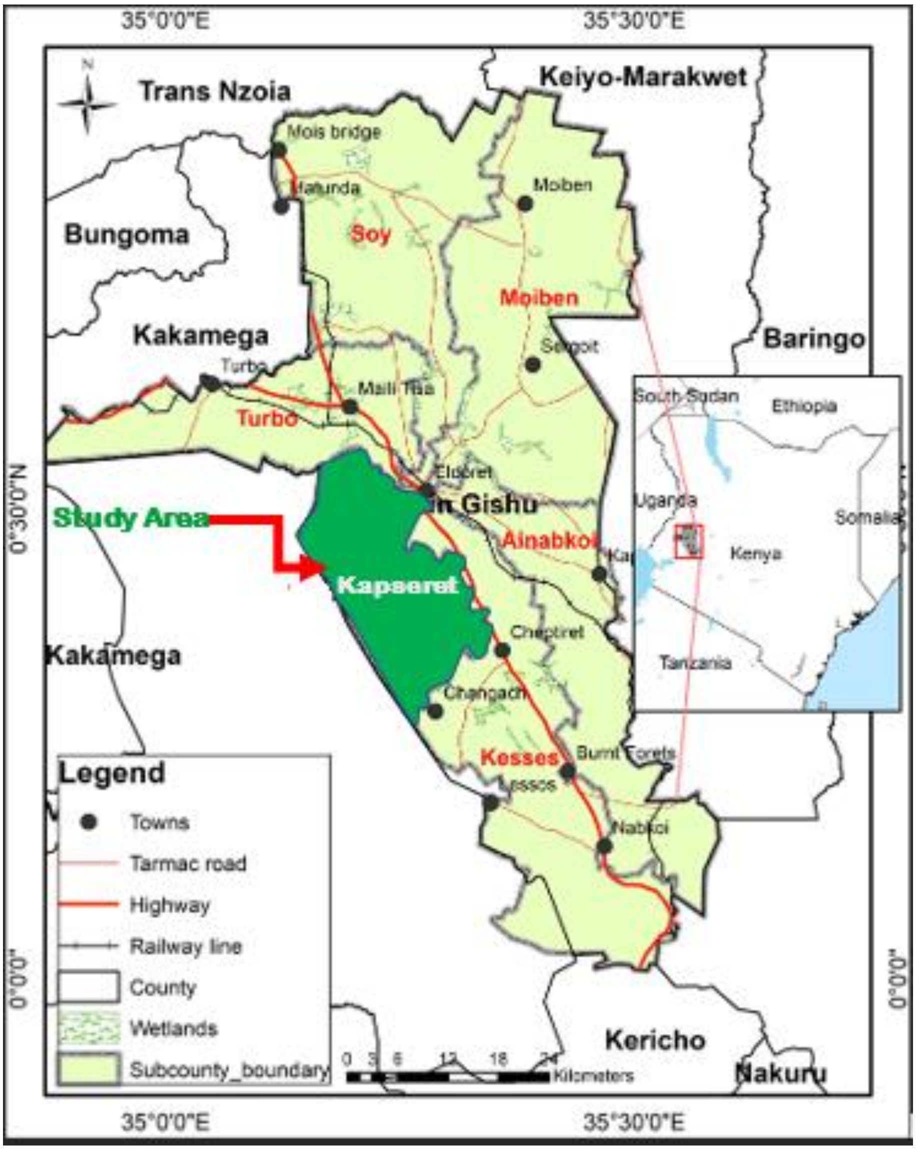
APPENDICES

Appendix I: A map of the study area in Kenya



Appendix II: Practical Activity on Reflection and Congruence

OBJECTIVES

By the end of the practical activity, the learner should be able to;

(i) Apply concepts of reflection and congruence in a real life set up.

RESOURCES

(a) Marking ash
(b) Right angle frame
(c) Hammer
(d) Large protractor
(e) Peakcons
(f) Metre rule
(g) Poles
(h) Nails 0.5 inches

QUESTION

Your school intends to build two Mathematics laboratories that are congruent and a reflection of each other. They should be 1 metre apart from the walls facing each other. Given that, the dimensions and angles of the laboratories are as follows:

(i) Roofing
Slant height- 0.6 metres
Length – 1 metre
Angle -60 degrees
(ii) Walls
Length- 1 metre
Width- 0.5 metres
Height- 0.55 metres
Angle- 90 degrees

Procedure

- Using the hammer and the metre rule, mark the corners of the laboratory inserting the Peakcons.

- Using marking ash, mark out the foundation of the laboratories on the ground.
- Using the right angle triangle, erect the poles in each corner of the laboratory.
- Using the hammer and the nails join the length and the width of the walls and the roof of the laboratory.

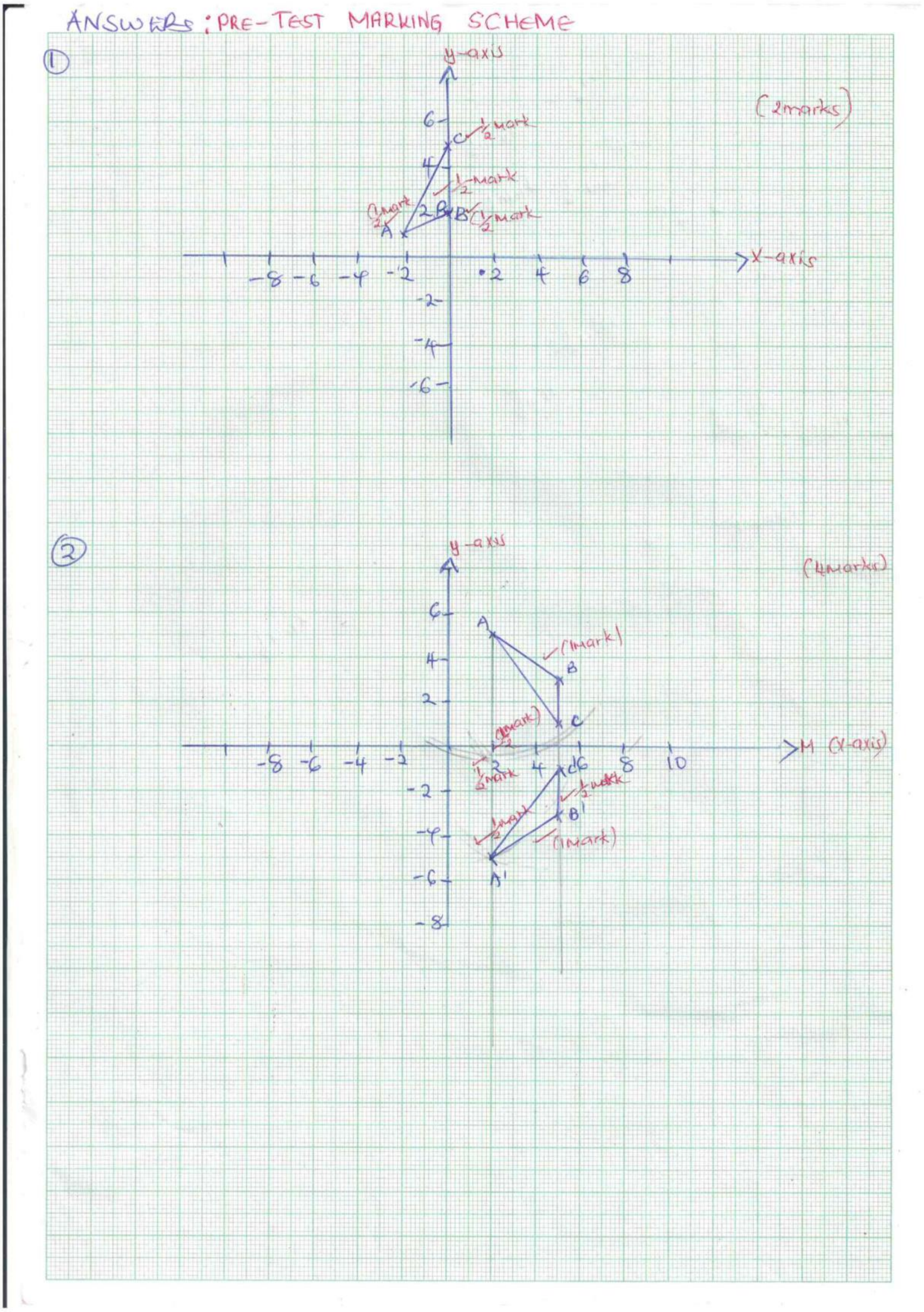
Reflect the laboratory you have constructed above and determine on its congruence.

