FLIPPED CLASSROOM LEARNING INFLUENCE ON MATHEMATICS PERFORMANCE AMONG LEARNERS IN THIKA HIGH SCHOOL FOR THE VISUALLY IMPAIRED, KIAMBU COUNTY, KENYA

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RESEARCH THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR AWARD OF THE DEGREE OF MASTER OF EDUCATION (SPECIAL NEEDS EDUCATION) IN THE SCHOOL OF EDUCATION AT KENYATTA UNIVERSITY

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Declaration

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

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DEDICATION

I dedicate this work to my husband, Dr. Peter K. Mulwa who inspired me to enroll for a Master's degree, my sons Onesmus Mulwa Kyalo Junior, Valentinoh Victor Munene Kyalo and Leon Renson Musumbi Kyalo for their endlessly cheering up that kept me going even at points of despair.

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Abbreviations and Acronyms

CG	Control Group
DVD	Digital Video Disc
FCL	Flipped Classroom Learning
KICD	Kenya Institute of Curriculum Development
KNEC	Kenya National Examinations Council
MoE	Ministry of Education
NACOSTI	National Commission of Science, Technology & Innovation
TG	Treatment group
VI	Visual Impairment

Abstract

Learners with visual impairment have continued to perform dismally in mathematics for the past decade. Despite the emerging teaching strategies that are learner-centered teachers predominantly utilize direct instruction methods when teaching mathematics. As learning technologies advance, new pedagogical strategies have developed to improve learners' performance. The purpose of this study was to establish the flipped classroom learning influence on Mathematics performance among learners with visual impairment (VI). The study objectives were to: assess the teaching strategies used in teaching Mathematics to learners with VI, Explore the flipped classroom learning activities suitable for teaching Mathematics to learners with VI, Investigate the effectiveness of flipped classroom learning activities on performance in Mathematics, and Establish the challenges experienced when using flipped classroom learning strategy in learning Mathematics. The study was guided by the meaningful learning theory. The study adopted the quasi-experimental study design enriched with descriptive. The study targeted all form two learners with visual impairment. Purposive, stratified and simple random sampling techniques guided selection of sample size. The data collection instrument used were; classroom observation schedules, interview schedule and pre-test and post-test. Pilot study was done at St. Lucy's high school for the VI. The quantitative data was analysed and presented inform of descriptive statistics and inferential statistics, using Statistical Package of Social Science, version 22. The main findings were; FCL helped learners with VI to learn independently and creatively, thus encouraging them to develop critical thinking skills; FCL is an effective teaching strategy that helped improve academic achievement of learners with VI by raising levels of involvement and access to instructional content and resources. Based on the study findings, the study commended that, The KICD to design a curriculum to allocate more time for Mathematics lesson and schedule training programs for mathematics teachers to expose them to different emerging teaching strategies such as FCL.

CHAPTER ONE

INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 Introduction

This chapter presents the background to the study, statement of the problem, purpose, objectives, research questions, significance, limitations, delimitations, theoretical framework, conceptual framework and operational definition of terms.

1.2 Background to the study

Education is a fundamental human right. It is vital to the financial and social success of every country. The right of learners with disabilities to education has been affirmed in a number of international documents, including the World Declaration on Education for All, which resulted from the World Conference on Education for All (1990). The proclamation underlined the significance of fairness and equitable access to basic education for everyone, with a particular emphasis on learners with disabilities. To operationalize this mandate, the International Council for Education of People with Visual Impairments (ICEVI) formed a strategic partnership with the World Blind Union, culminating in the establishment of the Global Campaign for Education of All Children with Visual Impairments. This initiative explicitly aligns with international commitments to eliminate barriers and ensure equitable educational opportunities for marginalized populations (ICEVI, 2014).

The Individuals with Disabilities Education Act defines "visual impairment" as a vision impairment that, even with treatment, has a negative impact on a child's educational achievement. The World Health Organization (WHO) projects that no fewer than 2.2 billion people around the globe experience visual impairment (VI).

Among these are adolescents with visual impairments who form 15% of the population. The statistics of adolescents with VI has been increasing annually across the globe leading to detrimental effects on well-being and economic development, including reduced education opportunities yet education is a suitable and effective way of empowering learners with VI (Suraweera, Bandara, Wickramarachchi, Dewage, Gunawardana, Nanayakkara and Jayathilaka, 2022). Past research findings, have supported this assertion by revealing that visual impairment is not a barrier to successful learning since it is not associated with cognitive domains and abilities. Notable mathematicians who are visually impaired have been documented throughout history. Among them are statistics instructor Michael Sanderson, geometry specialist Bernard-Morin and Emmanuel Girox and analysis lecturer Lawrence Baggett (Jackson, 2002). Nemeth, a visually impaired scholar in the United States, is also notable for inventing the mathematical braille code, which is called the Nemeth code that is still in use today. Despite the fact that learners with VI face challenges in Mathematics, these historical experiences have established that if given the right support, assistive aids and utilization of the right pedagogical methods, the learners could still acquire knowledge using the remaining senses and could equally compete with their sighted peers.

Although efforts have been made in enrolling learners with VI in school, globally, learners with visual impairment still face difficulties in information seeking and dissemination. The teaching methods utilized in classes to convey Mathematical concepts, shortcomings in learning materials, also learners' unfavorable attitudes about the subject often affect their performance (Wadnor, 2013). Conventional teaching strategies for learners with VI are frequently teacher-centered, which causes

learners to rely on the instructor for knowledge gathering and dissemination, resulting in poor performance in Mathematics (Fernández-Martín, Romero-Rodríguez, Gómez-García & Navas-Parejo; 2020).

The Flipped Learning Network (2014) defines flipped classroom learning as a "pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter". Traditional modalities of classroom-based instruction and assignments are reversed in flipped classroom learning. Learners' uses online videos or instructional Digital Video Discs (DVDs) outside of class. Learners' concentrates in class on learning and implementing knowledge from previously seen films. Individual or group problem-solving exercises, discussion, and other learner-centered activities that foster critical thinking and independence in knowledge searching are used to do this (So & Brush 2008; Strayer, 2012). The role of the teacher is to lead and support such knowledge. (Butrymowiez, 2012). The researcher's experience with international schools in Kenya has shown that FCL exists; It is an approach that can be used by any student, even those with visual impairment because it promotes critical thinking and independence in knowledge searching and dissemination to learners, which lead to improved mathematical achievement.

Flipped classroom learning has been adopted the world over to supplement conventional teaching methods. Studies on the influence of flipped classroom learning on learner performance in various subjects have posted positive results. A systematic review by Fernández-Martín, Romero-Rodríguez, Gómez-García & Navas-Parejo

(2020) asserted that student engagement through flipped classroom learning, enhances self-regulation, collaboration, motivation, and autonomy which leads to improvement in knowledge and attitude, independence in seeking information hence high performance in Mathematical subject areas.

In America, the worldwide web consortium (WWWC) rules on making web content accessible to users with disabilities, accessing programs that support touch and voice in computers, through screen readers using advanced technologies, have been fully adopted (Media Access America & Hollier, 2016). This has enabled content creation in FCL where learners with VI can easily access information leading to independence in learning, therefore, creating a flexible learning environment hence high performance in subject areas. For instance, Klingenberg, Holkesvik, and Augestad (2020) conducted a systematic review of digital learning in Mathematics for learners with severe VI established that interactive flipped classroom learning is a useful resource for students which enhanced their Mathematics performance. In addition, in a comprehensive literature evaluation on the impact of flipped classroom learning among higher education learners in Spain, Fernández, Romero, Gómez, & Navas-Parejo (2020) established that learners' participation through flipped classroom learning improves self-regulation, cooperation, motivation, and autonomy, resulting in improved knowledge and performance in Mathematical subject areas.

In a quasi-experimental study carried out in Taiwan to examine the effectiveness of flipped classroom learning on learners' performance and motivation, Bhagat, Chang, and Chang (2016) established that learners exposed to flipped classroom learning performed better in Mathematics than those who were taught using the conventional instructional method. Further, Wei, Cheng, Chen, Yang, Liu, Dong, & Kinshuk

(2020), found a substantial increase in Mathematics performance in experimental research involving sixth-grade students at a secondary school in Mainland China.

The flipped classroom learning technique has also boosted Mathematics performance in Africa. For instance, Mboshi (2018), conducted research on educating learners with VI in an inclusive setting in Cameroon, descriptive design was utilized to determine the most widely employed teaching tactics while educating learners with VI were read-aloud, lectures, guided learning, and the use of assistive technology. All of these strategies enhanced learners' performance; nevertheless, the researcher recommended that FCL to be implemented to improve learners' academic achievement. Makinde (2020) revealed that flipped classroom learning is a learner-centered strategy that delivered good performance in Mathematics. In a quasi-experimental research, Makinde assessed the influence of the flipped classroom on the learner performance of secondary school pupils in Mathematics in Lagos, Nigeria.

A national survey done by Akakandelwa and Munsanje (2012), in Zambia and a survey by ICEVI (2010), surveying the teaching of Mathematics to learners with VI in Kenya mainstream secondary schools identified considerable ineffective teaching strategies in the field of Mathematics. Both surveys concluded that "Failure to equip these learners, their teachers and education specialists with the appropriate resources and utilization of effective pedagogical strategies means that most learners with VI would perform below their sighted peers in their studies and would inevitably require to drop Science and Mathematical subjects" (ICEVI, 2014, p. 19). These findings concur with a report from KNEC (2019) that revealed that learners with VI have been performing poorly in Mathematics for the last decade. The low performance in Mathematics among learners with VI has been attributed to many factors, among them

the poor adoption of emerging pedagogical innovations by teachers (Mang'ula, 2011; Wairimu, 2019). The use of flipped classroom learning is one such innovation that has not been fully adopted at the school level.

The flipped classroom learning strategy has also been utilized in Kenya, with positive results. For instance, Kithinji (2020) revealed that flipped classroom learning increased academic achievement in science in a quasi-experimental investigation on the impacts of flipped learning facets on primary school learners' academic achievement. Kithinji's study noted that there have been few studies on FCL in Kenya. He also suggested that FCL to be used in the teaching of other subjects, besides more studies on FCL. Concurring to this, Ireri & Omwenga (2016) indicated that providing mobile learning to learners in a flipped classroom paradigm bridges learner entrance behavior while improving learner performance.

It is against this background that this study was conducted to find out the flipped classroom learning influence on Mathematics performance among learners in Thika high school for the VI.

1.3 Statement of the problem

Mathematics is an important subject at all levels of schooling worldwide. Despite the subject's strategic relevance, learners with visual impairment have continued to perform dismally in Kenyan national examinations. In Thika High School for the visually impaired, Mathematics performance produced a mean score of less than 3.5 points out of the possible 12 points for the last six years. This dismal performance makes further education and employment in STEM sectors extremely difficult for learners with VI. Studies revealed that learners with VI perform poorly in

Mathematics owing to insufficient assistive technology and instructors' unwillingness to implement suitable teaching strategies such as flipped classroom learning.

Flipped Classroom Learning has been used for learners without disabilities but minimally for learners with VI. Besides, limited studies have been done in Kenya on the use of flipped classroom learning approach in teaching Mathematics to learners with VI. The low performance in mathematics of learners with VI prompted the researcher to investigate whether flipped classroom learning strategy could help improve the performance in mathematics for learners with VI.

1.4 Purpose of the study

The purpose of this study was to investigate the flipped classroom learning influence on Mathematics performance among learners in Thika high school for the visually impaired, Kiambu County.

1.5 Research objectives

The objectives of the study were to;

i. Establish the teaching strategies used in teaching Mathematics to learners in Thika High School for the visually impaired, Kiambu County, Kenya.
ii. Explore the flipped classroom learning activities suitable for learning Mathematics in Thika High School for the visually impaired, Kiambu County, Kenya.
iii. Investigate the effectiveness of flipped classroom learning activities on performance in Mathematics to learners in Thika High School for the visually impaired, Kiambu County, Kenya.

iv. Establish the challenges experienced by learners with VI while using flipped classroom learning strategy in learning Mathematics in Thika High School for the visually impaired, Kiambu County, Kenya.

1.6 Research questions

i. Which strategies were used in teaching Mathematics to learners in Thika high school for the visually impaired in Kiambu County, Kenya?

ii. What activities in a flipped classroom learning were suitable for learning Mathematics in Thika High School for the visually impaired, Kiambu County, Kenya?

iii. What was the effectiveness of flipped classroom learning activities on performance in Mathematics in Thika High School for the visually impaired, Kiambu County, Kenya?

iv. What challenges did learners with VI experience while using flipped classroom learning strategy in learning Mathematics in Thika high school for the visually impaired, Kiambu County, Kenya?

1.7 Hypothesis

The study was guided by the following null hypothesis:

H_o^1: There is no statistically significant difference between the performance of learners exposed to FCL and those who were not.

