EFFECT OF FLIPPED CLASSROOM STRATEGY ON STUDENTS' ACADEMIC ACHIEVEMENT IN PHYSICS TO SECONDARY SCHOOLS IN KAUMA SUB-COUNTY, KILIFI COUNTY, KENYA

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A Thesis Submitted in Partial Fulfilment of the Requirements for the Degree of Master of Education (Physics Education Option) of Murang'a University of Technology

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DECLARATION

Student's Declaration

I hereby declare that this Thesis is my original work and to the best of my knowledge and has not been presented for a degree award in this or any other University. I understand what plagiarism is and I am aware of the University's policy in this regard. I understand that any false claim in respect of this work shall result in disciplinary with the University Anti-Plagiarism Policy.

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Supervisors' Approval

The undersigned certify that they read and recommended for acceptance of Murang'a University of Technology a thesis entitled ''**Effect of Flipped Classroom Strategy on Students' Academic Achievement in Physics to Secondary Schools in Kauma Sub-County, Kilifi County, Kenya''.**

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DEDICATION

I dedicate this thesis to my parents, Cosmas Mwachambi and Mariam Munyazi for their support, encouragement and prayers towards this achievement. I also dedicate it to my friends, Naomi, Mercy and Kararu for believing in me from the beginning of this journey to the very end.

Thank you very much.

ABSTRACT

Flipped classroom is an innovative teaching strategy that is getting popular day by day in the 21st century. Studies show that the strategy has a positive impact on student achievement in different subjects. Secondary schools students in Kauma Sub-County, Kilifi County, Kenya have been scoring dismally in the physics Kenya Certificate of Secondary Education examinations for six consecutive years as reported by the sub-county's 2022 KCSE report. This study investigated the effects of the flipped classroom on students' achievement in physics in the sub county. It also assessed the students' perception of the strategy towards physics instruction and the challenges they faced when adopting the flipped classroom strategy. The study adopted mixed research methods using the non-equivalent Solomon IV quasi-experiment and qualitative designs. The targeted population of this study was 1270 form one students from four secondary schools in Kauma Sub-County. Purposive sampling, stratified sampling and random sampling techniques were used to sample out 182 students from four schools that were involved in the study. Two schools were experimental and the other two were the control group. One experimental and one control group received a pre-test test, thereafter, the four schools were taught electrostatics (I) for a period of two weeks. Teachers observed and recorded the instruction process and recorded observable changes and challenges faced when using the strategy. Perception Likert-scaled questionnaires were administered to the students to rate their perception of the strategy. After the treatment, post-test achievement test was administered to all form ones in the four selected schools to assess effect of the treatment. A comparison of means of the students' achievement and perception was done and the differences noted down. The critical value obtained from ANOVA and α-value of 0.05 of the achievement scores was 0.036. Since 0.036< 0.05 leading to a conclusion that flipped classroom strategy significantly improved students' academic achievement in physics. A pared t-test was conducted on the retention data and a p-value of 0.000 was obtained leading to a conclusion that there was statistical difference in retention of concepts between students taught by flipped classroom strategy and those taught using the traditional lecture strategy. MANOVA test was conducted on the perception responses with a confidence level of 0.05, a significance value of 0.000 which was less than 0.05 leading to a conclusion that Students' perceived flipped classroom as an effective strategy for physics instruction. The data on challenges was analysed thematically through content analysis. The study recommends that flipped classroom strategy can be employed as a physics instructional strategy to teach learners who achieve dismally in physics. The study also recommends for similar studies to be conducted on in other subjects other than physics.

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ACRONYMS AND ABBREVIATIONS

EFC	Experimental Flipped Classroom
FC	Flipped classroom
FCS	Flipped Classroom strategy
KCSE	Kenya Certificate of Secondary Education
KNEC	Kenya National Examination Council
LMS	Learning Management System
MOOCs	Massive Open Online Courses
NACOSTI	National Commission for Science Technology and Innovation
NGOs	Non-Governmental Organizations
PISA	Program for International Student Assessment
PLNs	Personal Learning Networks
SMASSE	Strengthening of Mathematics and Science in Secondary Education
STEM	Science, Technical, Engineering and Mathematics
TIMSS	Trends in International Mathematics and Science Study
TOUPC	Test of Understanding of Physics concepts

OPERATIONAL DEFINITION OF TERMS

Flipped Classroom Strategy (FCS):	A learning strategy where students interact with learning materials prior to the class time trying to conceptualize the concept on their own while class time is used for discussions and clarification of concepts
Achievement:	Students' performance in tests on electrostatics (I)
Learning activities:	Experiments, observations, discussions done by students prior to or during class time for them to gain understanding of electrostatics (I) concepts
Learning resources:	Physical materials and handouts that aid the teaching and learning of electrostatic phenomena
Cognitive load:	The number of physics concepts that learners are expected to learn by the end of every lesson

CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

Flipped classroom strategy is gaining popularity in recent years as an innovative strategy to teaching and learning. In this strategy, students are given a an opportunity to interact with the learning materials prior to the class time trying to understand concepts on their own while class time is used for hands-on and interactive learning activities (Musdi et al., 2019). This strategy was initially used as a peer instruction strategy in 1990s where Harvard University students read printed materials before class time waiting for discussions and problem solving activities during class time (Baker 2016). Research has shown that this strategy can enhance student performance by promoting active learning, critical thinking, and engagement. For example, a study by Chen et al., (2018) found that students in flipped classrooms performed better in assessments as compared to those in the traditional settings. They attributed the success to increase of opportunities for collaborative learning and problem-solving during class time. Additionally, meta-analysis of 17 researches on flipped classroom strategy done in China by Lo, Hew & Chen (2017) showed that flipped classroom strategy led to moderate improvement in student achievement, particularly in STEM subjects.

Flipped classroom divides the learning process in to three phases. The first phase; interaction phase, focuses on students' interaction with learning materials outside the class which helps themto have an insight of what is expected from them by the end of a lesson (Låg & Grøm, 2019). It majorly focusses on the lower levels of learning in blooms taxonomy which are remembering and understanding (Siverkumar, 2023). In this phase the learner is expected to individually interact with sources of information using his metacognitive abilities to understand the concepts (Judy et al., 2022). This phase allows the learners to have autonomy over their studies and collaborate with peers (He, 2020). Videos, animations, handouts, experimental activities, online sources and charts are the major sources of information to learners in the pre-classactivities (Al-Samarraie et al., 2020; Akçayır & Akçayır, 2018). Also Meyliana et al., (2021) posed that active participation in instruction leads to a deep understanding of the concept rather than depending on rote memorization of

concepts and superficialunderstanding.

In the second phase; discussion and application phase. In this phase learners interactively share their knowhow of the concepts in groups during the class time (Galindo- Dominguez, 2020; Galindo- Dominguez, 2019). The subject teacher guides the discussion while clarifying some concepts. The teacher also helps the learners to attain to the upper levels of learning in the blooms taxonomy through problem solving activities and hands-on activities. It allows offline presentation of ideas from students and instructors, clarification of concepts, solving problem and performing activities for the technical classes (He, 2020; Al-Samarraie et al., 2023).

Lastly, the post class phase. Here leaners have a room for reflection, application, assessment and transfer of concepts (He, 2020; Siverkumar, 2023). After the presentation, discussions and corrections done during the class time under the guidance of their subject teacher, the learners broadens their understanding as they will learn more from the different perspectives of their peers and their teacher(Doğan et al., 2023; Li et al.,2023).