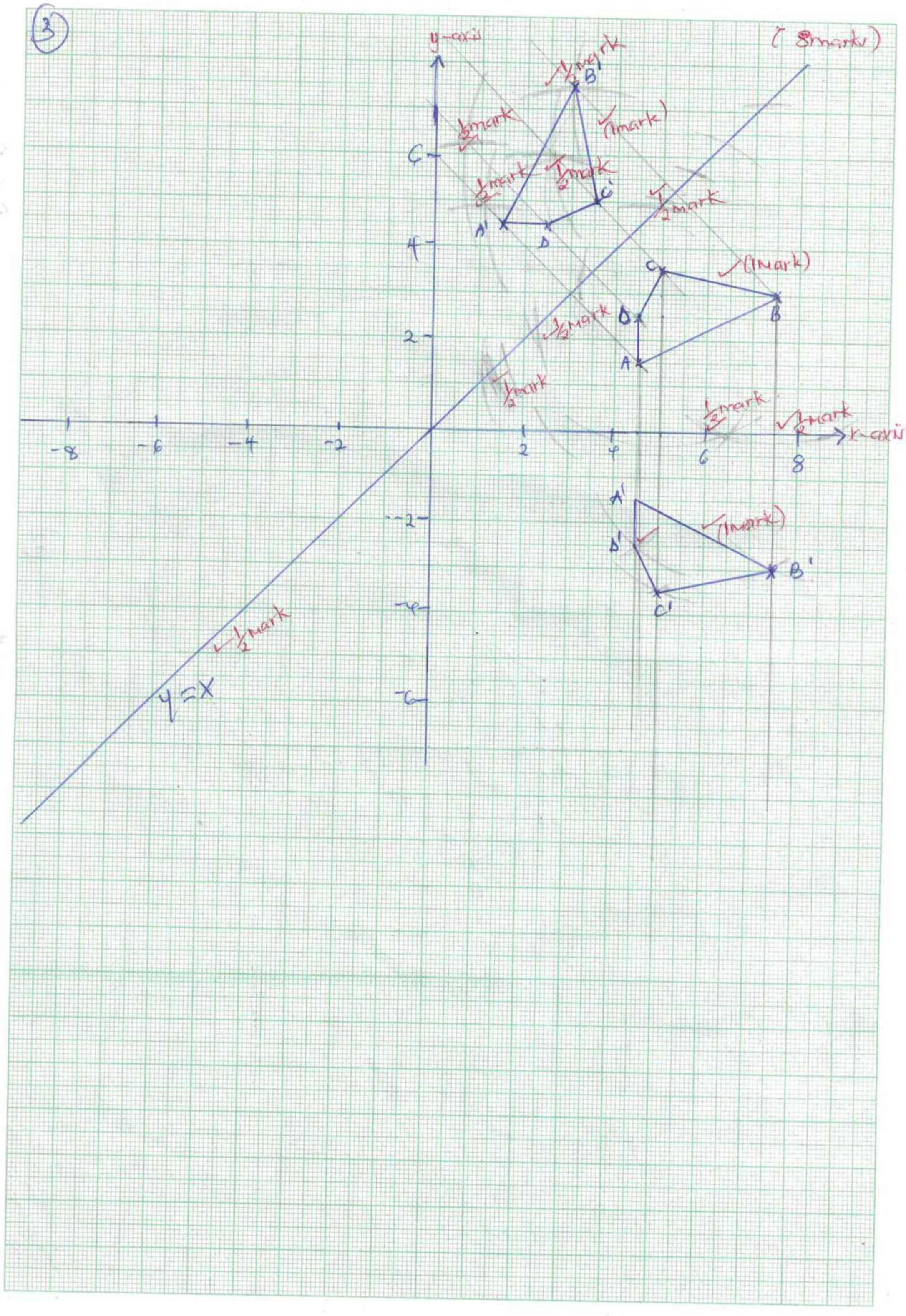
Appendix III: Pretest Questions and Post-test Questions