1.8 Significance of the Study

The study findings may guide the Ministry of Education (MoE) in policy formulation towards adoption and implementation of flipped classroom learning as an instructional strategy for teaching and learning in secondary schools for the learners with VI.

The Kenya Institute of Curriculum Development (KICD) may use the study findings in curriculum development and implementation of modern teaching strategies such as flipped classroom learning.

The University trainers may use the findings to train student teachers on emerging technological teaching strategies which are learner centred.

The Teachers for learners with VI may use the study findings to improve teaching and learning by incorporating learner centred activities which helps learners to learn independently and develop critical thinking and knowledge construction.

The learners with VI may use the study findings to improve their performance in STEM subjects and choose mathematics-related careers.

1.9 Limitation and Delimitation of the study

This section presents the limitation and delimitation of the study.

1.9.1 Limitation of the study

This study focused on only one learning area; Mathematics, and the findings may not be generalized to other learning areas. The learners in experimental group may have

discussed what they did during the six weeks of the experiment, with the control group. The ability of the teacher to teach mathematics to learners in the control group where a teacher with many years of experience could not be compared to a teacher with few years of experience.

1.9.2 Delimitation of the Study

This study focused on flipped classroom learning as an instructional strategy for teaching Mathematics, other teaching strategies were omitted. Only Form two learners and their Mathematics teachers participated in the study. Form two learners are well settled in school and are in a formative period, they are not in the entry class or the examination class, they are in their formative stage and they do Mathematics; hence targeted to participate in this study. The study focused on learners with VI and who only use braille as a media of reading and writing , learners with VI but use print in reading and writing were omitted. The researcher wanted to see how FCL could be conducted to learners who had total loss of vision, who were only able to listen to recorded audios as oppose to audio-visual videos used in FCL strategy for sighted learners.

1.10 Assumptions of the Study

The study assumed that teachers would embrace FCL as an additional teaching strategy to what they are already using to teach Mathematics. The study also assumed that teachers and learners at Thika High School for the VI would cooperate and give honest information.

1.11 Theoretical and Conceptual Framework

This section presents the theoretical and conceptual framework.

1.11.1 Theoretical Framework

The study was guided by the theory of meaningful learning (ML) (Husen, 1995). Husen's (1995). Theory of meaningful learning states that the teacher or instructional material e.g. books, computers, and television play an important role in ensuring that the learner is engaged appropriately with instructional materials. The five characteristics of the theory of meaningful learning according to Husen (1995) are Active; Constructive; Cumulative; Self-regulated and Goal-oriented. According to the principle of meaningful learning, Humans generate knowledge by contact with the world and with one another, rather than discovering it. The meaningful learning theory is built on learner cooperation, interaction, and engagement. Students are the core of instruction and cognition, according to meaningful learning theory, during the teaching process, teachers should employ a new teaching style and a new teaching design, Therefore, a new teaching mode and design suitable for meaningful learning theory are gradually formed.

Technology-enhanced interactive teaching and learning settings are promoted in modern educational techniques. Among the innovative approaches, the Flipped Classroom Learning (FCL) technique has gained significant prominence due to its potential to enhance problem-solving skills, foster collaboration, increase student engagement, facilitate social interaction, and improve communication, particularly in the context of Mathematics education (Bergmann and Sams, 2012; Cevikbas and Argün, 2017). This study is grounded in the principles of meaningful learning theory,

which posits that knowledge and meaning are socially constructed within the FCL framework through interactive and higher-order cognitive teaching-learning activities. According to this perspective, learning is conceptualized as the creation of an environment wherein learners actively engage in the process of constructing their own understanding (Schreiber and Valle, 2013). Within the framework of meaningful learning theory, the teacher assumes several critical roles in the FCL approach to enhance Mathematics performance (Bergmann and Sams, 2012; Cevikbas, 2018). These roles include: (1) establishing an interactive classroom environment and facilitating learners preparation for class sessions through the utilization of audio and online resources; (2) supporting learners in the construction of knowledge and meaning by providing scaffolding and timely, constructive feedback; (3) fostering learner engagement by encouraging critical thinking, inquiry, active engagement, interaction, and discussion; (4) designing and implementing instructional activities that promote active learning; and (5) employing innovative, goal-oriented assessment strategies. When technology is effectively integrated as an educational tool, it serves to amplify the principles of meaningful learning by enhancing opportunities for social interaction, communication, collaborative discussion, problem-solving, learner engagement, and cooperative learning. Consequently, within the meaningful learning framework, it becomes feasible to evaluate the transformative impact of FCL interventions on Mathematics instruction, identify the potential benefits and challenges associated with flipped Mathematics teaching, and develop an effective FCL design tailored to Mathematics education.

1.11.2 Conceptual Framework

Figure 1.1
Conceptualized Flipped classroom learning(Researcher's-Generated).

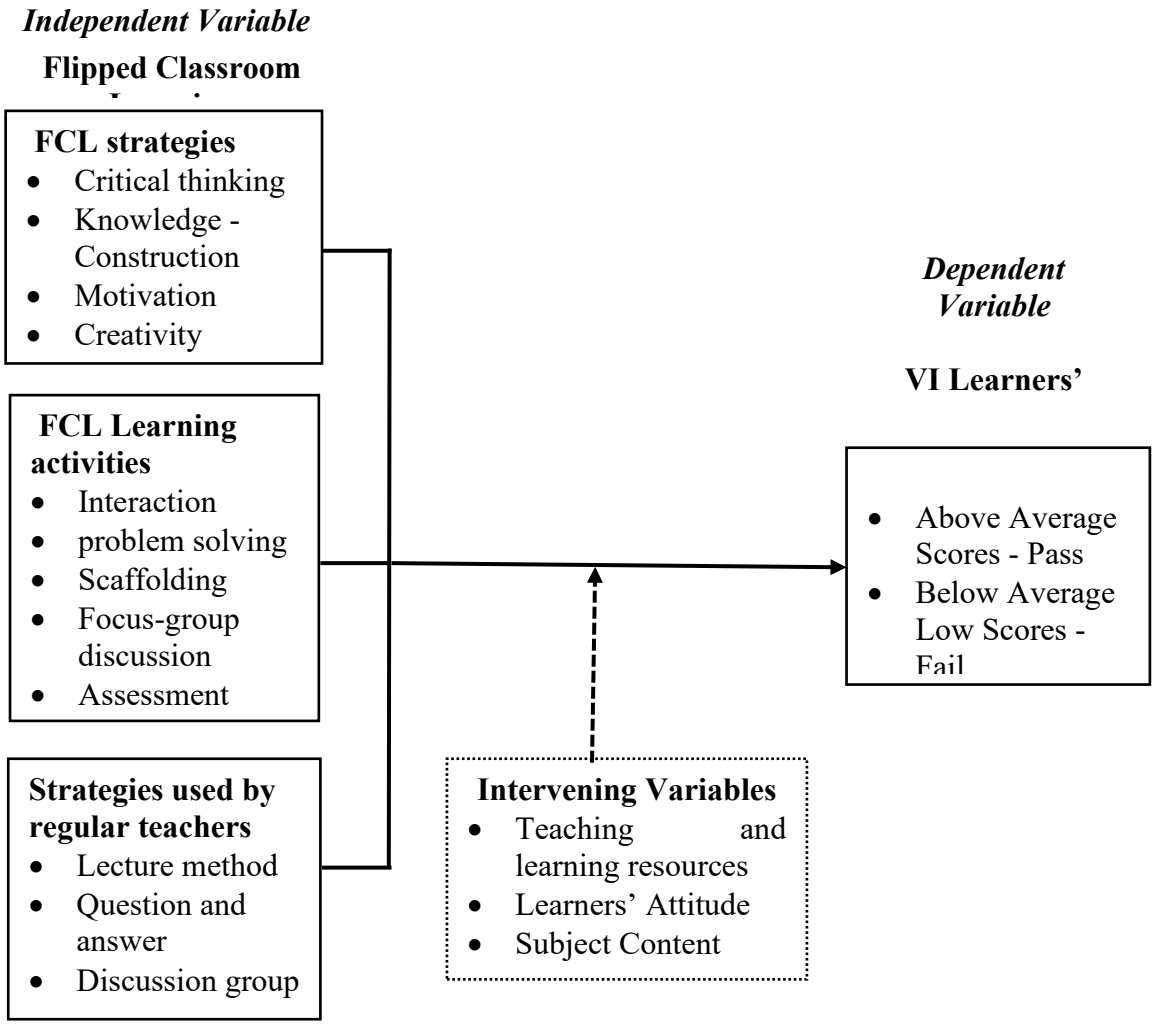

Figure 1.1 shows the conceptual framework that informed this study. This study presented the Flipped classroom learning technique, in which academic and social interactions between learners, content, and teachers take place through recorded audios, focus group discussions, and the instructor acting as a facilitator. The conceptual model is thus founded on the premise that the FCL technique has an influence on learner mathematical performance.

Flipped classroom learning is the independent variable, performance in Mathematics is the dependent variable and the intervening variables are teaching and learning resources, Learner's Attitude and subject content. The performance of learners with VI is influenced by FCL teaching strategy. The FCL is indicated by learning activities, learner engagement and the learning outcome. The learning activities involved in FCL include interaction, scaffolding, assessment and feedback. The FCL plays a crucial role in learner engagement during the in-class and out of class activities. Learners engage in problem solving, interaction, cognition and independent learning responsibility. Because of FCL activities, learners developed critical thinking, Knowledge construction, motivation and creativity. Some of the roles of FCL is to motivate the learners with VI throughout the lesson; helps develop knowledge construction through independent learning responsibility and problem-solving skills thus improving the mathematics performance of learners with VI.

1.12 Operational definition of key terms.

Flipped classroom learning: In this study, Flipped classroom learning refers to a strategy of teaching and learning where classroom-based instruction and homework are reversed in flipped classroom learning. Learners' listen to audios outside of class and concentrates in class on learning and implementing knowledge through Individual or group problem-solving exercises, discussion, and other learner-centered activities that foster critical thinking and reasoning.

Learners Engagement: Learner engagement is the measure that reflects the participation of learners during a Mathematics lesson in flipped classroom learning.

Learners with Visual Impairment: Refers to those learners with no perception of light and those with low vision, which is not enough to allow them to read print.

Teaching Strategies: Refers to teaching methods the instructor uses to instruct learners and those experiences in teaching that make the attainment of knowledge/skills interesting and appealing to learners.

Meaningful Learning: In this study,] Meaningful learning refers to learning experience where learners are actively, engaged and are self-regulated while interacting with content**.**

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter discusses related literature on; Strategies used in teaching Mathematics to learners with visual impairments, flipped classroom learning activities in Mathematics, effectiveness of Flipped Classroom Learning Activities on Performance in Mathematics, and finally, Challenges experienced by learners with VI why using flipped classroom learning strategy.

2.2 Strategies Used in Teaching Mathematics to Learners with Visual Impairments

Learners with visual impairment (VI) require Mathematical skills in order to fit and function well in the contemporary World. This calls for teachers of learners with VI to be creative and innovative in selecting and utilizing specialized and effective strategies for teaching Mathematics to such learners. Specialized teaching strategies facilitate successful engagement of learners including those with visual impairment (VI). Documented studies have explored the effectiveness of various specialized methods of teaching Mathematics. For instance, in a quasi-experimental study that explored the importance of developing graphic skills among Pre-Algebra students with VI in the United States, Rosenblum, Zebehazy, Gage, and Beal (2021) concluded that the use of direct instructions on how to locate and interpret data in graphs and maps improved level of independence in Mathematics classes and performance among the learners. Rosenblum, et al. (2021) used a wide range of learners in various grades from grade five to ten in only one area of mathematics with a sample size of

41. While, the findings by Rosenblum, et al. (2021) concur with earlier findings by Ahmad (2011) who in a quasi-experimental study that sought to verify the effect of direct instruction strategy on Mathematics academic achievement for 4th and 5th grade students with learning difficulties, observed that the approach had effect on basic skills performance and improvement in attitude towards Mathematics, the two studies focused on the direct instruction method which is more teacher centered, with minimal learner engagement. Further, the two studies by Ahmad (2011) and Rosenblum, et al. (2021) did not inform on the active learning activities learners were engaged in. Moreso, the study by Ahmad (2011) focused on learners with difficulties in learning Mathematics and did not inform on the effect of the strategy used on learners with visual impairment. In a departure from these two studies, the current study explored the Flipped Classroom Learning (FCL) influence on performance in Mathematics among form two learners with VI at the Thika High School for the visually impaired in Kenya.