With the high development rate of technology and innovations in the world, flipped classroom is being adopted globally and across all educational levels (Hew, Bai & Huang, 2021). For example, many primary and K-12 schools in North America are using flipped classroom strategy to enhance personalized and active engagement through allowing the students to access pre-class instructional materials on Khan Academy and TED-ed online platforms. Also tertiary schools facilitates STEM subject using this strategy as learners access pre-class materials on Massive Open Online Courses (MOOCs) platform (Deng 2019).

In Europe, U.K and Scandinavian countries have been using flipped classroom strategy to enhance autonomy and differentiated learning (Mitsiou, 2019). Government initiatives towards modern education in China are emphasizing educational institutions to adopt blended learning approaches with the support of DingTalk and Tencent classroom. International schools in the United Arab Emirates uses flipped learning in promoting student’s critical thinking and problem-solving skills. Furthermore, Saudi universities adopt flipped classrooms as part of broader efforts to modernize and to improve the quality of higher education.

However, the effectiveness of the flipped classroom strategy varies based on implementation and context. For instance, Zainuddin and Perera (2019) highlighted that while flipped classrooms generally lead to positive outcomes, the success largely depends on the quality of pre-class materials and the effectiveness of in-class activities. In higher education, flipped classroom strategy has been particularly beneficial for improving student performance and engagement in complex subjects.

In spite of this, there is low growth rate of technology development and inadequate infrastructure in Africa; efforts are ongoing to introduce flipped learning in schools (Baingana, 2024). For instance, in Nigeria, only a few private schools are using flipped classroom strategy. A study by Egara,& Mosimege (2024) on flipped classroom and mathematics achievements to senior secondary in Nigeria showed a positive impact to the students' performance in the subject. Also only Universities in South Africa have explored flipped learning to improve student engagement and address large class sizes, Parker et al (2022). In Kenya, Universities like University of Nairobi and Kenyatta University are using flipped classrooms majorly for training medicine and engineering courses. However, there are a few studies done in public secondary schools in Kenya indicating positive results but it has not been embraced in many schools in the country. For example, Chebotib, Too, & Ongeti, (2022) studied the effects of the flipped learning strategy on students' biology achievement in Uasin Gishu County extra county schools and recommended that it is a potential tool to better performance of students though the schools were homogeneous hence the results could not be generalized. In the coastal region of Kenya only one study on flipped classroom and physics performance was done in Mombasa county private secondary schools and the findings were positive towards the strategy. In Kilifi County, no school has embraced the use of flipped classroom for their instruction.

Studies on flipped classroom strategy show that, students in flipped classroom get more engaged during instructions. This increased participation is attributed to the fact that students have already been exposed to the material before class, allowing the learners to come prepared with questions and ideas as stated by Cardaciotto (2018). Furthermore, (Wagner et al. 2020) stated that flipped learning strategy generally shows better student outcomes as compared to traditional lecture-based

strategies. However, most of the available studies have focused on Western educational contexts. The focus on the western education led to a noticeable lack of adequate presence of studies on flipped strategy in the African context, especially at the secondary level. There was a need to address this gap. This study was therefore conducted in Kauma Sub County, a rural area in Kenya which is one of the countries in Africa.

The general performance of physics for the past seven years in Kenya has been low. According to the KNEC 2022 results report, the subject recorded mean scores that are below average for seven consecutive years. Table 1.1 shows the mean score of physics scored in Kenya from 2018 to 2022 as per the 2022 KCSE Physics Report

Table 1.1: Physics Mean Score as Per the 2022 KCSE Report

Year	Physics Mean marks score (%)
2018	21.61
2019	21.73
2020	23.69
2021	19.90
2022	22.04

The dismal performance in the general performance is highly contributed by the extremely low performance from the schools in rural areas. Kauma Sub-County being one of the rural areas, most schools in the have been performing lowly as evidenced by the schools' KCSE mean points records in the subjects in the previous years. The data in Table 1.2 shows the mean score of physics for 9 schools in Kauma Sub-County for the past 6 years as per the sub-county records.

Table 1.2: History of Physics Performance of Schools in Kauma Sub- County

School	2018	2019	2020	2021	2022	2023
A	3.26	3.48	3.12	2.98	3.42	3.66
B	1.98	2.42	1.67	1.87	2.45	2.21
C	2.48	2.34	1.93	2.23	2.76	2.46
D	-	1.97	1.51	1.67	2.31	2.39
E	1.76	1.85	1.52	1.97	2.23	2.13
F	-	-	-	-	1.67	2.03
G	2.51	2.76	2.34	2.47	3.12	2.94
H	2.14	1.96	1.45	1.68	1.94	2.09
1	-	-	-	-	1.48	1.74

Numerous factors, including ineffective teaching strategies, poor study habits, inadequate preparation, and challenges with mathematical and analytical skills, are blamed for the poor performance (Michael, & Wumi, 2020). The ineffective strategies of instruction in classrooms served as the base for this study as it aimed at testing whether flipped classroom strategy can help in improving the students' performance in the subject by using it to teach electrostatics (I), a topic in form 1.

The adoption of the flipped classroom strategy in Kenya has shown promising results, particularly in science subjects. A study conducted by Mutambuki & Fynewever (2017) in Nairobi secondary schools found that students in a flipped physics classroom performed better in both formative and summative assessments as compared to their peers in the traditional classrooms. The study also reported improved student attitudes towards physics and increased engagement during lessons. Though the findings were positive in this area, this was an urban center of study. Kauma Sub County is a remote area in Kenya. There was a need to do a similar research in a rural area to assess the effect on student's achievement and their perception of the flipped strategy. This justified the study.

1.2 Statement of the Problem

Lecture-based strategy has been the popularly used approach to educational instruction in secondary schools in Kenya. According to (Wafukho et al. 2022), this strategy leads to passive learning leading to lower student achievements. This approach also struggles with maximizing the learning opportunities rendering it less effective to teaching STEM subjects (Murithi & Yoo, 2021). Students in Kilifi County have been achieving dismally in physics as evidenced by the secondary schools in the county recording low KCSE mean grades in seven consecutive years. Strategies that optimize learning and engagement opportunities can help in addressing the low achievements. Flipped classroom has been stated as one of these strategies. While numerous studies report positive impact of flipped classrooms to student academic achievement in various subjects worldwide, there is little documented information in the Kenyan context and especially in physics education. The available literature on flipped classroom and physics achievement and how it is perceived in Africa mainly focuses on higher education settings, creating a knowledge gap on how the flipped classroom strategy may influence student physics achievement in the African rural secondary schools (Wafukho et al. 2022) Furthermore, the challenges faced when adopting the flipped strategy in one area might be different to those that can be encountered in another socio-cultural setting as a result of differences in access to resources and levels of acceptance of the teaching strategy by the community. This gap necessitated the need for this study to be done in Kauma Sub-County, considering the specific contextual factors that may affect its implementation and outcomes. Addressing this gap can help in increasing the number of empirical evidence and insights that inform educational policy makers seeking to enhance science education and student performance in similar settings across Kenya.

1.3 Objectives of the Study

1.3.1 General Objective

The Objective of this study was to investigate the effect of flipped classroom strategy on students' academic achievement in physics in and how flipped classroom strategy is perceived in Kenyan public secondary schools.