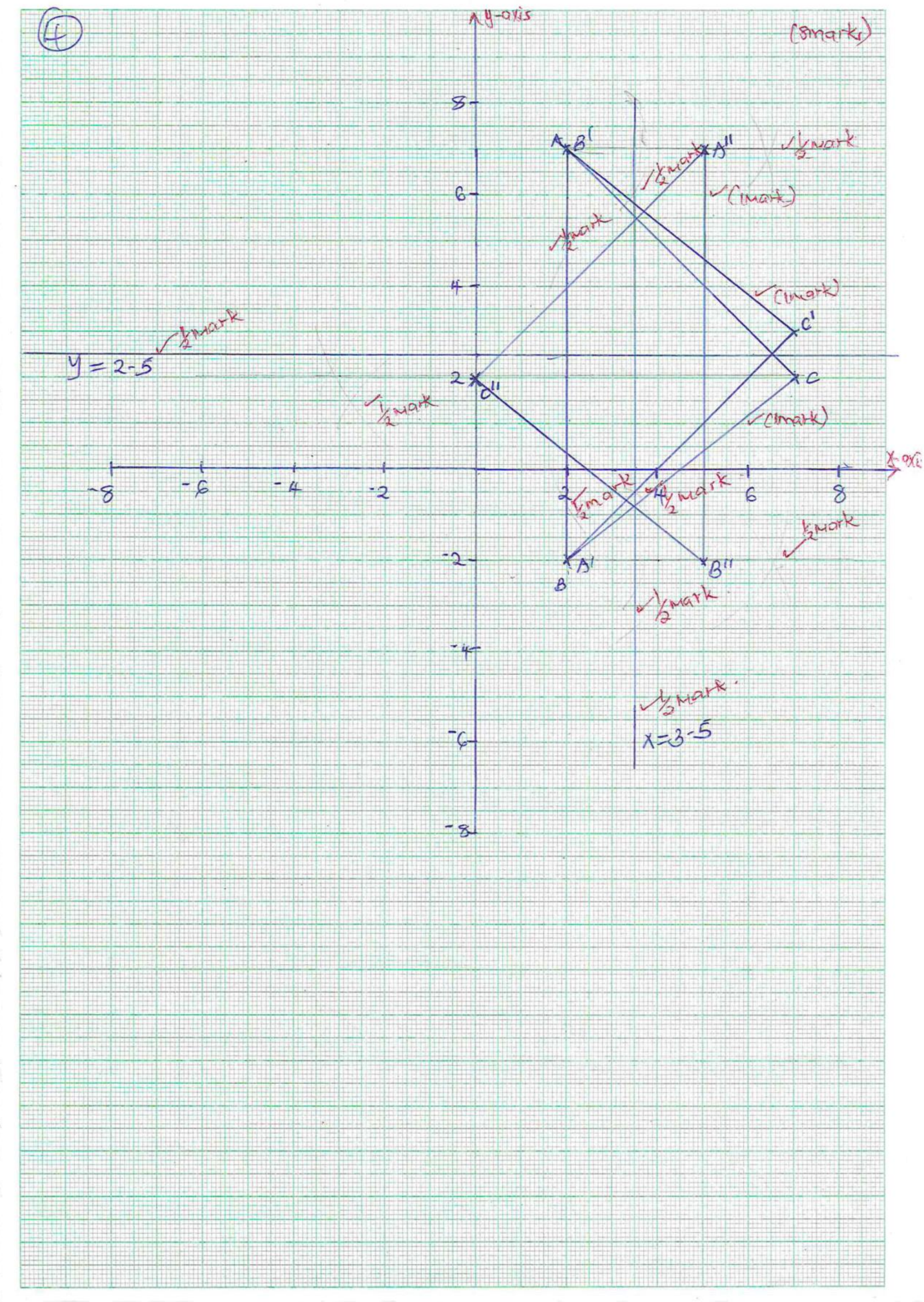
PRETEST QUESTIONS

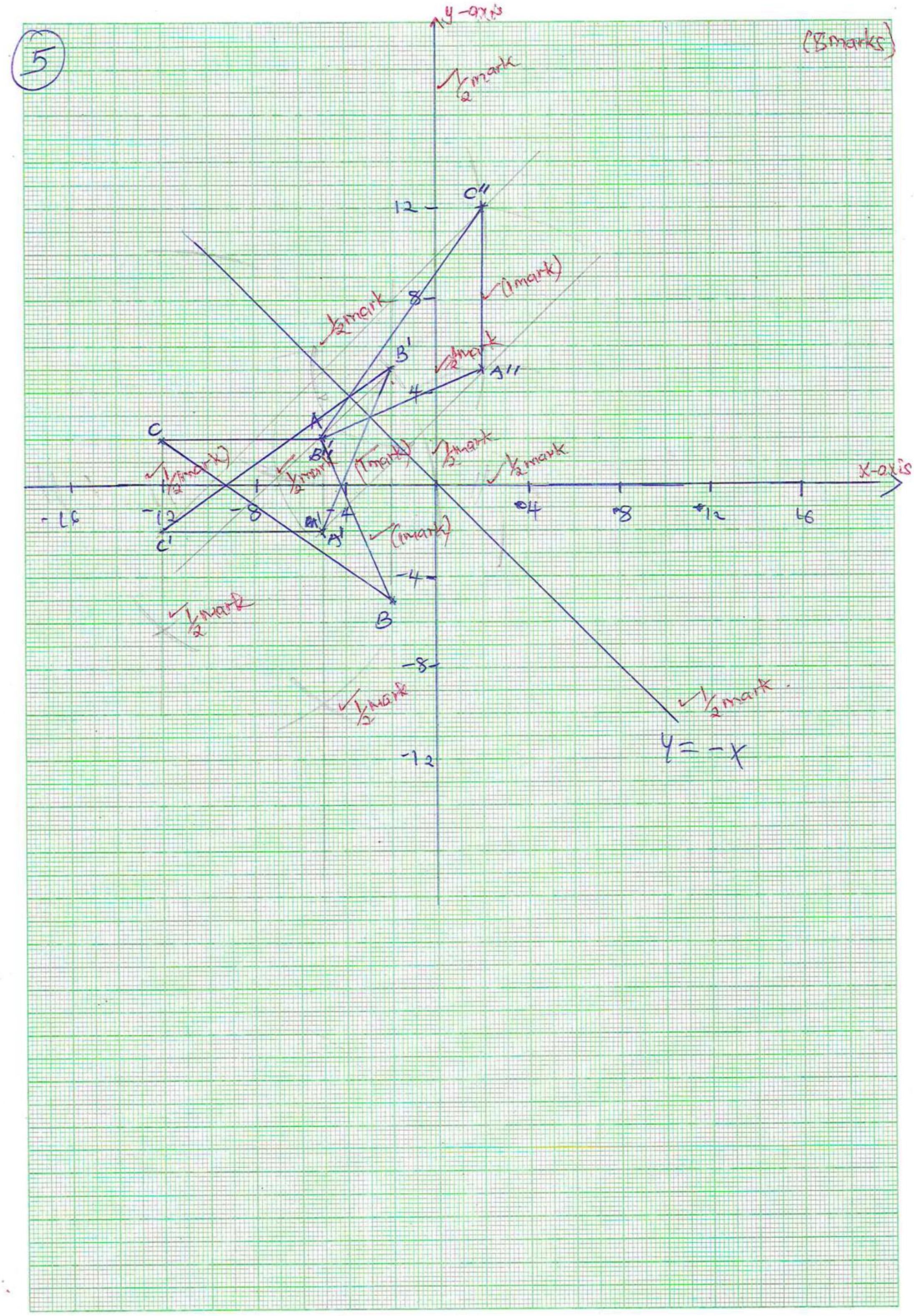
1. Draw a triangle A (-2, 1), B (0, 2), C (0, 5) on the graph provided below (2marks)
2. Construct the image to a triangle A(2, 5), B (5, 3) and C (3, 1) given below under reflection in a mirror line M (4marks).
3. The vertices of a quadrilateral ABCD are A (4.5, 1.5), B (7.5, 3), C (5, 3.5) and D (4.5, 2.5). Draw on the same axis the quadrilateral and its image after a reflection by construction in;
   a) x- axis (4marks)
   b) y=x (4marks)
4. If A (2, 7), B (2, -2) and C (7, -2) are the vertices of a triangle. Find the image of the triangle by construction under a reflection in the line;
   a) y=2.5 (4marks)
   b) x=3.5 (4marks)
5. If A (-5, 2), B (-2, -5) and C (-12, 2) are vertices of a triangle, find the image of the triangle by construction when it is reflection in y axis followed by a reflection in the line y=-x (8marks)