A descriptive study by Kautz (2016) identified strategies used by a developmental Mathematics teacher and learners' perceptions towards these strategies in higher institutions in the United States. The descriptive study involved observation of teachers of Mathematics, classroom practice and triangulation via learners' questionnaires and interviews. Four study participants were selected]through snowball sampling technique. Learners who were eighteen years and above were observed and video recorded in the classes before, during and after the teaching of an algebraic concept. The study focused on three teaching strategies. They included direct instruction, group work and constructivist, while using these teaching strategies the learning activities included were; learner's engagement, modeling, scaffolding,

use of manipulations, use of Technology, use of graphic organizer, use of humor and fun, real-world relevance and use of games. Use of manipulates and use of games were not observed on the recorded video at all. Use of technology was observed on three instructors, use of graphics organizer and humor on two instructors while real world relevance on one instructor. However, Kautz (2016) conducted research with a limited sample size of four typical learners, employing Snowball sampling methods to study general teaching practices. Further, Kautz (2016) focused on three instructional approaches, direct instruction, group work and constructivism. Thus, the study by Kautz (2016) cannot be used to generalize the influence of other strategies such as the flipped classroom learning. In contrast, the present study examined a larger group of forty learners participating in a forty-minute mathematics classes using the purposive sampling technique to gather data from classroom schedules.

In a similar vein, a descriptive study by Carole, Beal and Rosenblum (2018) in USA that investigated the efficiency of a tablet computer program (iPad App) in assisting learners with VI learning in pre-algebra to answer mathematical word problems, revealed that when using the iPad app, learners answered Mathematics problems correctly. Carole, et al. (2018) asserted that the use of the app significantly enhanced learner motivation compared to traditional literacy media. The authors investigated a tablet computer application (iPad app) for its effectiveness in helping learners studying pre-algebra to solve mathematical word problems. The study involved 43 learners who are visually impaired, including those who had no perception of light or had low vision. Among the participants, six braille users and 11 print users completed units in level 1, while three braille users and 11 print users completed eight alternating mathematics units presented using either their traditional literacy medium or the iPad.

A sample problem for each unit was provided to guide the teachers in determining which of the three levels was appropriate for the learners. Twenty percent of the mathematics problems incorporated graphics such as maps, line graphs, and bar graphs. During each session, teachers of learners with visual impairment rated the level of support they provided to learners and assessed their motivation. The results indicated that learners answered more mathematics problems correctly when using the iPad app. Teachers reported that learners demonstrated higher levels of motivation with the app compared to traditional literacy media. Additionally, learners frequently utilized the hints provided in the app when they encountered difficulties in solving a problem correctly on the first attempt. Carole et al. (2018) further noted that both learners with visual impairment and their teachers found the app and its graphical features to be user-friendly and motivating. However, in contrast to Carole, et al. (2018) study which used learners with low vision who use print as a medium of reading and writing, and learners who use braille as a medium of reading and writing, the current study focused exclusively on learners who rely solely on braille as their medium of reading and writing. Furthermore, the current study examined three mathematics units using a flipped classroom learning strategy, which is a learner-centered approach, and investigated its influence on Mathematics performance among learners with VI.

In order to support the learning process and help learners with visual impairment understand mathematics, Ma´ckowski, M., Kawulok, M., Brzoza, P. and Spinczyk, D. (2023) conducted an experimental study in Poland; employing a digital platform featuring differentiated interaction modalities it involved the use of a platform where sighted learners interacted with Mathematical content using a graphical user interface

(GUI) with mouse and keyboard controls, whereas participants who were visually impaired accessed mathematical content through a keyboard and assistive technologies like a screen reader and speech synthesizer. Ma'ckowski et al. (2023) created a strategy that tailored the learning path for each learner. The evaluation process showed a statistically significant improvement in learning results achieved by learners with VI and an increased cooperation between learners with VI who had the opportunity to take on the role of a teacher, indicating effectiveness of the proposed approach and active engagement of learners, which aided in overcoming challenges that hinder learning of mathematics such as uncertainty, lack of motivation and difficulties in acquisition and retention of the concepts taught. While the experimental framework developed by Ma´ckowski et al. (2023) successfully facilitated learner engagement through its multimodal design, it was critical to note that the methodology did not integrate flipped classroom learning strategies—a pedagogical innovation central to this study.

Further, in a related study that explored Cameroon's perspective on teaching learners with VI in an inclusive setting, Mboshi (2018) highlighted some of the common strategies used as; large writing on the chalkboard, the use of coloured chalks, and reading aloud what is written on the chalkboard. The study was conducted in an inclusive environment, where the class included learners with diverse disabilities but concentrated on learners with visual impairments. Mboshi (2018) used a variety of methods to collect raw data, included a traditional structured literature review of the study's main variable using Google Scholar, a review of textbooks on the major themes, publications by foundations and institutions, technical and workshop reports, and conference proceedings. However, the current study was conducted in a special

secondary school for learners with visual impairment, using quasi experimental study design enriched with descriptive to collect raw data on Flipped classroom learning influence on mathematics performance among learners with visual impairment. However, Mboshi (2018) did not point out the use of FLC as one of the strategies nor did he hint at how the use of the strategy influence performance among learners with VI.

Additionally, research conducted by Wairimu, Chomba, and Awori (2019) regarding the strategies adopted by teachers when utilizing assistive technologies to teach Mathematics to learners with visual impairment in special primary schools in Kenya indicated that instructors predominantly rely on direct instruction techniques. A descriptive research design was used to carry out the investigation. The purposive sampling approach was used to sample classes 7 and 8 from five special primary schools in Kenya. The study included a sample of nine mathematics teachers who were observed in class instructing learners with visual impairments using a variety of instructional methods. The raw data was gathered using the Classroom Observation Schedule. Qualitative research data was manually analyzed by identifying, examining and interpreting patterns and themes in textual material. The study found that teachers of Mathematics utilized inappropriate teaching strategies when teaching Mathematics to learners with visual impairments. The study indicated that the incorrect use of teaching methods and instructional strategies is genuine and has led to a lack of enthusiasm in working out Mathematics problems, resulting in decline of Mathematics performance among learners with visual impairment. The study did not however give an account of how the use of the strategy influenced performance among the learners. While the descriptive study involving primary school pupils by Wairimu,

et al. (2019) recommended the use of innovative strategies in teaching Mathematics among learners with VI. Five counties participated in the study: Kisumu, Siaya, Mombasa, Meru, and West Pokot. Purposive and stratified random selection procedures were employed to choose research participants. The researcher collected data from 20 learners with VI from classes 7 and 8, ten Mathematics teachers and five deputy head teachers at the designated special primary schools. The overall study sample consequently consisted of thirty-five participants. in contrast, the current study was conducted in only one school, forty-seven study participants were involved, form two learners with visual impairment were involved to collect data using a quasi-experimental study design. Wairimu, et al. (2019) did not point out how assistive technologies such as screen readers could be used in FCL activities. In contrast to the study by Wairimu, et al. (2019), the current study interviewed a sample of six teachers of mathematics to collect raw data on the teaching strategies used to learners with visual impairment, observation schedules and pre-test; post-test tools were used to collect raw data. Further, in bridging this gap, this quasi-experimental study was conducted on secondary school learners with VI and established how the use of FCL influence performance in Mathematics among the learners.

2.3 Flipped Classroom Learning Mathematics Activities Suitable for Learners with Visual Impairment

Learners nowadays differ significantly from those of a few decades ago in terms of characteristics, expectations, behaviors and attitudes (Cevikbas and Argün, 2017). These 21st-century digital natives want to get information quickly and more specifically through various technological platforms while having fun and expand

their knowledge in all spheres (Cevikbas and Kaiser, 2020). In order to respond to the expectations of these learners, teaching techniques and learning environments must be adjusted. Further, teachers must be willing to cede some level of control in the learning environment in order to let learners to collaborate, take charge of their own learning and socialize as they create knowledge. As such, teachers should adopt active learning strategies such as the FCL which offers opportunities for learner-learner and learner-content interactions to enhance comprehension of concepts learnt.

In line with this viewpoint, a meta-analysis study on how FCL develops critical thinking skills among learners in Indonesia by Nugraheni, Surjono and Aji (2022) revealed that many learning activities, both inside and outside the classroom, could be designed to allow active engagement of learners. Nugraheni, et al. (2022) opined that flipped classrooms could be integrated with other learning methods while utilizing different technological platforms to increase their effectiveness in developing learners' critical thinking skills. Nugraheni, Surjono and Aji (2022) noted that in flipped classroom learning (FCL), learning activities are divided into two parts: outside the classroom (pre-class) and inside the classroom. Outside the classroom, students engage in activities such as watching videos, using PowerPoint presentations, screen casts, and podcasts, accessing online content like websites and articles, note-taking, completing online quizzes, solving assigned problems, reviewing questions, utilizing computer simulations, and completing assignments. Additionally, some learners study by reading online, creating mind maps from audio and text, summarizing their learning, asking and proposing questions, previewing materials, reflecting on their learning process and brainstorming topics. Inside the face-to-face flipped classroom learning, predominant activities include discussions and

presentations, solving more advanced problems, creating mind maps, answering written questions, applying knowledge from online units, developing personal concepts, producing videos, completing quizzes, engaging in reflective practices, and responding to open-ended questions.

The study by Nugraheni, et al. (2022) systematically gathered data from four databases, which included Google Scholar, Research Gate, EBSCO, and Emerald. The study synthesized the findings of 16 studies published from 2015 to 2020. The results of the study demonstrated that a wide range of learning activities could be effectively designed and implemented within a flipped classroom both outside and inside the classroom so that it allowed learners to be actively involved in learning. The current study was carried out in Kenya, a third world country. Besides, the study only concentrated on learners with VI who use braille to read and write. The sample size for the study was 47. Forty learners with VI, six mathematics teachers and the principal. Further, the researcher applied a quasi–experimental research design enriched with descriptive design. However, the findings from the qualitative study by Nugraheni, et al. (2022) cannot be used to explore the impact of FCL on critical thinking during Mathematics activities among learners who use braille as a media of reading and writing and also use audio records which are only limited to sounds leaving out the visual part. The current study was therefore carried out and empirically demonstrated the influence of FCL teaching strategy on performance in Mathematics among learners with VI.

In a descriptive study by Yovkova and Peytcheva-Forsyth (2024) on incorporation of flipped classroom learning in teaching learners with special educational needs to

enhance inclusive education in higher education in Spain, averred that FCL activities replace lectures in the classroom with a series of interactive problem-solving exercises designed to encourage active learning, motivating learners to apply and better comprehend the concepts learnt. The flipped classroom learning strategy allows teachers to deliver knowledge ahead of time while still offering appropriate active learning opportunities in class. The study by Yovkova and Peytcheva-Forsyth (2024) involved three main groups of students in higher education; hearing impaired, dyslexic and visually impaired. However, the current study focused on learners with visual impairment who are in their secondary school. The researcher used a quasi-experimental study design to observe these learners apply the skills in FCL which has widely been tested on learners who are able to see and the results could not be compared in this study where only learners with VI were involved in a secondary school for the VI in Kenya.

Fatimah, Adiningsih, Lubis, and Fathani (2022), conducted a study in Indonesia involving grade five and six learners. The study revealed that learning activities in FCL strategy are moved from classroom discussion and exercises and substituted with listening to recorded audios at home. These activities significantly improved Mathematics learning achievement because the Flipped Classroom model's learning approach gives learners more time to grasp the overall topic, and the availability of the video encourages them to view it again if they feel they forgot about the prior subject. The researcher used a population of class five and class six learners with visual impairment who use braille as a media of reading and writing in SLBN ABD Kedungkandang Malang city. the sample size was 12 learners taken using a saturated sampling technique. The experimental class used the Flipped Classroom learning

model for class six learners, and the control class used a direct learning model as a comparison, namely for class five learners.

However, the findings of the study by Fatimah et al. (2022), which focused on the effect of FCL on improving Mathematics learning outcomes among learners with VI in class five and six, with learners who are using braille as a media of reading and writing, therefore these learners could not watch audio visual videos where they could get more content through the visual images formed from what they watch. However, this could not be generalized to form two learners who use braille as a media of reading and writing and recorded audios in FCL and could not make any visual images. The study was carried out in an African setting; in a third world country, Kenya involving forty learners with visual impairment.