1.3.2 Specific Objectives

The specific objectives of this study are:

i. To determine the effect of the flipped classroom strategy on academic achievement of physics in secondary schools in Kauma sub-county.
ii. To compare the retention ability of physics concepts between students taught using the flipped classroom strategy and those taught using lecture-based strategy in Kauma sub-county.
iii. To assess how students in Kauma sub-county secondary schools taught by flipped classroom strategy perceived the strategy
iv. To identify challenges faced by learners and teachers when using flipped classroom strategy for physics instruction in Kauma sub county, Kilifi County Kenya.

1.4 Research Hypotheses

HO_1: The flipped classroom strategy does not significantly improve students' academicachievement in physics

$H0_2$: There is no significant difference in retention of physics between students taught using the flipped classroom strategy and those taught using traditional teaching strategies.

HO_3: Students' do not perceive flipped classroom as an effective strategy for physics instruction.

1.5 Research question

What are the challenges faced by teachers and students when implementing the flipped classroom strategy?

1.6 Significance of the Study

This research can demonstrate whether the flipped classroom strategy can bridge the achievement gap in physics, a subject where students typically underperform. Secondly, the findings can inform teacher training and professional development programs on the need for equipping educators with the skills and resources necessary for the implementation of flipped classroom strategies. Additionally, the study's insights can guide educational policymakers in making data-driven decisions to integrate technology and active learning pedagogies into the curriculum in Kenyan schools. Ultimately, this study could potentially lead to more extensive educational reforms aimed at improving STEM education and fostering academic excellence in the rural areas.

1.7 Scope of the Study

The study was conducted in public secondary schools in Kauma Sub-County, Kilifi County, which is located in coastal region of Kenya. Kilifi County is selected for this study because of the high records of low performance in physics in the Kenya national examination for secondary schools (KCSE). Four sampled schools were electrostatics (I) for two weeks. . Pre and post achievement score tests, unstructured questionnaires and observation checklist were used to collect data.

1.8 Limitations of the Study

This study was limited to public schools and a limited sample size in the sub county hence findings would be difficult to be generalized. Further, teachers and students used self-reporting mode leading to a social bias.

1.9 Assumptions of the Study

The study assumed that all participants cooperated with the adoption of the FC, the learners did not know that they were being observed, the school heads adjusted school activities for learners to have enough time of interaction with the learning materials, there was notechnological and power shortage in the sampled schools, the FC strategy was acceptable in the community of study. Lastly, the answers provided in the questionnaires and observation checklists were honest.

1.10 Contributions of the Thesis

The study made the following contribution;

i. The study confirmed that students in flipped classroom strategy achieve better in Physics compared to those taught using lecture strategy.
ii. Flipped classroom strategy promoted better retention of concepts as compared to those taught using lecture strategy
iii. The study confirmed that student in Kauma Sub-County perceived flipped classroom as a helpful strategy for physics instruction
iv. The study identified challenges faced by both teachers and students in Kauma Sub-County when using flipped classroom strategy for physics instruction.

1.11 Organization of the Thesis

This thesis is organised in five chapters including introduction, literature review, research methodology results and discussions and conclusion and recommendations.

The first chapter covers the background information of the study, statement of the problem, objectives of the study, research hypotheses, a research question, and significance of the study, scope, limitations, assumptions and the contributions of the study.

The second chapter focus on the literature review, theoretical framework, empirical review on the specific objectives of the study and the conceptual framework of the study.

Chapter three contains the research methodology, research design and target population, sampling techniques, sample size, validity and reliability of the data collection tools used in the study. It also focuses on the data collection procedure and how the data would be analysed and presented. Lastly it contains the ethical issues that were considered in the study.

The fourth chapter presents the collected data for the study, data analysis and presentations and discussions of the findings.

The last chapter contains summary of the study, conclusions and recommendations of the study for practice, policy and further studies.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter contains theoretical framework of the study, academic research related to this study, empirical review of flipped classroom strategy and conceptual framework of the study.

2.2 Theoretical Framework

This strategy is guided by learning theories that emphasizes on experiential, self-directed and activelearning. This study therefore adapted the following theories;

2.2.1 Constructivism Learning Theory

This study adopted the constructivism learning theory by Jean Piaget (1880). The theory states that knowledge is obtained through human interaction. This theory asserts that, the construction of knowledge by learners is through their experiences, active interactions and reflections of their experiences. Therefore, the instructional approaches to be used should be the ones that allow learners interact with the material for it to be effective. Piaget (1964) did an experiment on how children develop cognitively and he observed that accommodation and assimilation of new concepts are the key processes of interaction between ideas and experiences.

Flipped classroom strategy combines several interactive activities so learners can create knowledge through social interactions and personalized learning (Pali, 2021). Since learners usually interacts with leaning materials prior to class time, the experience gained forms a basis for deeper learning during class time which is in line with this theory.

In this study, students in the flipped classrooms interacted with the learning materials on electrostatic (I); did experiments and made observation on electrostatic (I) concepts trying to understand the concepts on their own before going to discuss and get clarifications on concepts that were abstract to them. They were later expected to reflect on their experiences with the learning materials to create knowledge. Lastly, they were to have peer interactions to share their experiences and understanding of the presented concepts.

2.2.2 Cognitive Load Theory (CLT)

This study also adopted the Cognitive theory by John Sweller (1998). Sweller divided the human memory into working memory and long term memory. He defined working memory as the spacewhere information is stored temporarily before being processed and stored in the long term memory. He said that, the working memory is limited in space and can only hold limited information at a time and emphasized on the provision of small chunks of information at a time which the working memory can handle for learning to take place. This prevents overloading the working memory which may stop it from working. After the information has been stored in the working memory it is then processed and stored in the long term memory where when needed, the learner can just recall the information back to the working memory.

Flipped classroom allows provision of the learning materials prior to class time; learners have enough time to interact with these materials as they feeding the working memory with small information at a time hence the strategy reduce the cognitive load (Zhang, Chen, Ge, Hung & Mei, 2019). During the class, less work is discussed maximizing the chances of understanding the concepts. Flipped classroom reduces the germane load hence learners can integrate new knowledge to the existing knowledge with (Morton & Colbert-Getz 2016). Also Tonkin, Page &Forsey (2019) in their study on managing cognitive load suggested that, presenting information in multiple modalities enhances learning and increases the likelihood of processing the information into long-term memory. They attached this to the ability of FCA to incorporate visual elements and verbal explanations. They concluded that, use of multiple modalities in content presentations can help improve learning and reducing the cognitive load.

In this study, learners had a lot of time to interact with the learning materials. This gave students time to receive small chunks of information at a time hence during their personal time with the materials. During class time only a little amount of information was to be added to what they had already acquired which aligns well with the CLT.

2.3 Empirical Literature Review

An empirical review is a review that gives a summary of what other researches has done explaining the strategies used, findings and the comments they made based on the evidence collected in the research. The evidence is usually the data collected from naturally occurring situations or the findings obtained from experiments (Nyokabi, 2022). Here empirical review on flipped classroom and achievement, retention of concepts, its perception and challenges faced when adopting the strategy for physics instruction will be discussed.