PRETEST MARKING SCHEME



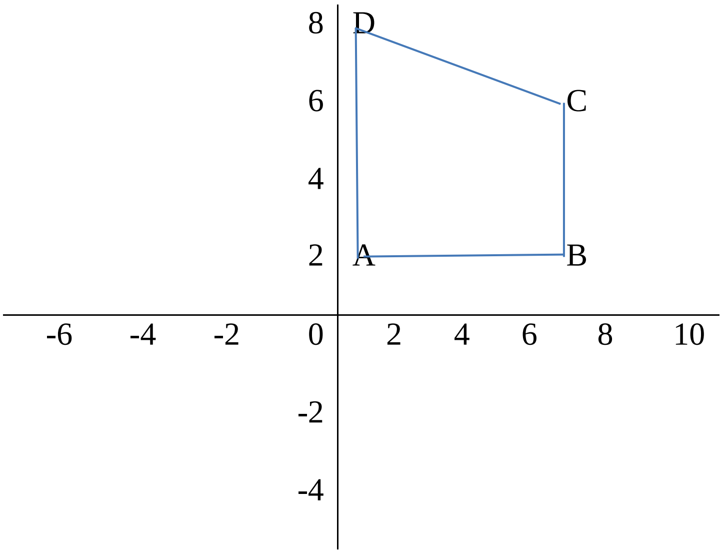

3
(8 marks)
y-axis
x-axis
y = x
A
B
C
D
A'
B'
C'
D'
√1/2 mark
√(1 mark)
-8
-6
-4
-2
2
4
6
8


4
(8marks)
y-axis
x-axis
y = 2.5
x = 3.5
A
B'
A''
C'
C
C''
A'
B
B''
½ mark
(1mark)
8
6
4
2
-2
-4
-6
-8


5
(8marks)
y-axis
x-axis
y = -x
C''
A''
B'
A
B
C
C'
A'
12
8
4
-4
-8
-12
-16
-12
-8
-4
4
8
12
16
(1mark)
½mark

POST TEST QUESTIONS

1. A letter T has vertices at (3, 8), (4, 8), (4, 8) and (4, 6). It is reflected in the x-axis. draw the image of T by construction (3marks)
2. The object shown below is reflected in the line x=-4, followed by a reflection in the line y=x; finds the position of the image under the;



a) First reflection (3marks)

b) Two reflections by constructions (3marks)

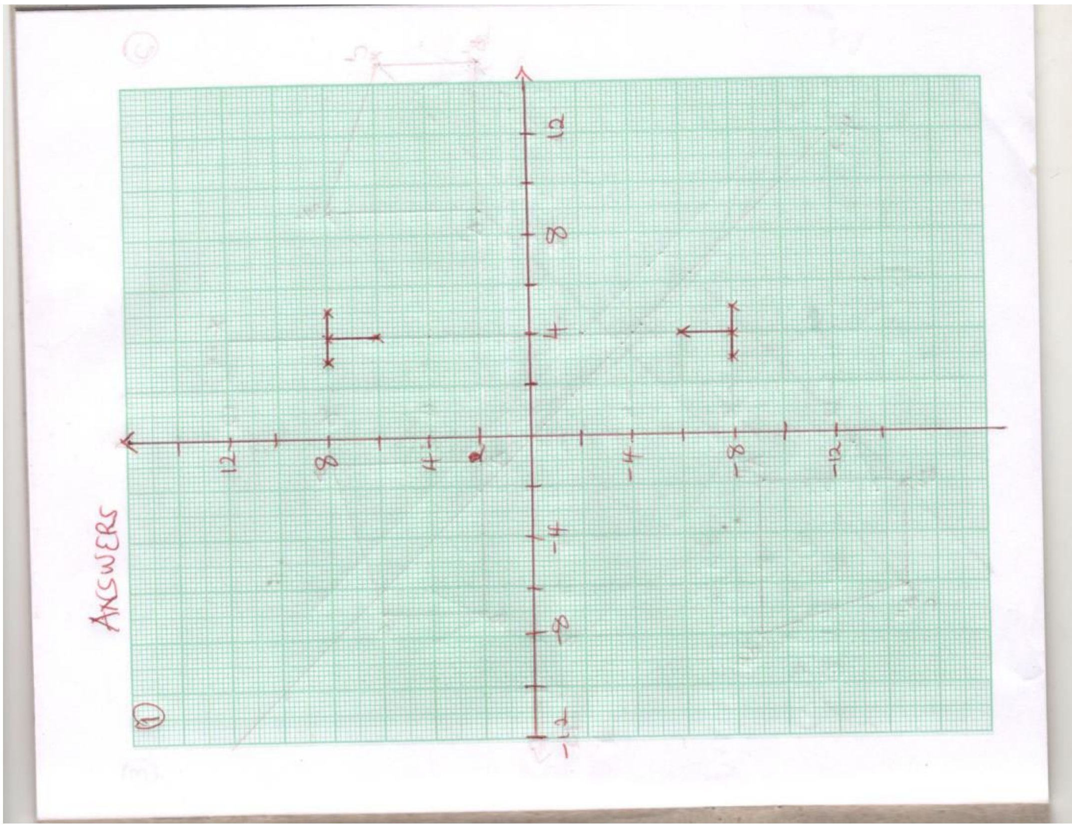
3. A letter N has vertices at (2, 6), (3, 6), (3, 8) and (4, 8). It is reflected in the y – axis followed by a reflection in the line y=2. Determine the coordinate of the final image by construction (7 marks).
4. The coordinate of the vertices of the letter V are (8, 4), (9, 2) and (10, 4). If the letter is reflected in the line x=-2 followed by reflection in the line y=x, determine the coordinates of the;