A quasi-experimental study by Akintolure, S. O., Akinola, V. O., Olaleye, E. O., & Braimoh, D. S. (2024) on effect of flipped classroom learning on learners' academic performance in practical physics amongst secondary schools in Lagos state, averred that Flipped classroom practices increased the academic performance of learners in practical physics statistically and significantly. Akintolure et.al (2024) involved learners without disabilities in regular government secondary schools with a sample size of one hundred learners from four different schools. The data collection tools used were Physics Practical Achievement Test (PPAT) and Physics Practical Classified Aptitude Test (PPCAT). Quantitative data was used to determine activities that were used to increase academic performance and the e- learning videos out of the classroom were found to be effective. In this regard he further averred that one of the most important features of videos that increase academic performance is that they can

be watched again in a quiet environment according to learning preferences and stay in the virtual classroom system at all times. it was also noted that the questions included in the videos also positively affected the increase in academic performance. It was however, revealed in this research that the flipped classroom learning has brought about positive change in the attitude of students towards practical physics classes. Akintolure et.al (2024) concluded that flipped classroom learning practices have a positive effect on learners' academic performance and this would in turn bring about higher scores in physics. However, in contrast to Akintolure et al. (2024), the current study was carried out in only one special school for the VI with a sample size of forty learners who use Braille as a media of reading and writing where activities in FCL for Learners with VI cannot be compared to activities in FCL for learners who are sighted.

2.4 Effectiveness of Flipped Classroom Learning Activities on Performance in Mathematics

Flipped classroom learning activities have been associated with learner performance in instances where the strategy has been used in teaching. In a mixed research study to evaluate the utilization of the FCL strategy to boost special instructors' Mathematical proficiency for teaching among teacher trainees in the United States (U.S), Kaczorowski, Kroesch, White and Lanning (2019) noted that FCL activities were useful and enabled learners to interact with the course content at their own speed. Kaczorowski, et al. (2019) established that FCL activities enabled learners to optimize learning time, which resulted in improved performance in Mathematics. However, the conclusion reached by Kaczorowski et al. (2019) that the use of FCL was beneficial in the mastery of Mathematics concepts among teacher trainees in the United States,

cannot be relied on to assume a similar effect when the teaching approach is used among learners at lower levels of study, particularly secondary school learners with VI in a developing country like Kenya. As a result, this study was conducted to determined how FCL influenced performance in Mathematics among Kenyan learners with VI.

In a systematic review of the impact of the FCL in teaching Mathematics in higher education, Fernández-Martín, Romero-Rodríguez, Gómez-García, and Ramos Navas-Parejo (2020) inferred that the instructional approach, was pivotal in reinforcing learners' understanding and attitudes towards Mathematics. Fernández-Martn, et al. (2020) linked improved mathematical understanding and attitude among learners to FCL activities that promoted collaborative work, autonomy, and self-regulation of learning, resulting in improved academic achievement in the subject. While the study by Fernández-Martn, et al. (2020) solely relied on research findings published in Web of Sciences and Scopus, this study adopted a quasi-experimental design and established with evidence the influence of FCL on performance in Mathematics among learners with VI in Kenya.

In a related study, Fatimah, Adiningsih, Lubis, and Fathani (2022) asserts that FCL activities increase learners satisfaction and creativity, which make them more engaged and responsible when studying on their own. Fatimah, et al. (2022) opined that learners engaged in FCL post higher performance than those who are not, due to the enhanced learner engagement. In the quasi-experimental study, Fatimah, et al. (2022) sought to establish effect of FCL in enhancing Mathematics learning outcomes of learners with VI in Indonesia, however, they used a small sample size of 12 learners,

employed a saturation sampling technique. Thus, the findings in their study cannot be relied upon to generalize the effect FCL among learners with VI drawn from bigger sample size and target population. While this study used a similar research design, it used the purposive sampling technique and a bigger sample size of 40 learners with VI.

Nja, Orim, Neji, Ukwetang, Uwe, and Ideba (2022) in their study in Nigeria have observed that the effect of FCL on learner performance depends on the attitude of the learners involved and may differ with the level of study, the area of study and technological platform used. In their study that investigated learners' attitudes towards chemistry and academic achievement in Nigeria, Nja, et al. (2022) revealed the use of the strategy enhanced learners' attitudes toward chemistry, consequently improving their academic performance. However, the study by Nja, et al. (2022) involved university undergraduate students with visual ability hence their findings cannot be used to establish how FCL influenced performance among form two learners with VI in Thika, therefore this study was carried out.

In a quasi-experimental study to examine the influence of the flipped classroom on the learning outcome in Mathematics of secondary school learners in Lagos, Nigeria, Makinde (2020) averred that flipped classroom learning is a learner-centered strategy that yielded high learning outcomes in the subject. The study used a sample size of 268 learners in regular classrooms and instruments of data collection were performance tests and questionnaires. The study by Makinde (2020) did not involve learners with visual impairment, thus, its findings could not be used to generalize the same outcome when such learners were involved. This study addressed the gap by

involving a sample of 40 students with visual impairment, six teachers of Mathematics and one head teacher.

A quasi-experimental study by Akintolure, et al (2024) on effect of flipped classroom on learners' academic performance in practical physics amongst secondary schools in Lagos state, averred that Flipped classroom practices increased the academic performance of learners in practical physics statistically and significantly. Akintolure, et.al (2024) involved learners without disabilities in regular government secondary schools with a sample size of one hundred learners from four different schools. the data collection tools used were Physics Practical Achievement Test (PPAT) and Physics Practical Classified Aptitude Test (PPCAT). Quantitative data were used to reveal how and in which activities the increase in academic performance was realized and the e- learning videos out of the classroom were found to be effective. In this regard he further averred that One of the most important features of videos that increase academic performance is that they can be watched again in a quiet environment according to learning preferences and stay in the virtual classroom system at all times. it was also noted that the questions included in the videos also positively affected the increase in academic performance. It was however, revealed in this research that the flipped classroom has brought about positive change in the attitude of students towards practical physics classes. Akintolure et.al (2024) concluded that flipped classroom learning activities has a positive effect on learners' academic performance and this in turn brought about higher scores in physics. However, in contrast to Akintolure et al. (2024), the current study was carried out in only one special secondary school for learners with VI with a sample size of forty learners who used Braille as a media of reading and writing and determined the

influence of flipped classroom learning on performance in mathematics among learners with VI.

2.5 Challenges Experienced in flipped classroom learning strategy

Despite the obvious benefits of FCL in Mathematics teaching, empirical studies have highlighted challenges that may be faced in FCL. For instance, a study by Lo and Hew (2017) An in-depth review of the flipped classroom shortcomings in China, involving kindergarten to twelve grade learners, points out that students' and teachers' beliefs and views can create barriers to FCL. Students in FCL may skip out-of-class activities and arrive in class without having watched or listened to the lecture videos or audio respectively due to a lack of independent learning responsibility. However, the findings in the study by Lo and Hew (2017) involving learners from kindergarten to twelfth grade cannot be used to generalize the same outcome when form two learners with VI are involved.

A quasi-experimental study by Chen et al. (2016), on Exploring student perceptions in a flipped Mathematics course in Taiwan, opines that online platforms such as YouTube, Teacher Tube and Khan Academy offer readily available audio and videos that can be beneficial to learners in a FCL environment. However, Chen et al. (2016) goes ahead to observe that such resources may not cover or correspond to all topics or the content a teacher plans to cover, however, this study bridged this gap by using self-recorded audios which will be content related and beneficial to learners with VI.

A descriptive study by Trigueros et al. (2020) in Spain opined that without the Internet, FCL approaches are ineffective and educators must be able to use technology properly while teaching Mathematics. Trigueros et al. (2020) further observe that

organizing and managing resources, tasks, students, and information at the same time might be difficult for instructors who wish to improve their digital abilities. The study by Trigueros, et al. (2020) involved a population of 547 learners as opposed to this study that involved 40 learners with VI using pre-recorded audios that may not require internet connection to access. Furthermore, while flipping the classroom, teachers may encounter additional issues such as dissatisfaction, hesitation, and bias toward FCL. (Bagley 2020; Chen 2016). These purported challenges are mostly observed on teaching learners without disabilities in developed countries, hence this study on FCL influence on Mathematics performance among learners in Thika high school for the visually impaired, Kiambu county Kenya was conducted.

A descriptive study by Nkepah, B. D., & Mboshi, N. S. (2024) Examining the Mathematical Competences of Visually Challenged Students at the University of Bamenda-UBa in Cameroon revealed that visually impaired students face significant challenges when studying statistics, particularly in interpreting graphical data and obtaining appropriate educational materials. This study sheds light on the mathematical skills and challenges experienced by visually impaired learners in learning mathematics. The findings indicated that while learners with visual impairment demonstrate proficiency in basic mathematical operations, they experience considerable difficulties with more advanced mathematical concepts, particularly in the domain of statistics. This highlighted the need for tailored educational approaches to support their learning needs. In terms of challenges, visually impaired learners encounter significant difficulties in interpreting graphical data, accessing suitable educational materials, and comprehending statistical notation and symbols (Nkepah & Mboshi 2024). Methodologically, the study employed a

mixed-methods research approach, specifically utilizing an exploratory sequential design to gather both quantitative and qualitative data. The population of the study comprised 13 visually impaired students from the University of Bamenda who had completed statistics as part of their research methodology course. The researcher used questionnaires and semi-structured interviews as the primary data collection tools. In contrast, the current study adopted a quasi-experimental study design with a population of forty visually impaired learners using pre-test, post-test interview guide and observation schedule as primary data collection tools.

2.6 Summary of Literature Review

In this chapter, information on FCL was evaluated in accordance with the study's objectives. There was a critical investigation and analysis of many references; the analysis clearly demonstrated that research on FCL on learners with VI is quite limited internationally, in Africa, and specifically in Kenya. The evaluated research was done on a population of learners who are sighted leaving out the learners with VI. The current study filled the gap of the population being studied; only learners with VI and those who used braille as a medium of reading and writing were involved in this study. Additionally, most of the studies employed a sample size of vast numbers but this study used a sample size of 40 learners with VI. The studies that were reviewed were conducted in developed countries, with minimal studies conducted in developing countries like Kenya, resulting in a gap. Because of the regional disparities, the learners may respond differently towards FCL, hence conducting this study and examined how these learners behave in Kenya. Additionally, the current study used a quasi-experimental design enriched with descriptive design, which aided in the collection of qualitative and quantitative data, in contrast to some reviewed studies

that used the descriptive design and may have missed some observable information that could have been critical. This study focused on flipped classroom learning influence on Mathematics performance among learners in Thika high school for the VI Kiambu County, Kenya.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter focuses on research design, variables, location of the study, target population, sampling techniques and sample size, research instruments, piloting, validity and reliability, data collection techniques, data analysis techniques and logistical and ethical considerations.

3.2 Research Design

This study adopted a Quasi-experimental research design enriched with descriptive to collect qualitative and quantitative data. Specifically, the study used the Pre-test, Post-test design with experimental group and control group. According to White and Shagun (2014), in quasi-experimental designs, a control group that is as identical as possible in basic features to the treatment group is investigated, and the control and treatment groups can be manipulated to determine the causal effect. Quasi-experimental research design was adopted in this study because the researcher introduced a new teaching and learning strategy, FCL to learners with VI.

The researcher through the experiment gathered quantitative data by providing a pre-test to the learners and compared the results with the post-test after the intervention using flipped classroom learning strategy, this determined how effective the intervention was. After six weeks of the experiment, the researcher administered a posttest to the chosen sample to see if FCL resulted to improved learning and educational outcomes among learners with VI.

According to Rahi (2017), descriptive design involves the assessment of the current

status by examining opinions, attitudes, demographics, preferences, practices, and procedures. Therefore, the descriptive design tool was used in gathering teachers' opinion on the teaching strategies used in teaching mathematics to learners with VI , as well as observing learners during FCL strategy.

Table 3.1

Quasi-Experimental Research Design

P	T_1	X	T_2

P- Sample populations

T_1- pretest

X- Treatment

T_2- posttest

Qualitative data was obtained through observation schedule for the learners and interviews guide for the mathematics teachers, where the researcher observed different traits exhibited by the learners in relation to using FCL and their opinions towards using FCL strategy in teaching and learning Mathematics.

T5he quasi-experimental design was appropriate in this study because the researcher aimed at collecting raw quantitative data of learners' performance using pretest and posttest design before and after introduction of the FCL strategy to the experimental group. The researcher also collected raw qualitative data on different strategies regular teachers used in teaching Mathematics and learners' involvement during the in-class activities when using FCL strategy.

3.2.1 Variables

In this study, the independent variable; Flipped classroom learning, was manipulated by the researcher and got the outcome in Mathematics performance among learners with VI. Teaching and learning resources and learners' attitude were the intervening variables. The researcher controlled the intervening variables by training the learners on the FCL strategy and grouped them to share the available resources. The dependent variable was Mathematics performance among learners with VI.

3.3 Location of the Study

This study was conducted at Thika high school for the visually impaired in Kiambu County, Kenya. Thika high school for the VI has very high population, it is the biggest school that takes learners with VI from across the country, it has also integrated ICT in teaching and learning. This made it ideal for the FCL treatment.

3.4 Target Population

The study targeted 102 form two learners in Thika high school for the VI, all the six teachers teaching Mathematics in Thika high School for the VI, because they use different teaching strategies when teaching Mathematics to learners with VI, and one head teacher.