2.3.1 Effect of the Flipped Classroom Strategy on Academic Achievement of Physics

Flipped classroom is an inverted strategy of instruction where most learning activities are done outside before the class time while only a few activities done during the class time (Lag & Grøm, 2019). This strategy has been in debates since the year 2000 and it is getting more popular with the rapid development and enhancement of technology over the years. Several names have been used to describe this strategy of teaching over the years; inverted classroom (Lage et al., 2000), inverted teach (Davis, 2013) and just-in time learning (Novak, 2011).

Today, it is being applied in different fields of learning such as medicine, engineering, linguistics and education fields. For example, Chebotib et al. (2022) conducted a study in Uasin Gishu County, Kenya, to investigate the impact of flipped learning on academic achievement in Biology. Using a quasi-experimental design with the Solomon four-group method, they found that students taught using flipped strategies scored significantly higher than those taught conventionally. The study emphasized the role of computer-based concept mapping in enhancing cognitive development and achievement (Chebotib, Too, & Ongeti, 2022). Also, Maduegbunam & Okigbo (2025**)** explored the flipped classroom instructional strategy in Anambra State, Nigeria, focusing on mathematics achievement. Their quasi-experimental study revealed that students taught with flipped methods outperformed those taught via lecture-based instruction. The researchers recommended integrating flipped strategies into curriculum planning to improve learning outcomes (Maduegbunam & Okigbo, 2025).

Talan & Gülseçen (2019) compared flipped, blended, and traditional learning environments in Turkish vocational schools. Their findings showed that students in flipped classrooms produced significantly higher academic achievement and participation levels. The study used one control group and two experimental groups, highlighting the flipped model's effectiveness in promoting active learning (Talan & Gülseçen, 2019). Li et al., (2023) concluded that FCS is a useful tactic to meet the diverse learning needs of students by using both the e-learning and physical platform to present the concepts. The online platform presents in form of videos, animations and pictures making abstract concepts to appear realistic to the learners. The online platforms also allow learners to interact with peers from different schools to discuss on the concepts creating broader connections and sharing ideas as stated by Papadakis et al., (2019). Cho et al., (2021) on flipped classroom and active learning to mechanical engineering students and perception of concepts, they used mechanical engineering students to collect evidence. The results showed that most of the learners changed their perception towards the course and they concluded that the FC has positive impacts to learner's perceptions of concepts.

Furthermore, (Bawane et al., 2020) in the medicine field, they conducted astudy on the impact of FC strategy to optimizing understanding of medical concepts to undergraduate students. They used a quasi-experiment method. Their findings indicated that learners in the FC had a great significant statistical difference in motivation to learning as compared to those in the lecture-based classroom. The results of a study on the effect of the flipped classroom strategy to physics courses done in two German secondary schools indicated that the strategy has a positive effect on the learning gain as well as on motivation and self-concept Finkenberg & Trefzger, (2019).

Tunggyshbay et al. (2023) performed a systematic review of 30 studies on flipped classrooms in Physics education. Their analysis revealed consistent positive effects on student achievement across diverse contexts. The review emphasized the importance of pre-class preparation and in-class active learning in enhancing academic outcomes (Tunggyshbay, Balta, & Admiraal, 2023). (Doğan et al., 2023) studied the effectiveness of flipped classroom practices in teaching of science subjects the results were positive and concluded that it as an effective and strategy to

teaching sciences. Also (Adonu et al., 2021) researched on the impact of FCS to student achievement and concepts retention in biology and the implication of the strategy to teaching science subjects and recommended that, FC can be used to teach other science subjects such like physics. Though the strategy is seen to be of great impact to learners, some learners reported it to be challenging as the out of class activities are time consuming and overwhelming (Guo et al., 2020).

A study to test the effect of the strategy to physics learning done in Uludag university by Sengel (2014) showed that though the students initially struggled to adopt the new strategy, the academic results were greatly improved. Additionally, Cagande & Jugar (2018) conducted a quasi- experiment to college students on the effect of the FCS to understanding of kinematics graphs and student motivation and the results obtained indicated that the strategy has a significant positive effect to understanding the kinematics graphs. Furthermore, Ndiji et al., (2020) did a study to determine the effect of FC strategy to student achievement and retention of concepts in public senior secondary schools in Nigeria, their results showed a superior achievement improvement as well as improved concept retention ability by the learners in the FC. Also, Olanrewaju & Richard (2023) studied college Physics students in Nigeria, comparing flipped and traditional lecture methods. Their findings showed that flipped classrooms significantly improved academic achievement and retention. The study used validated achievement tests and found no significant gender differences in outcomes (Olanrewaju & Richard, 2023). Aljaraideh (2019) examined flipped classrooms in Jordanian universities and found high student achievement and satisfaction. The descriptive study highlighted flipped learning's role in developing critical thinking and problem-solving skills, which contributed to improved academic performance (Aljaraideh, 2019).

Lastly, Nyarango & Nyakango (2021) on their study on how flipped classroom strategy enhance English learning in public schools in Nairobi, Kenya found out that flipped strategy improves concepts understanding. They recommended that students should be allowed to create their own learning materials. This study will help the researcher to allow teachers involve the learners in creating the learning materials to ensure the strategy is effectively implemented.

As much a lot of research has been done on flipped classroom, most of them were done at the higher education level (Uzunboylu &Karagozlu, 2017). About 79% of the research reports and reviews on flipped classroom available are based on universities and colleges, about 9% in primary education and 12% in secondary education. Among the 12% available work on flipped classroom, most of them are based on mathematics and English and about a quarter of them on pure sciences. This research therefore aimed at increasing the empirical evidence of effectiveness of flipped classroom to learning physics at the secondary school level in an African setting and in rural areas to provide empirical evidence of its effectiveness in different cultural contexts.

2.3.2 Students Ability of Concepts Retention in a Flipped Classroom

Olanrewaju and Richard (2023) conducted a quasi-experimental study in Nigeria comparing flipped classroom learning strategy (FCLS) and traditional lecture method (TLM) in college Physics. Using validated retention tests and achievement scales, they found that students taught using FCLS retained Physics concepts significantly better than those taught via TLM. The study involved 60 students and used t-tests to analyse retention scores, revealing that flipped learning promotes long-term memory and conceptual mastery (Olanrewaju & Richard, 2023). Tunggyshbay et al. (2023) performed a systematic review of 30 studies on flipped classrooms in Physics education. Their findings showed that flipped strategies consistently improved retention and understanding of Physics concepts. The review emphasized the role of pre-class preparation and in-class active learning in reinforcing knowledge and reducing cognitive overload (Tunggyshbay, Balta, & Admiraal, 2023).

Musdi et al. (2019) in Indonesia explored the impact of flipped classrooms on retention in science subjects. Their findings showed that students retained more information when they engaged with content before class and applied it during interactive sessions. The study used pre-tests, post-tests, and delayed post-tests to measure retention over time (Musdi, Agustyani, & Tasman, 2019). Chen et al. (2018) examined flipped learning in U.S. high schools and found that students retained Physics concepts better when taught using video-based pre-class materials followed by collaborative in-class activities. The study used a mixed-methods

approach and highlighted the importance of scaffolding and feedback in supporting retention (Chen, Lui, & Martinelli, 2018).

Lo, Hew, and Chen (2017) conducted a meta-analysis of 17 studies in China on flipped classrooms. They concluded that flipped strategies significantly improved retention across STEM subjects, including Physics. The analysis emphasized the importance of well-designed pre-class materials and structured in-class activities (Lo, Hew, & Chen, 2017). Zainuddin and Perera (2019) studied flipped learning in Malaysian secondary schools and found that students retained Physics concepts better when taught using flipped methods. The study used retention tests and interviews, revealing that students appreciated the opportunity to revisit materials and clarify misconceptions during class (Zainuddin & Perera, 2019).