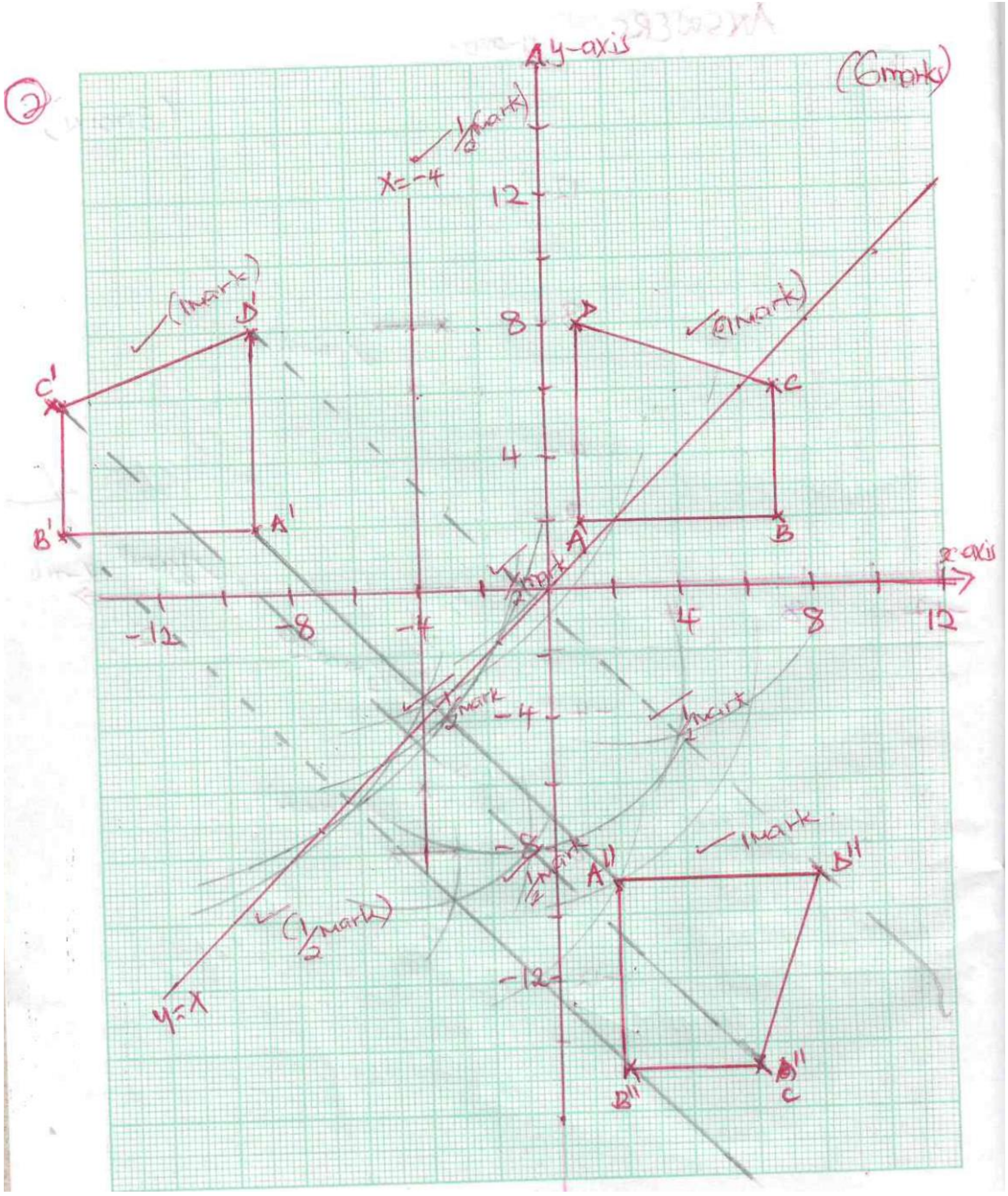
a) First image (3 marks).

b) Final image by construction (3 marks).

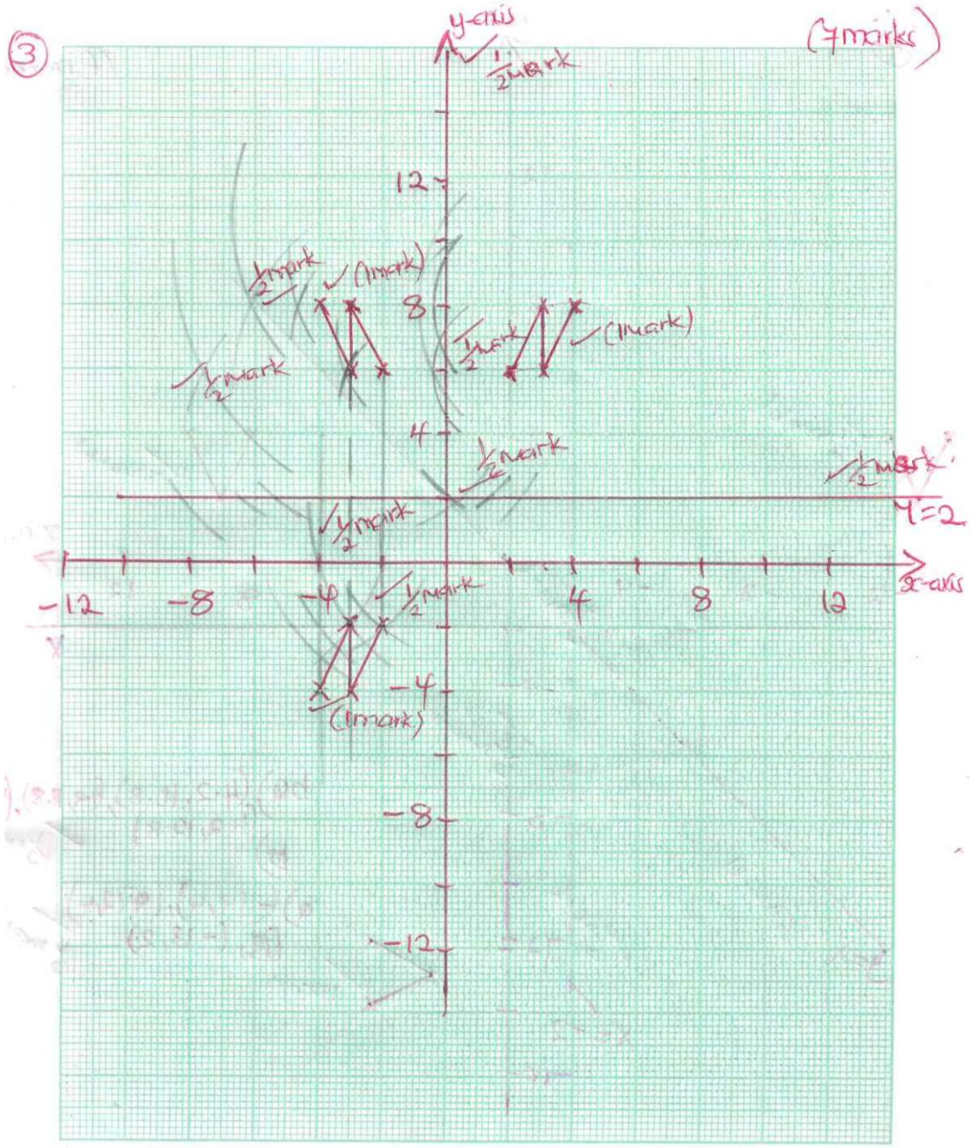
5. The vertices of a polygon ABCDEF are A (-4, 6), B (-2, 3), C (-7, 1) D (-7, 4), E (-8, 5) and F (-7, 6). Find the final image by construction under the reflection in the line; y=x, followed by a reflection in y=-x (8 marks)