3.5 Sampling Technique and Sample Size

The sampling technique and sample size are explained in this section.

3.5.1 Sampling Technique

The researcher used purposive sampling technique to select teachers who teach Mathematics in Thika High school for the VI and the headteacher. The stratified sampling was applied in selecting learners with VI based on the criteria of female and

male status. From the different strata, simple random sampling technique was utilized to select form two learners with VI and use braille to read and write, for the experimental and control group this gave the participants an equal chance of participation to the study that determined the influence of flipped classroom learning on performance in Mathematics for learners with visual impairment.

3.5.2 Sample size

Sample size in this study comprised of one Head teacher, six teachers teaching Mathematics in the school and 40 form two learners, representing (39.22%) of the 102 form two learners with VI learning Mathematics. The sample size of 47 represented 43.12% of the target population of 109 respondents.

Table 3.2

Target population and sample size

Types of respondents	Target Population	Number sampled
Head teacher	1	1
Teachers of Mathematics	6	6
Learners	102	40
Total	**109**	**47**

3.6 Research Instruments

In this study, data was collected using learners' achievement tests (pre-test and Post-test); interview guide for the Mathematics teachers, and an observation schedule for the learners.

3.6.1 Pre-test and Post-test.

The pre-test on the Mathematics topics covered was administered to learners participating in the study (control and treatment groups) before the treatment was conducted. This enabled the researcher to establish the learner content knowledge level. The pre-test contained ten questions from three different topics assessing the concept of cubes and cube roots, gradient and equations of straight lines, and finally Area of a triangle. The pre-test was administered to both groups and graded using a standardized marking scheme. The researcher took over the classroom with the treatment group and the control group classroom was taught by the regular teacher. The teaching was done on both groups where the three topics taught, were distributed within the six weeks. The researcher prepared the lesson and pre-recorded the audios on the topic, which learners listened to during the out of class activities, the focus group discussion and presentations were done during the in the class activities for the treatment group during FCL strategy. The control group used the traditional teaching strategy with the regular teacher where the teacher was informed to teach them in the regular way as they do in their everyday lesson. The pretest and post-test were administered before and after the treatment respectively to both experimental and control groups to determine their performance. The results were used to determine whether there was a statistically significant difference in performance between learners exposed to FCL treatment and those who were not. After six weeks of the flipped classroom learning strategy intervention, a post-test was administered and determined the learning outcome after the intervention. The questions in the post-test were re-ordered so that a learner could not notice the repeated questions. The results of both tests were compared and determined the influence of FCL strategy on performance in Mathematics to learners with visual impairment.

3.6.2 Interview guide

An interview was conducted to Mathematics teachers and was used to get relevant qualitative information on teaching strategies used in teaching Mathematics to learners with VI. The interview guide contained probing questions which guided the researcher and the interviewee. This was used to collect their opinions on teaching strategies used in teaching Mathematics in Thika High School for the VI. The interview took at most ten minutes for each teacher. This was conducted the first week of the study. (Appendix II).

3.6.3 Observation Schedule

The researcher used a non-participant observation approach during FCL treatment once a week. The researcher observed learner's behavior during the FCL in class activities and collected relevant information on learners' experiences during in class activities. The observation schedule was marked after every 10 minutes (Appendix III).

3.7 Piloting

Pilot study was conducted at St. Lucy's high school for the visually impaired in Meru county. St. Lucy's school was selected because learners have similar characteristics as those in Thika High school for the VI. The researcher piloted the research instruments with ten learners with VI, 2 Mathematics teachers and the principal.

Some of the changes effected after piloting include; Problems in the interview guide and questions included in the pre-test and post-test, were detected and the researcher corrected them before embarking on the actual research study. The practice helped in ascertaining the validity and reliability of the research instruments. Changes were

made on the pre-test scoring guide and the interview guide. Initially the pre-test and post-test item-scoring guide was so high. After the selected participants undertook the tests, the researcher moderated the scoring guide. Besides the researcher was keen to identify some of the concepts had been repeated in some questions forcing the researcher to reduce some of the test items and re-score the remaining items. Changes on the interview guide were made after the researcher and the two teachers cross checked some of the questions included; The researcher removed the question on the age and gender of the teacher since there was a question on the teaching experience of the teacher, which was more relevant to the study. Piloting enabled the researcher to draw coding framework for open-ended questions included in the interview guides. This was achieved by crosschecking the answers provided by study participants.

3.7.1 Validity of the Research Instruments

The validity of the research tools was enhanced by applying content validity procedures in efforts of measuring all the concepts under the current study. The content validity of the test items was guaranteed through triangulation. First, the researcher increased the study's validity by triangulating the instruments, and then simulated them independently. To ensure content validity of the test items the researcher and research assistant scrutinized the test items one by one. Member checking technique was utilized in reviewing the test items and assessing their worth to collect relevant data.

3.7.2 Reliability of the Research Instruments

The test-retest method was used on the pretest and post-test during piloting of the study to enhance the reliability of the instruments. This strategy used a one-week interval between the first and second tests and used the same respondents from the

pre-test group. The following steps were taken by the researcher to enhance reliability: The researcher administered a pretest to the piloting group and they finished it in 2 hours. The pre-test was scored and analyzed. The flipped classroom learning intervention was done on the same group for one week. The learners in the group were given a 2-hour post-test on the same themes. The post-test was scored and analyzed by the researcher. Using the Spearman rank correlation coefficient formula, the researcher compared the two scores from the pre-test and post-test.

The test results were compared, and a correlation coefficient (r) of 0.8 was obtained.

A research instrument is only considered reliable if its correlation coefficient is larger than or equal to 0.75, according to Orodho (2004).

3.8 Data Collection Techniques

Before the specified topics were taught, a pre-test was given to the treatment group (TG) and control group (CG) and graded using a standard marking scheme. Following the pre-test, the teacher in the control group taught the selected topics using traditional teaching methods, while the researcher in the experimental group used the flipped classroom learning strategy, which included in-class activities such as group discussion, scaffolding, focus group discussions, problem solving, teacher feedback, asking and answering questions, and other activities that promoted critical thinking. Outside of class, the majority of homework assignments involved listening to audio-recorded lessons, taking notes, answering written questions and participating in group discussions with guiding questions. The instructor in the control group (CG) did not use FCL strategy but used the traditional teaching methods, however, he was instructed not to inform the learners that they are under any study. A constant

monitoring of the process was done and a progress report was done on a weekly basis. Following the research period, a similar post-test was administered to all learners in both the treatment and control groups. The two-hour test was graded out of a possible 25 points, with test scores recorded for performance analysis.

Table 3.3

Assessment criteria for pre-test and post-test

Criteria	**Pre-test**	**Post-Test**
Pass	10-25	12-25
Fail	1-09	1-11

The above table shows the format of pass and fail criteria in the pre-test and posttest. Students who scored 10 and above on the pre-test passed, while those who scored 09 or lower failed. Students who scored 12 or above on the post-test passed, while those who scored 11 or lower failed.

The data was collected from the form two learners. The form two class had a double stream where one of the class acted as an experimental group and the other one was a control group. the researcher taught the experimental group using the FCL teaching strategy while one of the regular teachers of mathematics taught the control group using the conventional teaching strategies.

The FCL treatment was given for six weeks and the post-test was administered. The post-test covered the same topics covered in the pretest (Appendix 1).

Observation schedules was conducted on learners' behavior during flipped classroom learning lessons in the classroom. The researcher used a non-participant observation approach during FCL treatment once a week. The researcher observed the learner's

behavior during the FCL in class activities. The observation schedule was marked after every 10 minutes (Appendix III). Interviews schedules on teachers were done during the study; it took at most ten minutes to interview each teacher. Audios were recorded to collect data from each interviewee about their opinions on teaching strategies used in teaching Mathematics. This was conducted during the first week of the study.

3.9 Data Analysis.

Before the analysis, the quantitative data from the pre-test and post-test was edited, arranged, and coded. Data was analyzed using both descriptive and inferential statistics. In the analysis, the Statistical Package for Social Sciences (SPSS) version 22 was utilized. The coded data was loaded into an SPSS spreadsheet and analyzed using percentages, mean, median, and standard deviation. The data was presented in descriptive statistics that included frequency distribution tables, mean tables, charts, and cross tabulations that made it easy for comparison and summarization. The comparison of the mean scores was done through analysis of variance (ANOVA). The ANOVA tests helped in testing the significance difference between the two sets of performance to determine the effect of flipped classroom learning on performance in Mathematics among learners with VI. Qualitative data was analyzed using the thematic content analysis method. Reponses from the respondents were grouped into similar themes or ideas depending on the objective addressed then allocated specific codes which helped in developing a codebook. The codes were further allocated numerical values which was further analysed as quantitative data. Verbatim quotes from data collected using the interview schedules were incorporated in discussion of the study findings.

3.10 Logistical and Ethical Considerations.

This section covers logistical and ethical considerations.

3.10.1 Logistical Considerations.

The researcher obtained an official introduction letter from the Graduate School at Kenyatta University to initiate the research process. Subsequently, the researcher applied for and secured a research permit from the National Commission for Science, Technology, and Innovation (NACOSTI), which was presented to the county education directors in the study locale to obtain the necessary approvals. Following these formalities, the researcher visited the selected school to seek consent from the principal, ensuring that all ethical and procedural requirements were met before commencing the study.

3.10.2 Ethical Considerations.

The researcher ensured the respondents' confidentiality by not sharing information from one respondent to another and not revealing their real identities when collecting and analyzing the data. The learners participated after the researcher consulted them and their teachers. The researcher revealed to the participants the intention of the study. The researcher did not compel the participants to sign the informed consent forms that were provided to them before collecting data for the study. The respondents were assured of anonymity through a cover letter accompanying the interview guides that described the purpose of the study.

CHAPTER FOUR

PRESENTATION OF FINDINGS, INTERPRETATION AND DISCUSSION

4.1 Introduction

The study aimed at determining the influence of flipped classroom learning on Mathematics performance among learners in Thika high school for the visually impaired, Kiambu County, Kenya. This chapter consists of presentation, analysis, interpretation and discussion of findings of the study based on the following four research objectives:

i. Established the teaching strategies used in teaching Mathematics to learners in Thika high school for the visually impaired, Kiambu County, Kenya
ii. Explored the flipped classroom learning activities suitable for learning Mathematics in Thika High School for the visually impaired, Kiambu County, Kenya
iii. Investigated the effectiveness of flipped classroom learning activities on performance in Mathematics in Thika high school for the visually impaired, Kiambu County, Kenya
iv. Established the challenges experienced by learners with VI while using flipped classroom learning strategy in learning Mathematics in Thika high school for the visually impaired, Kiambu County, Kenya.

4.2 Demographic Information

Data relating to the characteristics of the participants based on the following demographic traits was collected: professional qualification, years of experience and gender.

4.2.1 Demographic Information of Mathematics Teachers

Data pertaining the highest level of teacher educational qualification, gender and teaching experience was collected and findings summarized in Table 4.1.

Table 4.1

Demographic Information of Mathematics Teachers

Variable		Frequency	Percentage (%)
Gender	Male	4	66.67
	Female	2	33.33
Educational Background	Masters	1	16.67
Training level:	Bachelors	5	83.33
	Diploma	-	-
	Others	-	-
Teachers teaching experience	Less than 5 years	1	16.67
	5-15 years	2	33.33
	Others (over 15 years)	3	50.00

Table 4.1 shows that out of the six (6) Mathematics teachers in Thika High School for the VI who participated in this study, four (4) were male while two (2) were female. Table 4.1 also shows that one (1) of the teachers had a Master's degree, five (5) were Bachelor's degree holders while none of them had Diploma certification. Table 4.1 further shows that out of these teachers, one (1) had less than five (5) years of experience, two (2) had between five (5) and fifteen (15) years of experience while three (3) reported over fifteen (15) years of experience. The findings in Table 4.1 reveal that all the teachers who participated in this study were qualified to teach the secondary school level.

4.2.2 Demographic Information on Form Two Learners with VI and Use Braille

Table 4.2 shows the demographic data based on the gender and age of the learners with VI at Thika High School for the VI who participated in this study.

Table 4.2

Demographic Data of Learners with VI Based on Gender and Age

Age	Male	Female	Frequency	Percentage
16-17	10	11	21	52.5
18-19	6	8	14	35.0
20-21	3	2	5	12.5
			40	**100**

Table 4.2 shows that the mode, mean, and median ages were 17 years, 19 years, and 18.5 years respectively. The youngest study participant was 16 years old while the oldest was 21 years old. The boys made up 19 (47.5%) of the research participants while the girls made up 21 (52.5%) of the study participants totaling 40 (100%). It is worth noting from the age distribution that the majority of study's participants, particularly girls, entered school at an advanced age, which might be attributed to late diagnosis, ignorance and economic challenges of the parents/care givers as well as cultural factors that give preference to the boy child in matters education. In a study that investigated the influence of culture on girl child education in Central Pokot Sub County, Kenya, Andiema (2021) supported this view point by observing that cultural factors contribute to delayed enrollment and transition among the female learners and affected their academic achievement and acquisition of knowledge required for

progression through the several levels of basic education as compared to their male counterparts.