Most of the studies on retention of concepts were conducted in Western or Asian contexts leading to inadequate availability of localized research in Kenyan secondary schools, especially in rural counties to inform educational policy formulation. Nevertheless, the existing studies rarely account for differences in student backgrounds, learning styles, or access to technology, which can influence retention outcomes.

2.3.3 How Students Perceive Flipped Classroom Strategy

Students from different levels of learning have been appreciating the approach acknowledging its ability to increase student engagement during instruction process, increasing learning autonomy and flexibility in learning (Lee & Kim, 2021). Furthermore, Say & Yildirim (2020) found that students had good opinions toward the strategy and show a high degree of satisfaction with it since it recognizes their participation and interactions making learning to be fun.

According to Ahmed & Asiksoy's (2021) research, students' perceptions of virtual laboratories improved as a result of gamified flipped learning, which also improved their self-efficacy and innovative skills. This was a result of the learners getting more engaged and changing their attitude towards virtual laboratories which led to high levels of understanding and also improved classroom interactions.

Fornons et al., (2021) examined high school students' perceptions of the flipped classroom in mathematics. Findings of the study indicated that students accepted the strategy. Learners accredited it as an effective strategy to learning due to its self-centered characteristic and the collaborative aspect. (Bawang, & Prudente, 2018) did a study on Students' understanding of physics concepts and perceptions in a flipped classroom environment. Their study findings showed overall good results after the flipped classroom intervention; there was a substantial difference in the mean student engagement scores, the mean scores of students' attitudes about learning physics before and after intervention also differ significantly and learners expressed opinions that were positive towards physics.

Aljaraideh (2019) explored students' perceptions of flipped classrooms in Jordanian private universities. The study found high levels of satisfaction, citing improved engagement and critical thinking. The study focused only on university students, limiting its applicability to secondary school learners. It also lacked qualitative insights into students' emotional responses. Also, Dela Cruz et al. (2024) surveyed midwifery students in the Philippines, revealing that flipped classrooms enhanced motivation and self-regulated learning. However, their study was specific to midwifery, making it difficult to generalize findings to the education field. It also relied heavily on self-reported data and therefore it was not possible to conclude that the strategy is perceived positively by learners.

Johnson (2013) studied high school math students in Canada and found that learners appreciated the flexibility and self-paced nature of flipped classrooms. Though students appreciated the strategy the study did not include other subjects such as physics therefore the data lacked longitudinally to assess perceptions in other subjects. Further, Lo & Hew (2017) conducted a meta-analysis of flipped classroom studies across STEM fields. They concluded that students generally perceive flipped learning positively. The meta-analysis aggregated diverse contexts, making it hard to isolate perceptions specific to Physics. It also did not account for cultural or regional differences. Zainuddin & Perera (2019) investigated Malaysian students' perceptions and found that flipped classrooms fostered autonomy and competence. Chen et al. (2018) reported that U.S. high school students found flipped Physics classes more engaging and effective than traditional ones. Musdi et al. (2019) found that

Indonesian students appreciated the interactive nature of flipped classrooms in science subjects. However, study did not differentiate between subjects, and the perception data were not triangulated with classroom observations.

Tunggyshbay et al. (2023) reviewed flipped classroom strategies in Physics and noted that students valued the active learning components. Weakness: The review did not include student voices directly and relied on secondary data, which may not reflect nuanced perceptions. According to Ajmal & Hafeez (2021) flipped classrooms as promote lifelong learning and critical thinking among Pakistani students. Though the study showed positive findings, it was theoretical and lacked empirical data from actual classroom implementations. Further, Rehman & Fatima (2021) found that students appreciated learning in flipped classrooms but struggled with time management.

Cole & Kritzer (2009) conducted a conceptual study in the United States, focusing on strategies for successful online teaching, including flipped classroom elements. The study emphasized improved instructor-student interaction and flexibility in instructional delivery. However, their study was theoretical, based on instructional design principles and teaching experiences in online environments. Thus the study lacked empirical data and did not include student feedback or perception analysis specific to flipped classrooms. Talan & Gülseçen (2019) conducted an empirical study in Turkish vocational high schools to examine students' satisfaction and engagement in flipped classrooms. The study used a quasi-experimental design with pre- and post-tests and student surveys to measure academic engagement. This study was limited to vocational schools and on engagement only and therefore it could not be generalized that students perceived the perception positively.

Though these studies showed positive perception of the flipped strategy, the available literature is majorly on western countries and not in the African context. Further, the perception of the strategy to physics instruction in Kenya was not explored.

2.3.4 Challenges Faced with Flipped Classroom Instructional Strategy

In their research on the potential and challenges encountered when adoption FCS, Jiang et al., (2022) noted several challenges which included time restrictions and technology barriers. They also stated that, for effective implementation of the FC strategy, there is a need to change the way the lesson planning has been in the lecture-based strategy.

With the ability to use of virtual learning resources in a flipped classroom there is a need of a Learning Management System (LMS) to reduce the negative effects and to control the learning process. Moodleplatform is one of the applications of the LMS that have been used for online learning due to its ability to support videos, discussion forums, chat materials and quizzes as reported by Simanullang & Rajagukguk (2020). Due to these abilities, Moodle allow students to have a regulated access to a variety of learning materials and as well as interactions with their teachers and friends. To mitigate the limitation of lack of a proper mechanism to manage the learners learning process within the flipped classroom strategy, Louhab.et al (2020) concluded that, FC should involve Moodle platforms to manage their learning process as it present information depending on the student's level of knowledge and skills.

2.4 Conceptual Framework

The theoretical framework served as the basis for the conceptual framework. The independent variable in this study was flipped classroom strategy, learning resources and In-class activities were the intervening variable, while students' academic performance and perception were the dependent variables. As summarized in Figure 2.1.

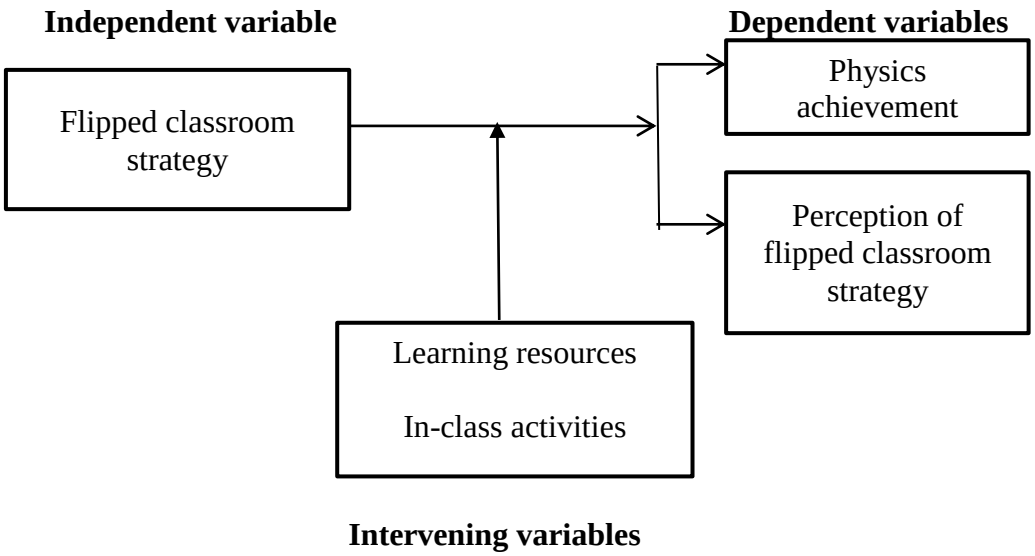


Figure 2. 1 Conceptual Framework

2.5 Chapter Summary

This chapter provided literature reviews for the study. It contains the theoretical frame work and empirical reviews of the flipped classroom strategy on its effect to achievement and retention of concepts learnt through the strategy. The chapter also explains how learners from different levels of education perceived the strategy and states some challenges experienced when using the strategies in different places in the world. Lastly the chapter contains details of the conceptual framework of the study.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter captures the research design, location of the study, target population; sampling techniques that were used, sample size involved in the study, data collection instruments used, validity of the study, reliability of the study, data collection procedures, data analysis methods and ethical considerations