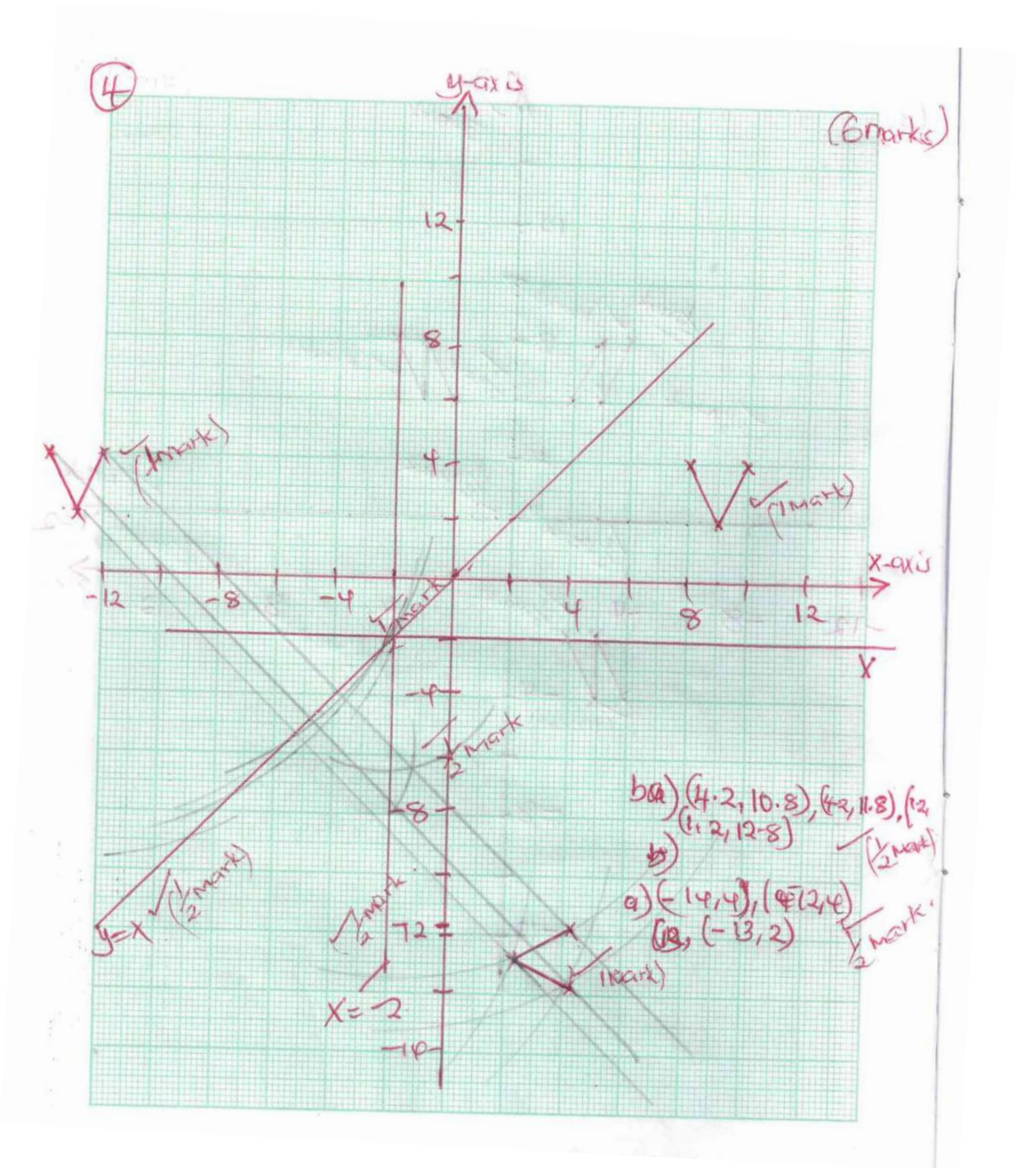
POST-TEST MARKING SCHEME



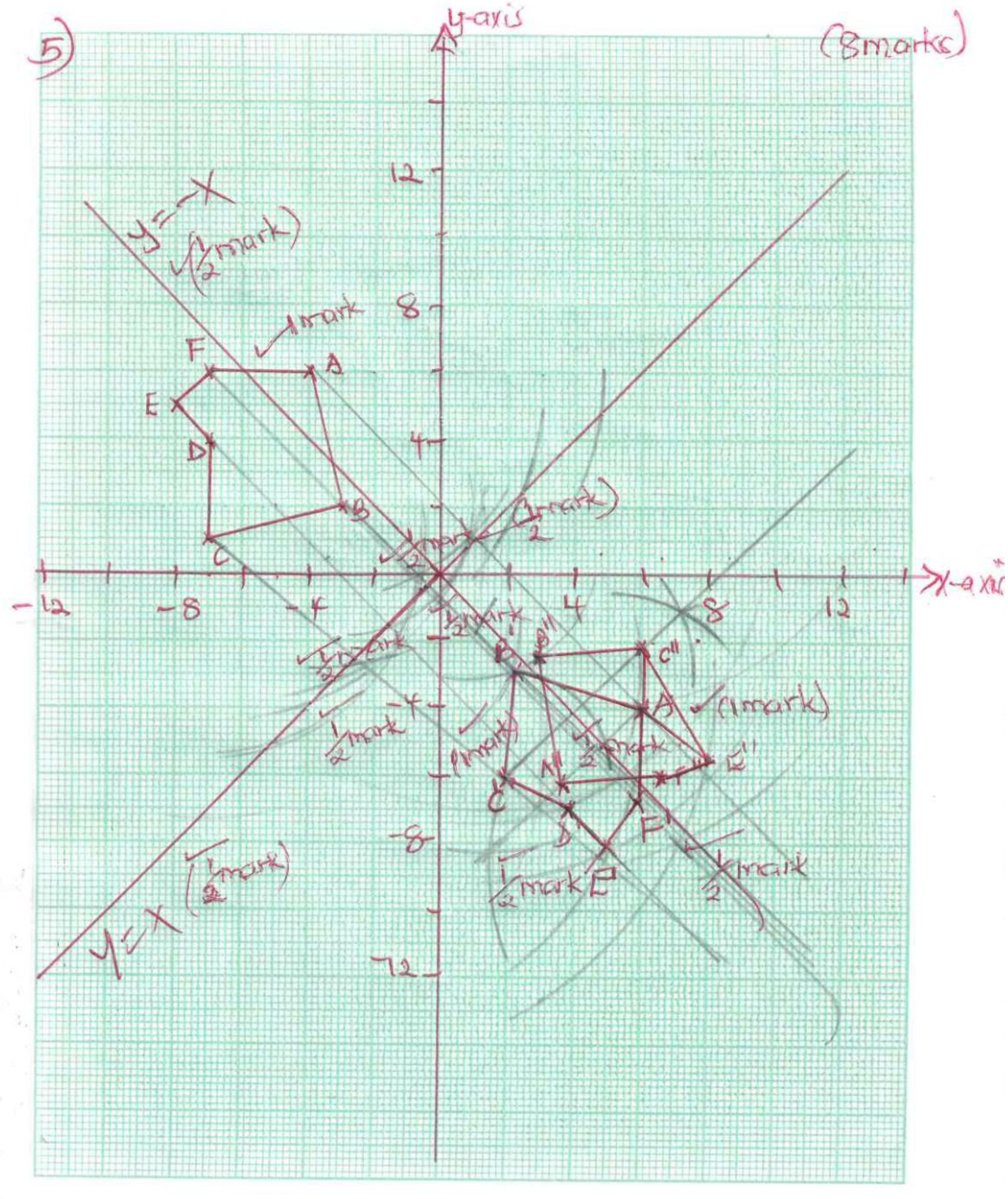


2
(6marks)
y-axis
x-axis
X=-4
y=x
12
8
4
-4
-8
-12
-8
-4
4
8
12
D
C
A
B
D'
C'
B'
A'
A''
D''
B''
C
(1mark)
(1mark)
1mark
(1/2 mark)