4.2 Teaching Strategies Used in Teaching Mathematics to learners with VI.

The study aimed at finding out the teaching strategies that were employed by teachers of Mathematics when teaching Mathematics to learners with VI in Thika High School for the VI. The researcher interviewed the six (6) teachers of mathematics. Each teacher was interviewed once. The findings are summarized in table 4.3

Table 4.3

Teaching Methods Used to Teach Mathematics Learners With VI

Variable	Frequency (n)	Percentage (%)
Direct instruction		
1. Question and answer.	6	100.00
2. Tutorials/lecture method	6	100.00
3. Scaffolding	3	50.00
Group work		
1. Discussion	2	33.33
2. Peer tutoring	2	33.33
Constructivism		
FCL	0	0.00

Table 4.3 shows that all the six (100%) Mathematics teachers interviewed used question and answer method and the tutorial/lecture method. Table 4.3 also shows that fifty percent (50%) of the teachers used scaffolding method, a third (33.33%) of the mathematics teachers used both discussion and peer tutoring methods respectively. Table 4.3 further shows that no teacher (0%) used FCL strategy. This was evident that

this study had a significant contribution to the strategies and methods of teaching learners with VI. The following is a response from one of the participants;

Participant Code R

"…. it is hard to use the Flipped classroom learning method with these learners because it is time consuming and the curriculum is too wide. there can be no time to do the projects and experiments since each lesson is limited to forty minutes" (interviewed on 25/09/2023)

participant S had the following to say on why teachers find it easy to use direct instruction methods.

Participant code S

"……I always use direct method to teach mathematics, mostly lecture method and question and answer method. the two methods are easy and they align with the time allocated for a single lesson, even when there is a double lesson, I consider using these methods so that I can cover the syllabus. not that we as teachers are not aware of other teaching strategies such as

this you are introducing (FCL), the problem

is that they are time consuming and we have

limited time to cover the syllabus"

(interviewed on 26/09/2023)

The findings were further analysed and presented on Figure 4.1

Figure 4.1

Teaching Strategies used to learners with VI

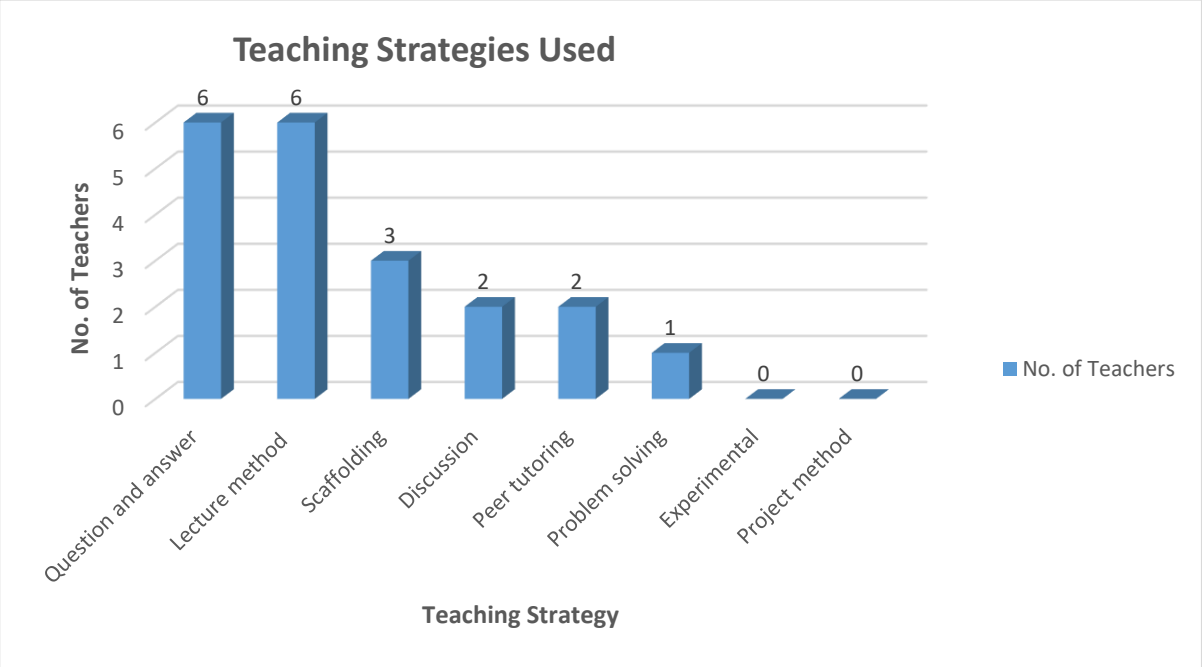

Figure 4.1 shows that the study's findings on teaching techniques revealed that Mathematics teachers used a variety of teaching approaches while teaching Mathematics to students with VI. The following teaching approaches were noted: question and answer, tutorials/lecture, scaffolding, discussion, problem solving and peer tutoring. The teachers predominantly used direct method such as question and answer and lecture methods as revealed on figure 4.1. These findings concur with the findings of a study conducted by Wairimu, Chomba, and Awori (2019) on the

strategies used by teachers while teaching Mathematics to learners with VI in Kenyan special primary schools, which established that instructors predominantly utilize direct instruction methods such as questions and answers, lectures, among others. This study's findings also revealed that seventy percent (70%) of teachers agreed that technology-based learning motivates learners and boosts independent knowledge seeking thus resulting to better performance. One interviewee had the following to say;

Participant code P

"……*technology based learning is gaining momentum in this era where technology has become everything in our daily living. Whenever learners are engaged in technology, like in the period of Corona where we tried teaching online classes, learners were so excited and they could grasp more content." (Interviewed on 27/09/2023)*

These findings are supported by Wairimu (2019) study which averred that learners with VI must be exposed to peers through technology-based learning to exchange new ideas and experiences, which in turn fosters favorable attitudes toward mathematics, thus positively impacting the learner achievement in the subject. The findings of this study are further supported by Carole, Beal and Rosenblum (2018) who in their study concluded that the use of a learning management systems (LMS) application

motivates learners more than when employing the traditional literacy media. Regarding teachers' preparedness in using the various teaching strategies while teaching Mathematics to learners with VI, the majority of teachers revealed that most of the time they are not adequately prepared in terms of lesson planning and identifying of lesson activities, citing limitations such as a heavy workload and insufficient resources.

In terms of whether the Mathematics teachers at the Thika School for the VI use flipped classroom learning (FCL) during Mathematics lessons, the interview revealed that most of them were not familiar with the strategy. On the reasons why they did not embraced the strategy in teaching Mathematics, four (4) teachers cited lack of adequate skills in the use of technology was the main challenge, two (2) of them cited that some topics could not be taught using FCL, five (5) teachers reported that a lot of time is required to prepare for Mathematics lessons and finally three (3) Mathematics teachers pointed out that the rigid school timetable could not accommodate for scheduling of extra time that was needed to give learners individually or in groups an opportunity to make presentations and discussion. One interviewee had the following to say;

Participant code Q

"…….I had not tried flipped classroom learning before. The issue has been lack of time but with embracing technology, I have learnt that it is possible to use the strategy to ensure that learners are engaged beyond the

official lesson time." (Interviewed on

26/09/2023)

The findings of this study are supported by the UNESCO (2014) report which pointed out that subjects taught through technology-based teaching and learning approaches are inadequately covered due to inadequate time allocated to lessons and lack of skills among teachers.

4.3 Flipped Classroom Learning (FLC) Activities Suitable for Learning Mathematics

The objective two of this study explored the flipped classroom learning activities suitable for learning Mathematics to learners with VI. Learning activities during FCL are switched between inside and outside the classroom activities. In this study, the teacher prepared a special learning audio records for learners with VI, emphasizing the audio intonation so that students listened audibly to the material as guided by the researcher. The audio was made by recording the researcher's sound explaining material such as in direct classroom learning. The audios were uploaded to the identified five computers where learners accessed them. The FCL activities outside the classroom involved learners listening to recorded audios from the teacher before class time. Upon listening to the audios, learners discussed in groups of four (4) following guiding questions given by the researcher and taking notes as well as answering written questions. The discussions ensured that learners understood the materials before meeting in the face-to-face sessions.

In-class activities included: addressing issues that learners with VI could not understand while studying outside of class, large group discussion with the facilitator (researcher), examining the content using the question and answer technique. Small

groups focus discussions were held, as well as presentations from each group, each group presented their findings after discussion and working out the guiding questions. The small focus group discussions were done on the topic at hand and the researcher moved from one group to another listening on the discussion and recording some of the discussions. The following is a verbatim of one of the learners during the focus group discussion.

Learner code 5

"……. I have been struggling to understand
on how to find an equation of a
perpendicular lines but as we were
discussing in our group, I have listened to
each one explaining and I have understood
it. I wish we could be doing such discussions
with guiding questions from the teacher,
mathematics could be sweat to learn"

Concurrently, the researcher completed an observation guide, the findings are summarized on table 4.4.

Table 4.4

Observation during FCL mathematics lesson

Variable	Frequency (n)	Percentage (%)
Learners collaborating with partners during discussion groups in FCL lessons.	18	90
Learners actively involved in the learning activities during FCL lesson.	18	90
Learners able to recall what they listened from the recorded audio.	17	85
Learners asking for extra time after the FCL lesson time.	16	80
Learners having difficulties in participating in learning activities during FCL.	3	15

The summary of the observations made during the lessons. Ninety percent of learners were actively involved in the learning activities during FCL while 85% of learners were able to recall what they listened from the audios, 80% asked for extra time to continue with the task during the lesson, 90% of learners collaborated with their peers during the discussion groups while 15% were having difficulties in participating in learning activities during FCL lesson. On this aspect, one of the participants had the following to say;

Participant code S

"……flipped classroom learning facilitates active learning activities which take learning of mathematics beyond the cognitive level. Learners seemed to retain more of the concepts taught when involved in flipped classroom learning. This could be seen during discussion sessions when the learners reported what they understood from the audios. Even most shy learners gained confidence and actively participated in the discussion activities"

This concurred with the finding from a study by (Nugroho & Maryono, 2020; Jdaitawi, 2019) which concluded that the flipped classroom model helps students learn independently and creatively, encouraging critical thinking skills. However, one sixth of the learners were having difficulties in participating in learning activities during the lesson. These findings concurred with the study by Lo and Hew (2017) in China which averred that few learners in FCL may skip out-of-class activities and arrive in class without having watched or listened to the lecture videos or audio respectively due to a lack of independent learning responsibility thus hindering them from participating to in-class activities.

Ninety percent of learners collaborated with their peers during discussion in FCL lessons. This was in agreement with other studies included in the study's literature

review. A systematic review of the impact of the FCL in teaching Mathematics in higher education, Fernández-Martín, Romero-Rodríguez, Gómez-García, and Ramos Navas-Parejo (2020) inferred that the instructional approach, was pivotal in reinforcing students' understanding and attitudes towards Mathematics. Fernández-Martn et al. (2020) linked improved mathematical understanding and attitude among learners to FCL activities that promoted collaborative work, autonomy, and self-regulation of learning, resulting in improved academic achievement in the subject.

A descriptive study by Yovkova, B., & Peytcheva-Forsyth, R. (2024) on incorporation of flipped classroom in teaching students with special educational needs to enhance inclusive education in higher education in Spain, averred that FCL activities replace lectures in the classroom with a series of interactive problem-solving exercises designed to encourage active learning, motivating students to apply and better comprehend the concepts learnt. The flipped classroom learning strategy allowed teachers to deliver knowledge ahead of time while still offering appropriate active learning opportunities in class.

4.4 Effectiveness of flipped classroom learning activities on performance in Mathematics

The third objective of this study investigated the effectiveness of flipped classroom learning activities on performance in Mathematics in Thika high school for the visually impaired, Kiambu County, Kenya.

The researcher administered a pre-test and a post-test six weeks apart. The pre-test enabled the researcher to obtain information on individual learner’s areas of weakness in different topics before the FCL strategy was implemented to the treatment group while the control group continued with the conventional teaching strategies. The

pretest was administered to both control group and treatment group. It took two hours to complete, the researcher together with one of the teachers of mathematics marked the pretest and the scores were as shown on table 4.5

Table 4.5
Pre-Test Scores

RANGE	O – 5	6 – 10	11 – 15	16 – 20	21 – 25
Control Group	4	12	3	1	0
Treatment Group	6	8	5	1	0

Table 4.5 shows the results of the pretest. On the control group, 4 learners scored between 0 to 5 marks, 12 learners scored between 6 to 10 marks, 3 learners scored 11 to 15 marks and 1 learner scored between 16 to 20 marks out of 25 maximum marks. On the treatment group, 6 learners scored between 0 to 5 marks, 8 learners scored between 6 to10 marks, 5 learners scored between 11 to 15 marks, 1 learner scored between 16 to 20 marks out of the 25 maximum marks. None of the learners in either group scored between 21 to 25.