3.2 Methodology

This study adopted mixed method methodology. This methodology combines both qualitative and quantitative research methods (Omariba, 2023). Mixed method was suitable for this study as the qualitative data obtained helped in explaining the quantitative data that was collected.

3.3 Research design

Kumar (2018) defined a research design is an overall plan for conducting a research in a logical manner, in order to address the research problem efficiently. Patten & Newhart (2017) added that the research design outlines sampling technique, data collection procedure and data analysis procedures.

This research adopted Solomon IV non-equivalent Quasi- experiment design (Omariba, 2023). This design comprises of four randomly selected groups that participate in data collection. Twoof the groups are treated as experimental groups and the other two becomes the control groups (Wanjala, 2020). The purpose this design is to test whether the treatment has an impact to the outcome. In this study, four schools were selected randomly from the ten of schools located in Kauma Sub-County, Kilifi County Kenya. From the four groups, two schools were experimental while the other two schools were control groups. One experimental and one control school were to be subjected to a pre-test achievement score test before the treatment. Thereafter, all selected schools were to be taught the same topic, Electrostatics (I), for a period of two weeks. The experimental schools were to be taught using the flipped classroom strategy while the control schools were to be taught using the conventional traditional strategies. Thereafter, all groups were to be subjected to a post-test achievement test as summarized in Table 3.1. Two groups did a pre- and

post-test to control the history and maturation effects. The treatment and control groups were from different schools to prevent contamination effect. Two groups did not do the pre-tests in order to mitigate the regression effects.

The post-test was to be taken as a typical test given after a topic has been covered, while the pre-test was to be considered as a typical classroom test that students often take during instruction. The Physics teachers in the experimental schools were given a flipped classroom teaching module on electrostatic (I) to guide them on how to teach the topic. For a school with many form one streams, all the streams were to be treated the same, but only the achievement score of one stream in each school was analysed to test the hypotheses of the study.

Table 3.1: Research Design

GROUP	PRE-TEST	TREATMENT	POST-TEST
E_1	√	√	√
E_2	-	√	√
C_1	√	-	√
C_2	-	-	√

3.4 Location of Study

The study was conducted in the coastal region of Kenya, in Kilifi County, Kauma sub-county public secondary schools. Kauma sub-county public secondary schools were selected for study because they had been recording the minimal grades of physics in the County as compared to the other schools in the neighbouring Sub-Counties (MoE, 2022). Furthermore, Kilifi County was selected for the study because the current focus of the educational research in the County was on how to improve students' performance in physics. Nevertheless, the flipped classroom strategy is not popularly used in this area.

3.5 Target Population

The study targeted 1270 form one students enrolled in ten public schools in Kauma Sub-County asper Kauma Sub-County enrolment records of 2024. This study was to focus on the public secondary schools in the Sub-County. Form ones are fit for the study because they have not yet chosen subjects therefore giving a good sample size. Also the form ones are still transiting to the secondary school life and they stand a

chance to change their perception towards the subject and improve their achievement level in the subject since they have not learnt much in the subject. Table 3.2 shows the distribution of the 1270 students in the ten schools.

Table 3. 2: Distribution of the Target Population

Identification letter	Type of school	Number of form ones
A	Boy's school	198
B	Mixed school	136
C	Mixed school	203
D	Mixed school	120
E	Mixed school	107
F	Mixed school	67
G	Mixed school	155
H	Mixed school	98
I	Mixed school	96
J	Mixed school	90
Total		**1270**

3.6 Sampling

As described by Ndikaru (2020) sampling is the process of selecting a subset of the target population which will be involved in data collection for a research. The subset usually acts as a representative of the targeted population under study (McEwan, 2020). In this study, was defined as the process of selecting the schools, form and streams from the targeted population that participated as informants of the study.

3.6.1 Sampling Techniques

Sampling Techniques are the methods that are used to identify the subset of the targeted population that represents the entire population (Berndt 2020; Omariba, 2023). The techniques used in selecting the sample for this study were simple random, stratified and purposive sampling as discussed below:

3.6.1.1 Simple Random Sampling

Simple random sampling is a probabilistic sampling technique where all participants stand a chance to be selected. It requires a sampling frame to identify the participants (Omariba, 2023). In this study, simple random sampling was used to select the four schools that participated in the study. Furthermore, in a case where the selected schools had several streams, all the streams were treated the same, to avoid Hawthorne effect as stated by Clark et al., (2021) that treating all streams the same helps the participants not know that they are being studied hence no one will change their behaviour hence collection of reliable data. To identify the stream whose data was analysed, simple random sampling was also used as all the streams to had equal chances of being selected. To identify the schools and the stream whose data was analysed, pieces of papers equivalent to the number of schools and streams were written letters on them each representing a school. The papers were then picked randomly without replacement; the first four papers picked represented the schools that were involved. For the streams, the first paper that was picked represented the stream whose data was analysed.

3.6.1.2 Stratified Sampling

Stratified sampling is a sampling technique that involves placing the targeted population into small groups basing on the characteristics of the participants. Each group contains members who have the same characteristics (Omariba, 2023; Berndt 2020). In this study the students were grouped according to their forms, each form was a stratum of its own. The strata of form one students were used since the students in this form had not chosen subjects therefore giving a good number of a sample size. Also the form ones were still transiting to the secondary school life and they stood a chance to change their perception towards the subject and improve their achievement level in the subject since they had not learnt much in the subject.

3.6.1.3 Purposive Sampling

Purposive Sampling is a non-probabilistic sampling method as (Omariba, 2023: Berndt. 2020) described it. According to Lohr (2021) it involves selecting of a sample basing on the researchers convenience. Purposive sampling in this study was used to select the sub-county whose schools were involved in data collection for this research. Similarly, other researchers such as that done by Munna & Kalam, (2021)

and Fatah & Zumrotun, (2023) employed purposive sampling which justifies it as a good and acceptable sampling technique.

3.6.2 Sample Size

Sample size is the exact number of participants or subjects that represent the whole population under study (Berndt, 2020; Omariba, 2023). The sample size is usually represented by 'n' and it affects the accuracy and the ability to draw inferences from the data collected (Besekar et al., 2023). The sample size in this study was determined by the number of students in the selected class of the respective schools that were involved in the data collection process. A sample size of 182 students from the sampled four schools were involved in this research since the study was a quasi and did not allow reconstitution of the participants.