3
y-axis
(7marks)
1/2 mark
12
1/2 mark
(1mark)
8
1/2 mark
(1mark)
1/2 mark
4
1/2 mark
1/2 mark
y=2
1/2 mark
-12
-8
-4
1/2 mark
4
8
12
x-axis
-4
(1mark)
-8
-12



4
y-axis
(6marks)
x-axis
y=x
x=-2


5)
y-axis
(8marks)
x-axis
y=-x
(1/2 mark)
1mark
(1mark)
(1/2 mark)
y=x
(1/2 mark)
F
A
E
D
B
C
A'
B'
C'
D'
E'
F'
A''
B''
C''
E''
12
8
4
-4
-8
-12
-8
-4
4
8
12

Appendix IV: Lesson Observation Form

SECTION A:

Gender:

a. Male ( )

b. Female ( )

Type of lesson:

a. Practical ( )
b. Theoretical ( )

Total number of students:………………

Male ……………….. Female ……………………

Time spend by teacher in classroom…………………………….

SECTION B:

NUMBER	INDICATOR	ASPECTS TO BE OBSERVED	SCORE (1= greatly exceeding expectation; 2= exceeded expectations; 3=matched expectation; 4= less than expected; 5= much less than expected				
			1	2	3	4	5
1	Learners' attentive	Student maintain eye contact to the illustrations of the concept being taught					
2	Learners' shows interest in learning	Student prepare short notes					
3	Learners' are self-driven and competent in problem solving	Learners' work on given exercise without a problem					
4	The learning environment is favorable for students/learners'	Learners' are confidants and do not fear asking questions. They raise their hands to ask questions					
5	Learners' are happy to answer questions in class with critical thinking	Learners' raises hands					

Appendix V: Teachers questionnaires

I am a master's degree student of Mathematics Education, Department of Centre for Teacher Education at the University of Eldoret, carrying project research on the Effects of Laboratory Methods on Mathematics Performance and Motivation among Secondary School Students of Kapseret Sub County in Uasin Gishu County, Kenya as the partial fulfillment of my degree graduation. So to complete this thesis, I have prepared some questionnaires for you. A researcher is very much thankful for your valuable help and would like to express gratitude to you and your institution. The information collected will be treated confidentially and used for academic purposes only

A. Personal details {Tick as appropriate}

1. Gender (a) Male [ ] (b) Female [ ]

2. Age: a) 20-30 ( ) b) 31-40 ( ) c) 41-50 ( ) d) over 50

3. Level of education: a) university ( ) b) secondary ( ) c) college ( )

4. How many years of experience do you have in teaching Mathematics

More than 24 [] between 15-24 [] between 10-14 []

between 5-9 [] below 5 []

5. Which of the following methods have you been trained on?

a) Lecture method ( )
b) Demonstration method ( )
c) Laboratory method ( )
d) Problem solving method ( )
e) Discovery method ( )
f) Others…………………..

SECTION B: Effects of instructional method on Mathematics performance on reflection and congruence among your students

Read each of the statements described in the questionnaire carefully and express honestly your opinion by putting tick marks (√) at the appropriate space where SA = strongly agree A = agree U = undecided DA = disagree SD = strongly disagree

Statement	**Level of agreement**				
The method that I used to teach this topic;	SA	A	U	DA	SD
Made the students to retain the learned concept longer					
Enabled the learners' to understand the concepts better than before.					
Helped in removing abstractness					
Boosted the learners' performance					
Enabled use of complex equipment and allowed students to develop skills.					
Often cheaper and less time-consuming than other methods.					
increased effective Teaching and learning					
It helps the students to build interest in learning the subject.					
provides opportunity to exhibit the relatedness of Mathematical concepts with everyday life					
It provides greater scope for individual participation in the process of learning.					
Builds confidence in learning the subject.					
Enabled the learners' develop skills necessary for more advanced study or research					
promoted the development of scientific thinking in students					
Enabled the students to answer the given questions correctly.					

SECTION C: Effect of Instructional Method on students' motivation for the topic reflection and congruence on Mathematics among your students

Read the questionnaire carefully and express honestly your opinion by putting tick marks (√) at the appropriate space where SA = strongly agree A = agree U = undecided DA = disagree SD = strongly disagree

Statement	**Level of agreement**				
The method that I used to teach this topic:	SA	A	U	DA	SD
Enable the students to like the subject.					
Build the students confidence.					
Increased the learners' participation in the process of learning					
Made the students to think and understand things and the world around them rather than making them memorize the facts					
Made the students to develop interest in learning the subject.					
Increased learners' attention.					
Made the learning of subject to be enjoyable.					
Made the learners' to do Mathematics willingly					

(i) In which other ways are your students motivated?

SECTION D: Challenges faced by Teachers of Mathematics in using instructional method in teaching and learning Mathematics in your Secondary School

Read each of the statements described in the questionnaire carefully and express honestly your opinion by putting tick marks (√) at the appropriate space where SA = strongly agree A = agree U = undecided DA = disagree SD = strongly disagree

Statement	**Level of agreement**				
In using this method to teach this topic:	SA	A	U	DA	SD
The instructional resources are unavailable in our school laboratory.					
I don't have skills to select appropriate and innovative instructional materials to use.					
Made it difficult to complete the whole course in time since it is time consuming.					
There are no sufficient leisure periods even to think about construction and use of instructional materials					
The administration is not willing to support in terms of finance to purchase on instructional materials.					
The classroom is not equipped with a graph board.					
It is easy to complete the whole course in time using instructional materials.					
The administration often support both economically and physically to use instructional materials in teaching					
It is compulsion for me to take extra period due to insufficient Mathematics teacher					

(i) What are some of the other challenges faced on using this method?

Appendix VI: Students questionnaires

I am a master's degree student of Mathematics Education, Department of Centre for Teacher Education at the University of Eldoret carrying project research on the Effects of Laboratory Method on Mathematics Performance and Motivation among Secondary School Students, of Kapseret Sub County in Uasin Gishu County, Kenya as the partial fulfillment of my degree graduation. To complete this thesis, I have prepared some questionnaires for you. Researcher is very much thankful for your valuable help and would like to express gratitude to you and your institution. The information collected will be treated confidentially and used for academic purposes only.

Category of school: ………………………………………………………

A. Personal details {Tick as appropriate}

1. Gender (a) Male [ ] (b) Female [ ]

2. Age: (a) 12 years and below [ ] b) 13 to 15 [ ] c) 16 to 18 [ ]

d) 19 to 21 [ ] e) Above 21 [ ]

SECTION B: Effects of instructional method for the topic reflection and congruence on Mathematics performance among your students.