The pretest analysis for both treatment and the control groups findings were scaled as shown on table 4.6.

Table 4.6

Analysis of pre-test

Groups	*Count*	*Sum*	*Mean*	*Variance*
CONTROL GROUP	20	163	8.15	13.81842105
TREATMENT GROUP	20	162	8.1	12.62105263

Table 4.7 shows that the control group had a sum of 163marks of all the 20 learners scores. They had a mean of 8.15. The treatment group had a sum of 162 marks of all the 20 learners scores. They had a mean of 8.10. The mean of the two groups were almost equal, an indicator of similar entry behaviors for the learners who participated in the study. To determine whether there was a statistically significant difference in learners' academic performance between the control and experimental groups in the pre-tests, the mean scores were analysed using the Analysis of Variance (ANOVA) test. The findings of the test are systematically presented in Table 4.7.

Table 4.7

Pre-test ANOVA

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.025	1	0.025	0.001891112	0.96554111	4.09817173
Within Groups	502.35	38	13.21973684			
Total	502.375	39				

From Table 4.8, it can be observed that the one-way ANOVA statistics F (1, 38) =0.00189 and the

P-value=0.966 which was greater than the confidence level of P=0.05. This implied

that prior to the implementation of the FCL strategy, there was no statistically significant difference in the academic achievement levels of learners between the two groups. The pre-test results demonstrated a normal distribution at the onset of the study, this indicated that both groups were comparable in terms of their initial academic performance. Consequently, the findings suggested that the control and experimental groups were equivalent at the beginning of the study, thereby establishing a baseline of parity that supported the validity of subsequent comparisons following the intervention.

The study determined if there were any significant difference in academic performance between learners who were exposed to FCL strategy and those who were not. Both groups were taught the same topics for six weeks. The treatment group was taught using FCL strategy while the control group was taught in the same way they were taught earlier. The FCL strategy involved learner centered activities which encouraged critical thinking. the researcher recorded audios which learners listened to during out of class activities. the audios were accompanied by questions which were answered in groups after discussing the audio. activities in class included focus group discussions, asking and answering questions, presentations from the groups, exploration, and independent problem solving.

Following the FCL strategy for six weeks, the researcher gave the post-test to both groups which assessed the effectiveness of flipped classroom learning activities on performance in Mathematic. The results were summarized as shown on table 4.8.

Table 4.8

Post-Test Scores

RANGE	0 – 5	6 – 10	11 – 15	16 – 20	21 – 25
Control Group	4	7	7	2	0
Treatment Group	0	2	13	4	1

Table 4.8 shows the results of the post-test. On the control group, 4 learners scored between 0 to 5 marks, 7 learners scored between 6 to 10 marks, 7 learners scored 11 to 15 marks and 2 learners scored between 16 to 20 marks out of 25 maximum marks. None of the learners in control group scored between 21 to 25. On the treatment group, none of the learners scored between 0 to 5 marks, 2 learners scored between 6 to10 marks, 13 learners scored between 11 to 15 marks, 4 learners scored between 16 to 20 marks out of the 25 maximum marks. 1 learner scored between 21 to 25.

The post-test analysis for both treatment and the control groups findings were scaled as shown on table 4.9

Table 4.9

Post test Analysis

Groups	Count	Sum	Mean	Variance	STD Dev
Control Group	20	194	9.700	18.747	4.330
Treatment Group	20	276	13.800	10.695	3.270

Table 4.8 shows that out of the possible 25 marks, 20 learners who participated in the treatment group had a Mean of 13.8 and SD= 3.27. While the mean score for the 20 learners in the control group was M= 9.7 and SD= 4.33. When comparing the two

means, the treatment group mean was somewhat higher than the control group mean. This revealed the strength of FCL treatment in improving Mathematics outcomes of learners with VI. The results of the study were supported by other studies included in the study's literature evaluation. For instance, the quasi-experimental study by Makinde (2020) in Nigeria which examined the influence of the flipped classroom on the learning outcome in Mathematics of secondary school learners which averred that flipped classroom learning is a learner-centered approach that yielded high learning outcomes in mathematics.

To evaluate if there was any statistically significant difference in learner academic performance between the treatment and the control groups in the post-test, ANOVA statistics was used to generate inferential statistics and the results were summarized in Table 4.10.

Table 4.10
ANOVA Post Test

Source of variation	SS	Df	MS	F	P-value	F crit
Between Groups	168.100	1	168.100	11.419	0.002	4.098
Within Groups	559.400	38	14.721			
Total	727.500	39				

P-Value (α) = 0.05

Table 4.10, shows a one-way ANOVA statistic F (1, 38) =11.419, and a p-value=0.002 which was less than the confidence level of P=0.05. This finding indicated that a statistically significant difference in academic achievement was observed between learners who were taught using the Flipped Classroom Learning (FCL) strategy and those who were taught using conventional teaching methods. This

outcome suggests that the structured learning activities implemented within the FCL framework, which emphasize active engagement, collaborative interaction, and learner-centered instruction, contributed to an enhancement in learners' performance in mathematics. The results demonstrate that the pedagogical strategies inherent in FCL, such as pre-class preparation, in-class problem-solving, and the use of technology-mediated resources, effectively supported learners in achieving higher levels of academic success compared to traditional teaching methods. The null hypothesis, "**H_0^1**: *There is no statistically significant difference between the performance of learners exposed to FCL and those who were not".* Was therefore rejected and the alternative accepted.

These findings concur with the findings in a study by Fatimah, Adiningsih, Lubis, and Fathani (2022) which opined that students engaged in FCL post higher performance than those who are not, due to the enhanced learner engagement. Further, the study findings agree with the findings from the study by Fernández-Martín, Romero-Rodríguez, Gómez-García, and Ramos Navas-Parejo (2020) which concluded that the FCL instructional approach improved mathematical understanding and attitude among learners that promoted collaborative work, autonomy, and self-regulation of learning, resulting in improved academic achievement in the subject.

4.5 Challenges experienced by learners with VI while using flipped classroom learning strategy in learning Mathematics

The fourth objective in this study, established the challenges experienced by learners with VI while using flipped classroom learning strategy in learning Mathematics. Through the observation guide the researcher noted the major challenges experienced during the FCL strategy as summarized in table 4.11.

Table 4.11

Challenges in FCL

	Frequency (n)	Percentage (%)
Learners asking for extra time after the FCL lesson time.	16	80
Learners having difficulties in participating in learning activities during FCL lesson.	3	15
Learners not collaborating with partners during discussion groups in FCL lesson.	2	10
Learners not able to recall what they listened from the recorded audio.	3	15

Table 11 shows that 80% of learners ran out time and asked for extra time to complete FCL learning activities. This was attributed to the limited amount of time allocated to a lesson which made it difficult to complete the involving FCL activities. Besides, learners with VI requires more time to complete their tasks. 15% of the learners who participated in the study had difficulties in participating in learning activities during FCL lessons due to lack of independent learning skills, and could be attributed to low

motivation therefore not participating. 15% were not able to recall what they listened to, from the recorded audio and 10% were not collaborating with partners in discussion groups during FCL lessons.

Additionally, the challenge of learners who had difficulties in participating in learning activities during FCL lesson were attributed to learners failing to listen to the audios during out of class activities and inability to decipher the instructional messages carried in the media. this concurs with the findings from a study by Ding, S., Lin, L., Wang, G., & Chao, H. (2015) who alludes that Monitoring of leaners outside the classroom is difficult to ensure that learners had truly watched the video. Another challenge noted was that FCL required considerable amount of time whereas there is limited time allocated to a lesson, eighty percent of learners asked for extra time during the in-class activities siting a challenge of limited time in FCL. There was also a challenge during out of class activities that learners were not able to ask questions immediately, during audio lectures and discussions. This concurs with the findings by Nkepah, B. D., & Mboshi, N. S. (2024) in Cameroon who revealed that visually impaired learners face significant challenges when studying statistics, particularly in interpreting graphical data while in out of class activities. This study shed light on the mathematical skills and challenges experienced by visually impaired learners in learning mathematics. The findings indicated that while learners with visual impairment demonstrate proficiency in basic mathematical operations, they experience considerable difficulties with more advanced mathematical concepts especially during out of classroom activities where they are not able to ask questions for clarification to the instructor immediately. The challenges were analysed and summarized as shown in Figure 4.2.

Figure 4.2

Challenges of FCL Strategies

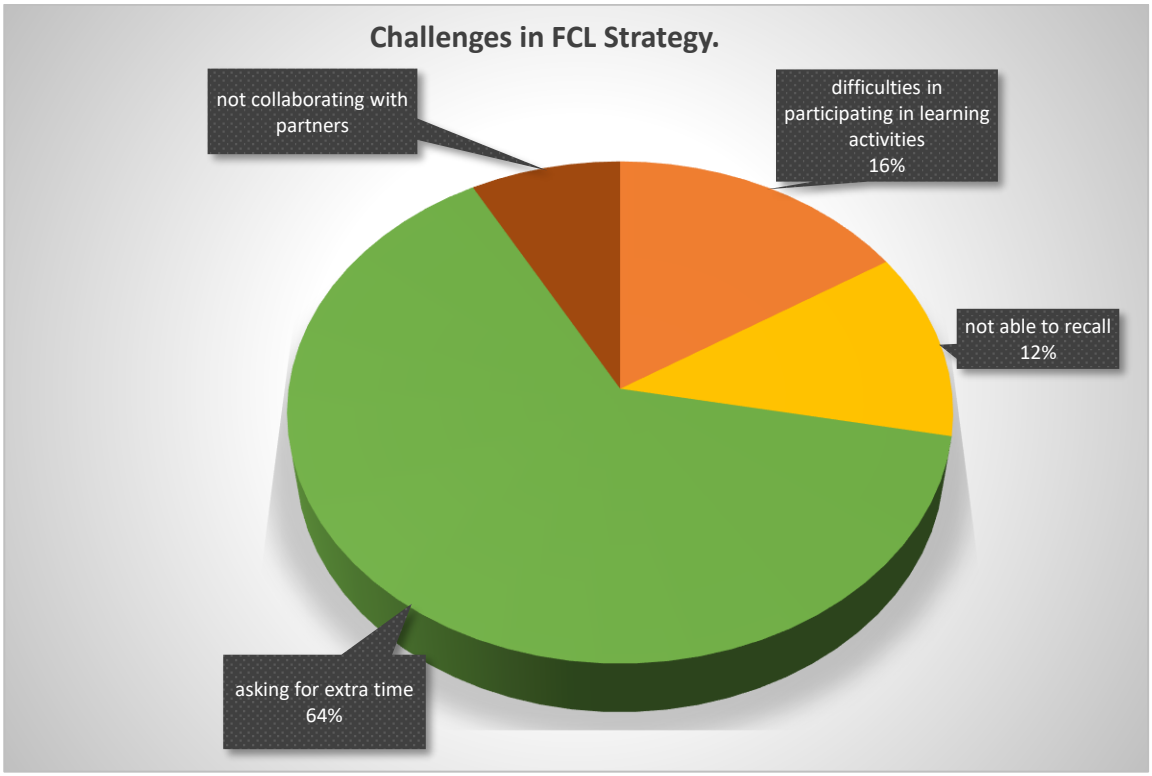

Figure 4.2 further shows the challenges observed during the FCL strategy; sixteen percent of Learners had difficulties in participating in learning activities during FCL lesson. This was attributed to learners failing to listen to the audios during out of class activities. The researcher observed that a few learners were unable to get what the audio recordings had. this could be attributed to a rare use of such audios in teaching Mathematics and also loss of concentration on the subject matter. But if they used the audios again and again, it could be no longer a challenge to them.

This concurs with the findings from a study by Ding, S., Lin, L., Wang, G., & Chao, H. (2015) who alludes that Monitoring of learners outside class, it is difficult to ensure that learners truly watch the FCL video and other media shared to them by their teachers. Another challenge noted was that FCL requires considerable amount of time

whereas there is limited time allocated to a lesson, sixty four percent of learners asked for extra time during the in-class activities siting a challenge of limited time in FCL. Twelve percent of learners could not recall what they listened to during out of class activities while eight percent had difficulties in collaboration with their partners during in-class discussion groups. There was also a challenge during out of class activities that students were not able to ask questions immediately during audio lectures and discussions. Institutional supports Flipped classroom approach relied on the extent of the investment by schools in computer resources (Huang and Hong, 2016).