3.6.3 Sampling Procedure

To select the sample, small papers were written identification letters of the ten schools were folded and shuffled. One paper was picked at random; the letter written on it decided which school was to be involved. This procedure repeated three other times without replacing the earlier picked papers till the four schools were identified. After the treatment, for a school with more than one stream, random shuffling of papers containing letters representing the streams was done and one paper was picked. The letter written on it represented the stream whose data was analysed.

3.7 Data Collection Instruments

The data collections tools used in this study were pre-test and post-test physics achievement tests, perception Likert scaled questionnaire and observation checklist as discussed below:

3.7.1 Achievement Score Test

An achievement test is set of questions on the topic understudy to test the performance of the students (Westberg et al., 2021). In this study, data on student's achievement in physics was collected using pre-test and post-test achievement score test to the EFC and CTC on the selected topic. The achievement test measured how well the learners understood the concepts and how much concepts they could recall after a period of time. The achievement tests had been reported to be a useful method of collecting numerical data on the level of meeting expected learning

outcomes by the students (Westberg et al., 2021; Arnold et al., 2020) this justified the use of achievement test in this research. Pre-test achievement test was done before the topic was taught to measure the knowledge the students already had about the topic, the post-test was administered after the topic was taught to measure the students' level of understanding and ability to recall the taught concepts. The pre-test and post-test achievement tests had three sections each; personal details, instruction and a set of questions with marks allocated to each question totalling up to 30 marks each.

3.7.2 Observation Checklist

A Likert scaled observation checklist was given to the subject teachers who acted as research assistants in this study. The observation checklist guided the research assistants on what to observe during the instruction period (Katz – Buonincontro & Anderson, 2020). The observation checklist had three parts, the first part required the research assistant to fill in general information about the institution, the second part had information about the importance of the study and the last part had the specific things to be observed during the instruction. The observation checklist was filled by all the form one physics teachers in the experimental schools. The data collected by this tool was qualitative which helped in explaining the achievement scores after the treatment.

3.7.3 Questionnaire

A questionnaire is a set of questions that are administered to respondents for the aim of data collection (Cohen et al., 2022). A questionnaire is useful because it is impersonal and standardized in nature allowing objective data collection and collection of information that is factual (Dewaele, 2018). Questionnaires are helpful since they allow the researcher to gather data that is accurate due to uniformity in questions and the answers that will be given.

In this research, the questionnaires was used to collect data on student's perception of the strategy used to teach the tested topic towards physics instruction and the challenges faced when implementing the strategy. The questionnaires for this study had three parts; introduction, Likert scaled and a section of open-ended questions. The Likert scaled part was used to measure the extent of agreement with the

perception statements on the strategy while the open ended questions collected data on the challenges faced when implementing the strategy. The questionnaire was answered by all students in the experimental classes.

3.8 Validity and Reliability

3.8.1 Validity

Validity is the ability of data collection instruments to accurately measure what it was meant to measure (Kothari & Garg, 2014).

3.8.1.1 Content Validity

This is a qualitative form of validity evaluating if the expressions contained in the data collection tools truly measure the intended phenomenon (Sürücü, & Maslakç, 2020; Omariba, 2023). To ensure content validity of the tools as per He et al., (2023) if an independent variable contains measurement items that covers all its items then the item is considered to have content validity, therefore, the questionnaires and the observation checklists covered all the parameters of perception to be tested which include learners interest in physics, self-efficacy on understanding physics concepts, attitude towards the strategy, perceived usefulness of the strategy, perceived helpfulness of the flipped classroom strategy and the challenges faced when implementing the strategy. Content validity in achievement tests was obtained by ensuring that the achievement test covered all the content taught during the treatment period.

3.8.1.2 Construct Validity

The second type of validity considered in the study was construct validity, according to (Sürücü, & Maslakç, 2020; Omariba, 2023), construct validity is concerned with the degree to which the instrument measures the concept or idea that it is meant to measure. To ensure construct validity the questionnaires and observation checklist were designed in a Likert scale of one to five to measure the student's degree of the effects produced by the teaching strategy. Also the questions in the achievement test were awarded marks where students scored depending on their ability.

3.8.2 Reliability

He et al., (2023), defined reliability as the ability of experiment tools to give results that are consistent over a period of time. Also, Meng, (2020) defined it as the degreeto which the results of a study can be replicable and gives the exact picture of the group under study. Furthermore, Sürücü, & Maslakç (2020) defined reliability as the capability of an instrument to produce the same results under the same circumstances using the same instrument. The reliability of the data collections questionnaire and the teaching module, were tested by piloting to ensure consistency and to minimize subjective biases and errors in data collection as much as possible using Crouchback Alpha was calculated on the questionnaire and a reliability value of 0.7 was established. This finding was in line with the recommendation by Tavakol & Dennik (2011) and therefore the questionnaire was reliable and ideal for the study.

3.9 Piloting

A pilot study was conducted in this study to evaluate the adequacy of the planned methods, procedures and the designed data collection tools (Lowe, 2019). In this study, four physics teachers from schools in Ganze Sub- County, a neighbouring Sub-County was given the flipped classroom module of the topic that was to be taught and the designed learning materials and taught their students for a period of one week (4 lessons). Teachers in the pilot schools gave feedback about the adequacy of the procedures. This process helped in testing the reliability of the data collection tools. The data collection tools were considered reliable by all the four physics teachers in the pilot schools.

3.10 Data Collection Procedure

The research proposal was approved by Murang'a University of Technology senators. An approval letter was then provided that allowed the researcher to proceed for data collection. The researcher then used the letter to ask for a research permit from National Commission for Science Technology and Innovation (NACOSTI). Upon getting the research permit form NACOSTI and with the permission of the principles in the sampled schools, teachers in the experimental schools were trained during a recess period on the flipped classroom procedures and data collection process since they were to act as research assistants. Pre-test exams were then administered to form ones in one experimental and one control group, to assess their

initial achievement on the selected topic before any instructional intervention. The data obtained was recorded and stored for analysis. Thereafter, the experimental schools were engage in flipped classroom activities and interact with materials that contain the content they were expected to learn. For the control schools instruction was done using the lecture-based instruction activities. During the treatment period, instructors conducted observations using checklists to document their observations on aspects such as teacher-student interactions, engagement levels and use of instructional materials during the in-class discussions. After the topic had been taught, all students from the experimental groups filled the questionnaires on their perception about the strategy. Post-test exams were administered to all the experimental and control groups to assess the participants' achievement after the instructional intervention. Seven weeks later, the post-test score test was re-administered to all groups to assess the difference in retention of the physics concepts between the experimental and control groups after the treatment.

3.11 Data Presentation and Data Analysis

Data presentation is the representing collected data visually to the targeted audience in order to communicate the findings effectively (Omariba, 2023). In this study, tables, pie charts and statements were used to present a summary of the collected data. Tables were used to present data on student perception and the scores of the achievement tests. Pie charts presented the pattern of students' perception of the strategy while statements presented the responses on challenges faced when using the strategy.

The effect of flipped classroom strategy to student's achievement in physics was tested by analysing the pre and the post-test achievement tests scores for the four groups. To understand the basic characteristics of the data collected, the mean, mode, median and standard deviation were calculated. In this study, the mean and standard deviations of the pre-test and post-test data was calculated to give descriptive information about the achievement. For inferential statistics, t-tests, one-way ANOVA, were computed to give a conclusion for $H0_1$.