Read the questionnaire carefully and express honestly your opinion by putting tick marks (√) at the appropriate space where SA = strongly agree A = agree U = undecided DA = disagree SD = strongly disagree

Statement	**Level of agreement**				
The method used in learning:	SA	A	U	DA	SD
1. Boosted the performance.					
2. Helped in removing abstractness in learning.					
3. Assisted in increasing effective learning.					
4. Helped the students to build interest in learning the subject.					
5. Enabled the use of complex equipment.					

6. Made the students retain concept for longer period					
7. Enabled the students relate Mathematical concepts with everyday life					
8. Provided greater scope for individual participation in the process of learning.					
9. Increased the learners'' attention.					
10. Made the students answer the given questions correctly					
11. Helped us used to develop skills necessary for more advanced study or research					
12. Rather than making the kids memorize the facts, they are made to think and understand things and the world around them.					

(i) In what other ways did the method you used in learning influence on your Mathematics performance?

SECTION C: Effect of instructional method on students' motivation of Mathematics in your Secondary School

Read the questionnaire carefully and express honestly your opinion by putting tick marks (√) at the appropriate space where SA = strongly agree A = agree U = undecided DA = disagree SD = strongly disagree

Statement	Level of agreement				
The method used to learn this topic:	SA	A	U	DA	SD
1. Increased the attention					
2. Provided greater scope for individual participation in the process of learning.					
3. Allowed students to develop skills and proficiency through manipulation of tools					
4. Made the students enjoy the subject.					
5. Made the students like the subject.					
6. Build confidence in learning the subject.					
7. Made the learners' to do Mathematics willingly					

In what other ways did the method you used in learning motivated you?

Appendix VII: HOD Interview Schedule

I am a master's degree student of Mathematics Education, Department of Centre for Teacher Education at the University of Eldoret, carrying project research on the Effects of Laboratory Methods on Mathematics Performance and Motivation among Secondary School Students of Kapseret Sub County in Uasin Gishu County, Kenya as the partial fulfillment of my degree graduation. So to complete this thesis, I have prepared some interview schedules for you. The researcher is very much thankful for your valuable help and would like to express gratitude to you and your institution. The information collected will be treated confidentially and used for academic purposes only.

Gender: Male ( )

Female ( )

1. What are the effects of the Laboratory method on Mathematical performance among your students?
2. Has the laboratory method motivated Mathematics students in your Secondary School?
3. What are the challenges faced by Teachers of Mathematics in using laboratory methods?

Appendix VIII: Letter of Introduction

JEPKOSGEI PURITY,
UNIVERSITY OF ELDORET,
P.O BOX 1125 -30100,
ELDORET

The principal,
……………………….….school

Dear sir/madam,

RE: PERMISSION TO COLLECT DATA IN YOUR SCHOOL

I am a post-graduate student at the Department of the Center for Teacher Education.

The University of Eldoret intends to study the Effects of Laboratory Methods on Mathematics Performance and Motivation among Secondary Schools students in Kapseret Sub County, Kenya. Since the study is conducted for academic purposes, any participation would be greatly appreciated. The respondent's name will remain anonymous, and the information supplied will only be utilized for the study.

Yours faithfully,

Jepkosgei Purity

Appendix IX: Research permit

University of Eldoret

P.O. Box 1125-30100, ELDORET, Kenya
Tel: 053-2063111/8 Ext.2032
Fax No. 20-2141257
Email: soe@uoeld.co.ke
www.uoeld.ac.ke

UNIVERSITY OF ELDORET

SCHOOL OF EDUCATION
CENTRE FOR TEACHER EDUCATION

Ref: UOE/B/CTE/REF/034 **Date**: 1st September, 2022

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

Dear Sir/Madam,

SUBJECT: RESEARCH PERMIT FOR: JEPKOSGEI PURITY
REG. NO.: SEDU/CTE/M /009/21

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

She is currently preparing for a Field Research Work on her thesis entitled: *Effects of Laboratory Method on Mathematics performance and motivation among secondary school students in Uasin-Gishu county, Kenya.*

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

Yours Faithfully,

HEAD
Centre for Teacher Education
UNIVERSITY OF ELDORET

DR. R. M. AMIN'GA
HEAD, CENTRE FOR TEACHER EDUCATION

University of Eldoret is ISO 9001:2015 Certified

Appendix X: NACOSTI Research permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: 820412

Date of Issue: 23/September/2022

RESEARCH LICENSE

This is to Certify that Miss.. Purity Jepkosgei of University of Eldoret, has been licensed to conduct research in Nakuru, Uasin-Gishu on the topic: Effects of Laboratory Method on Mathematics performance and motivation among secondary school students in Uasin- Gishu county, Kenya for the period ending : 23/September/2023.

License No: NACOSTI/P/22/20538

820412

Applicant Identification Number

Director General

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

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

Appendix XI: Research Permit from County Commissioner

REPUBLIC OF KENYA

MINISTRY OF EDUCATION

State Department for Early Learning and Basic Education

Email: cdeuasingishucounty@gmail.com
: cdeuasingishucounty@yahoo.com
When replying please quote:

County Director of Education,
Uasin Gishu County,
P.O. Box 9843-30100,
ELDORET.

Ref: No. MOE/UGC/ACT/9/VOLL. IV/268

28TH SEPTEMBER, 2022

JEPKOSGEI PURITY.
UNIVERSITY OF ELDORET
P.O Box 1125- 30100
ELDORET

RE: RESEARCH AUTHORIZATION.

In reference to your Licence Ref no. **NACOSTI/P/22/20538** dated 23RD September, 2022 from National Commission for Science, Technology and Innovation (NACOSTI), you are hereby granted the authority to carry out research on **"Effects of Laboratory Method on Mathematics performance and motivation among secondary school students in *Period Ending 23th September, 2023,"*** Within Uasin Gishu County.

We take this opportunity to wish you well during this data collection.

FOR: COUNTY DIRECTOR OF EDUCATION
UASIN GISHU COUNTY
28 SEPT 2022
P.O. Box 9843 - 30100, ELDORET
TEL: 053-2063342 / 0719127212

ANDREW MIBEI
For: County Director of Education
UASIN GISHU.

Appendix XII: Similarity Report

University of Eldoret

Certificate of Plagiarism Check for Synopsis

Author Name	Jepkosgei Purity SEDU/CTE/M/009/21
Course of Study	Type here...
Name of Guide	Type here...
Department	Type here...
Acceptable Maximum Limit	Type here...
Submitted By	titustoo@uoeld.ac.ke
Paper Title	EFFECTS OF LABORATORY METHOD ON MATHEMATICS PERFORMANCE AND MOTIVATION AMONG SECONDARY SCHOOL STUDENTS IN KAPSERET SUB COUNTY, KENYA
Similarity	6%
Paper ID	986412
Submission Date	2023-09-27 15:29:09

Signature of Student

Signature of Guide

Head of the Department

* This report has been generated by DrillBit Anti-Plagiarism Software