The challenges could be attributed to the fact that this was a new learning approach to learning, learners were not proficient with using ICT as a learning resources, overloaded or difficulty learning activities and poor socialization of some learners. To make FCL effective, teachers may thus frequently adopt the FCL pedagogical approach in teaching Mathematics among learners with VI; frequently integrate multimedia tools in the FCL activities like videos, audios, animations and simulations; present the mathematics in small chunks in order to enhance scaffolding and make collaborative learning activities interesting for all learners to participate.

These findings concur with the findings from a study by Lo and Hew (2017) conducted in China, involving kindergarten to twelfth grade learners, points out that Students in FCL may skip out-of-class activities and arrive in class without having watched or listened to the lecture videos or audio respectively due to a lack of independent learning responsibility. Further, a study by Trigueros, Ruben, José. Aguilar-Parra, Remedios Lopez-Liria, Adolfo, Cangas, Jerónimo, González, and Joaquín (2020) conducted in Spain revealed that in FCL, organizing and managing

resources, tasks, learners and information at the same time might be time consuming and difficult to the instructor.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The study was mainly conducted in order to investigate the flipped classroom learning influence on performance in Mathematics among learners in Thika high school for the VI. This chapter presents the Summary, the study's conclusions and the recommendations based on the findings of the Four (4) study objectives as well as suggestions for further related studies.

5.2 Summary of the Main Findings

On the objective regarding the teaching strategies used in teaching Mathematics to learners in Thika high school for the visually impaired, the study findings revealed that even with the rise of learner-centered teaching strategies, teachers predominantly utilize direct instruction methods. According to the study findings, the majority of the Mathematics teachers at Thika high school for the VI use question and answer method and the tutorial/ lecture method. All the Mathematics teachers use question and answer method and the tutorial/ lecture method. Fifty percent of the teachers use scaffolding method. Half of the Mathematics teachers revealed that they use discussion method while one thirds use collaborative method. None of the teachers used either experimental or project methods whereas only one teacher used problem solving method on rare occasions.

Regarding objective two the flipped classroom learning activities suitable for learning Mathematics in Thika High School for the visually impaired, the study found out that flipped classroom learning activities included in-class activities and outside the class activities which entailed listening to audios, focus group discussions, presentation of

discussion content, collaboration, guided question and answer assessment, peer tutoring, problem solving and observation schedules. This helped learners to learn independently and creatively, thus encouraging them to develop critical thinking skills therefore improving the performance in mathematics. Ninety percent of learners were actively involved in the learning activities during FCL while 85% of learners were able to recall what they listened from the audios.

Regarding the third objective, the effectiveness of flipped classroom learning activities on performance in Mathematics in Thika high school for the visually impaired. The learners took a pretest which was used to determine the entry behavior of both the experimental and control group. There after the experimental group was exposed to the FCL treatment for six weeks, while the control group continued with conventional teaching strategies. both groups were given the posttest after the six weeks, to determine the effectiveness of the FCL strategy which involved various activities. There was statistically significance difference in performance of learners exposed to the FCL strategy compared to the learners in control group. The analysis of variance test revealed a p-value of 0.002 which indicated that there was a statically significance difference between learners exposed to FCL treatment and those who were not.

Based on the fourth objective of the study, regarding the challenges experienced by learners with VI while using flipped classroom learning strategy in learning Mathematics. The main challenge identified was insufficient time allotted to Mathematics lessons which has mostly allowed the employment of traditional teaching techniques by regular Mathematics teachers at Thika High School for VI. Other obstacles encountered included a few learners having difficulty participating in

FCL learning activities, failing to listen to audios during out-of-class activities, and learners not receiving timely response on questions posed during out-of-class activities.

5.3 Conclusions

The following conclusions were derived from the study:

Based on the study finding which indicated that FCL helped learners with VI to learn independently and creatively, thus encouraging them to develop critical thinking skills therefore improving in the performance in mathematics, it is sound to conclude that the conventional teaching strategies are mainly teacher centered and the learner is left out as a passive listener thus discouraging learners from seeking information and developing critical learning skills and knowledge therefore posting dismal performance in Mathematics as revealed by Kenya national examination council yearly analysis.

Based on research findings, the learning activities in FCL are in-class and out of class learning activities. it is reasonable to conclude that the use of FCL activities improved academic achievement of learners with VI by raising levels of involvement and access to instructional content and resources. This emphasized the significance of incorporating FCL as one of the teaching strategies to learners with VI.

Concerning this study's findings that FCL is an effective teaching strategy that helps improve academic achievement for learners with VI. This study therefore concludes that there is need to train the teachers on how to adopt the FCL teaching strategy to supplement the conventional teaching methods.

Finally based on the research findings that the main challenge experience in FCL

strategy is insufficient time allotted to Mathematics lessons; the study therefore concludes that there is need to add lesson time for Mathematics to allow teachers enough time to apply the emerging teaching strategies.

5.4 Recommendation

5.4.1 Policy Related Recommendations

Due to its limited scope, the current study was unable to conduct an extensive investigation into the mathematical performance of learners with visual impairments (VI) across all academic levels. As a result, the current study's recommendations are the following:

- The government should enhance easy access to materials required for technological based learning for learners with VI so that these materials are readily available for use. Supportive infrastructure like electricity and internet access to schools for learners with VI should be put in place to enhance smooth integration of technological based learning.
- The KICD should design a curriculum to allocate more time for Mathematics lesson and schedule training programs for teachers. The trainings would expose teachers to different emerging teaching strategies such as FCL which are learner-centered thus making mathematic lessons more interactive and enjoyable for learners with VI thus improving their Mathematics performance.
- The universities and teachers' training colleges should ensure that teachers are trained in areas of handling learners with VI particularly in light of new technology-based learning such as FCL. This will allow them to confidently employ the strategy while teaching learners with VI. This training and awareness should be extended to other curriculum development stakeholders

so that they can embrace the technological based teaching strategies. Results show that, teachers were not conversant with the FCL as an alternative instructional strategy.

- The study findings revealed that FCL improves mathematics performance of learners with VI. The research recommends that teachers to adopt the FCL technique in teaching and learning to enhance mathematics performance among learners with VI.

5.4.2 Recommendations for Further Research

Further research is recommended in the following area:

- A similar study should be carried out at different school levels, pre-school, primary secondary and even universities.
- Explore the effectiveness of FCL on Mathematics performance in different disabilities such as physical disabilities, autism and hearing Impairment.
- A similar study to be carried out on teaching other subjects using FCL teaching strategy when teaching learners with VI.

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APPENDICES

Appendix I: Classroom Observation Schedule

Instruction:

The observation checklist seeks to collect information related to Flipped Classroom Learning during math lessons in Thika High School for the VI.

QUESTION	FREQUENCY	COMMENT (Indicate details of the observations made)
1. Do learners have difficulties in participating in learning activities during FCL?		
2. Are learners actively involved in the learning activities on FCL?		
3. Are learners able to recall what they listened from the recorded audios?		
4. Do the learners establish preferred collaboration with partners during the lesson?		
5. Are the learners interested in the learning activities on FCL?		
6. Are the learners enthusiastic to continue with FCL after the allocated time?		
7. Do the learners ask for extra time after the lesson on FCL?		

Appendix II: Interview Guide for Teachers

Instructions: The test tool seeks to collect information on teachers' competencies in the strategies they use in teaching Mathematics.

PART A

Education Background

Training Level

Degree { } Diploma { } Certificate { } Others { }

Teaching Experience

Less than 5years { }

5-15 years { }

Others { }

PART B

1. What teaching strategy do you use mostly during Mathematics lessons?

2. How prepared are you in using the strategy in class?

3. Describe the learners' participation when using this strategy.

SECTION C

4. Do you use FCL during Mathematics lessons?

5. Please indicate possible reasons why teachers may fail to integrate FCL in classroom:

_____

_____

_____

_____

Appendix III: Pre-test

Form 2

Continuous Assessment Test. Term 3 **Venue; Classroom**

Instructions: **Solve all the questions** **Time: 2hrs**.

Date: 14th September 2023.

1. Find the area of a triangle ABC in which AB = 5 cm, BC = 6 cm and AC = 7 cm (2mks)
2. A triangle has sides 10 cm, 7 cm and 9cm. Find:
   (a) It's area. (2mks)
   (b) The sizes of its angles. (2mks)
3. The perimeter of a triangle is 22 cm. If one of the sides is 9 cm, find the other sides if the area of the triangle is 20.976 cm^2. (2mks)
4. A tree casts a shadow 20m long. Find the height of the tree if the angle of elevation of the top of the tree from the tip of the shadow is 31 (2mks)
5. In a right-angled triangle, the shorter sides are 4.5cm and 9.2cm long. Find the sizes of its acute angles. (2mks).
6. Find the equation of the line passing through the given points:
   (a) (0,0) and (1.3) (2mk)
   (b) (0, -4) and (1, 2) (2mk)
7. Determine the equations of the lines perpendicular to the given lines and passing through the given points:
   (a) (a) y-5x+3=0; (3,2) (2mks)
   (b) (b) y = 8 - 7x; (-3, -4) (2mks)
8. Solve each of the following equations:
   (a) $(3^{2x})^3 = 3^4 \times 3^8$ (1mks)
   (b) $(7^5)^x = (7^4)^x \div 7^2$ (1mks)
   (c) $(3^{2x})^4 = 81$ (1mks)
9. Evaluate: $\sqrt[3]{216}$ (2mks)

Appendix IV: Post-test

Continuous Assessment Test. Term 3 **Venue; Classroom**

Time: 2hrs

Date: 14th September 2023.

Instructions: Solve all the questions.

1. The perimeter of a triangle is 22 cm. If one of the sides is 9 cm, find the other sides if the area of the triangle is 20.976 cm^2. (2mks)
2. In a right-angled triangle, the shorter sides are 4.5cm and 9.2cm long. Find the sizes of its acute angles. (2mks).
3. A triangle has sides 10 cm, 7 cm and 9cm. Find:
   (a) It's area. (2mks)
   (b) The sizes of its angles. (2mks)
4. A tree casts a shadow 20m long. Find the height of the tree if the angle of elevation of the top of the tree from the tip of the shadow is 31^0. (2mks)
5. Find the area of a triangle ABC in which AB = 5 cm, BC = 6 cm and AC = 7 cm. (2mks)
6. Determine the equations of the lines perpendicular to the given lines and passing through the given points:
   (a) y-5x+3=0; (3,2) (2mks)
   (b) y = 8 - 7x; (-3, -4) (2mks)

7. Evaluate: $\sqrt[3]{216}$ (2mks)
8. Find the equation of the line passing through the given points:
   (a) (0,0) and (1.3) (2mk)
   (b) (0, -4) and (1, 2) (2mk)
9. Solve each of the following equations:
   (a) $(3^{2x})^3 = 3^4 \times 3^8$ (1mks)
   (b) $(7^5)^x = (7^4)^x \div 7^2$ (1mks)
   (c) $(3^{2x})^4 = 81$ (1mks)

APPENDIX V: RESEARCH PERMIT

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **664778**

Date of Issue: **29/September/2023**

RESEARCH LICENSE

This is to Certify that Ms.. Jackline Ncekei Miriti of Kenyatta University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Kiambu on the topic: FLIPPED CLASSROOM LEARNING INFLUENCE ON MATHEMATICS PERFORMANCE AMONG LEARNERS IN THIKA HIGH SCHOOL FOR THE VISUALLY IMPAIRED, KIAMBU COUNTY, KENYA for the period ending : 29/September/2024.

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664778

Applicant Identification Number

Director General
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See overleaf for conditions

APPENDIX VI: RESEARCH AUTHORIZATION LETTER

KENYATTA UNIVERSITY
GRADUATE SCHOOL

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

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

Our Ref: E55/26950/2019

DATE: 18th September, 2023

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

Dear Sir/Madam,

RE: RESEARCH AUTHORIZATION FOR JACKLINE NCEKEI – REG. NO. E55/26950/2019

I write to introduce Ms. Jackline Ncekei who is a Postgraduate Student of this University. She is registered for M.ED Degree programme in the **Department of Early Childhood and Special Needs Education.**

Ms. Ncekei intends to conduct research for M.ED Proposal entitled, **"Flipped Classroom Learning Influence on Mathematics Performance among Learners in Thika High School for the Visually Impaired, Kiambu County, Kenya'.**

Any assistance given will be highly appreciated.

Yours faithfully,

KENYATTA UNIVERSITY
OFFICE OF EXECUTIVE DEAN
21 SEP 2023
GRADUATE SCHOOL
P.O. BOX 43844-00100 NAIROBI

PROF. ELISHIBA KIMANI
FOR: EXECUTIVE DEAN, GRADUATE SCHOOL

EK/ec