To assess the difference in extent of retention of concepts between the FC and the conventional classes, the achievement scores of the post-test achievement test that was administered three weeks later was analysed. The difference in mean scores of the respective groups was calculated to give descriptive information about the data. One way ANOVA test was computed to test the null hypothesis $H0_2$.

Since the interval between the response levels were equal, the frequency, mean, mode and percentages for each response on perception that was filled in the questionnaires calculated to give a general overview of the responses on perception of the FCS. Since the Likert- scaled questionnaire had more than three variables, MANOVA inferential test was suitable to test hypothesis as stated by Clark et al., (2021). MANOVA test was therefore done with the help of SPSS 16 to give the inference statement for $H0_3$

The qualitative data on challenges from the open ended questions was analysed thematically using content analysis and conclusions were made. After the data collection process, the researcher cleaned the data; identified the themes and concepts from the collected data. This heled in reducing the data to a manageable number of themes that was easy to interpret.

3.12 Logistics and Ethical Considerations

These are post field logistics (Omariba, 2023). In this study, after the data collections tools had been filled by the respondents, the researcher labelled the tools with letters to act as reference points when analysing the data and to ensure the data remained anonymous.

3.12.1 Ethical Issues Related Research

Ethics in research deals with moral values that guide the researcher when conducting a study (Omariba, 2023). In the study, the researcher acknowledged other people's work by proper citation of their work. Furthermore, the researcher did not conduct the research for personal gains neither did she had negative intentions to the lives of the participants.

3.12.2 Ethical Issues on Research Subjects

The researcher was given permission for data collection by Murang'a University of technology, NACOSTI and the school principals of the sampled schools before involving the learners to participate in the study. The researcher allowed the student to voluntarily participate in the study after being assured of confidentiality of the information they will provide and that no embarrassing questions were to be asked during the study as (Omariba, 2023) advised.

3.13 Chapter Summary

This chapter contains the research methodology, research design and target population, sampling techniques, sample size, validity and reliability of the data collection tools used in the study. It also focuses on the data collection procedure and how the data would be analysed and presented. Lastly it contains the ethical issues that were considered in the study

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents findings and their analysis of the study. The main objectives of the study were to investigate the overall effect of the flipped classroom strategy on the academic achievement of students in physics, to compare the academic achievement between students taught by the flipped classroom and the lecture-based model as well as the challenges faced by both teachers and the students when adopting and using the flipped classroom approach of teaching and learning in Kenyan secondary schools located in Kilifi county and limited to schools in Kauma sub county. The findings have been discussed according to the established literature of the subject matter. A teaching module on a form one physic topic, Electrostatics I, was developed indicating all the activities and resources to be used for each of the lessons for the whole topic.

4.2 General and Demographic Information

Random sampling was used to identify the participants of this study. Out of the four schools sampled, two of them were experimental while the other two were control groups. Therefore, four papers were cut, the papers were written E1, E2, C1 and C2. The physics teachers from the four sampled schools were to select a piece of paper randomly. Those who randomly selected E1 and E2 became the Experimental groups while those who picked the papers written C1 and C2 became the control groups of the study. The form one physics teachers from the E1 and E2 were taken through the teaching module which they used to teach the electrostatic (I) topic. The C1 and C2 groups taught the same topic with the lecture-based instruction strategy.

Three out of the four schools that were involved had more than one stream. All the streams were treated the same but data from one stream was to be analysed. To identify the stream whose data was to be analysed, random numbers equivalent to the number of streams of the form one classes were written with one of them written ‘yes’ while the rest were written ‘no’, then one student from each stream picked one of the papers randomly. The data of stream from which the one that picked ‘yes’ belonged to, was analysed for this study. Following this procedure, three physics

teachers and 182 students from the four sampled schools were involved in the study. The 182 students were distributed as shown in Table 4.1.

Table 4. 1: Distribution of the Sampled Population

Group	Class Size
E1	32
E2	56
C1	43
C2	51

4.3 Results and Findings

4.3.1 Pre-test Analysis.

A flipped classroom teaching module was prepared for Electrostatics (I). Before the module was put into practice, one experimental group E1 and one control group C1 were subjected to a pre-test achievement score test. The E1 group had 32 students while the C1 group had 43 students, therefore, a total of 75 form 1 physics students sat for the pre-test achievement score test. The pre-test test was summing up to 30 marks. After the students had done the pre-test, the papers were marked and recorded. Table 4.2 shows the summary of the scores attained by the experimental group 1 pre-test.

Table 4. 2: Pre-test achievement scores of the experimental group 1

	marks	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-5	21	65.6	65.6	65.6
	6-10	6	18.8	18.8	84.4
	11-16	5	15.6	15.6	100.0
	Total	32	100.0	100.0	

Table 4.2 shows that, out of the 32 students who sat for the pre-test in the experimental group 1, 21 (65.6%) of them scored marks ranging between 1 to 5 marks. Further, the Table shows that, 6 (18.8 %) students scored from 6 to 10. 5 (15.6 %) students scored above 10 marks before they were subjected to the flipped module. From this the researcher concluded that none of the students in the E1 class

could score more than half of the total score in Electrostatic (I). This concurs with a study by Kaleli (2021) on a study about the impact of personalized e-instruction on TPACK skills and performance of piano studies.

Further, the study sought to check the pre-test achievement scores of the control group as shown on Table 4.3.

Table 4. 3: Pre-Test Achievement Scores of the Control Group 1

	Marks	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-5	33	76.7	76.7	76.7
	6-10	7	16.3	16.3	93.0
	11-15	3	7.0	7.0	100.0
	Total	43	100.0	100.0	

Table 4.3 shows the score summary of 43 students in the control group 1 who sat for the pre-test achievement test on Electrostatic (I). The Table shows that, 33 (76.7%) students scored from 1 to 5 marks, this range had the highest percentage of the total percentage of the students who sat for the pre-test in the control group. Furthermore, 7 (16.3%) students scored from 6 to 10 marks out of the total 30 marks that they were to score. Those who scored from 11 to 15 marks were 3, which is 7% of the control group population who did the pre-test. From the findings the study concluded that in the C1 group none scored above 15 marks.

The descriptive statistics of the two pre-test scores were calculated with the help of SPPS 16 and summarized as shown in Table 4.4 and Table 4.5 for the E1 and C1 respectively.

Table 4. 4: Descriptive Statistics of E1 Pre-Test Scores

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Marks	32	13	1	14	3.844	3.244	10.523
Valid N	32						

Table 4.4 indicates that, 32 students did the pre-test in the E1 group. The highest score was 14 marks while the lowest score was 1 mark. Therefore, the range of the maximum and minimum score was 13 marks. The mean mark was 3.844 with a standard deviation of 3.244

Table 4. 5: A Summary of the Descriptive Statistics of C1 Pre-Test Scores

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
C1 pre-test	43	11.00	1.00	12.00	3.372	2.968	8.811
Valid N	43						

Table 4.5 shows that 43 students sat for the pre-test achievement score test on Electrostatic (I). The highest mark score in the C1 class pre-test was 12 marks, while the lowest mark was 1 mark giving a range of 11 marks. The C1 class had a mean of 3.372 marks in the pre-test score test with a standard deviation of 2.968.

Comparing these two pre-test descriptive statistics for the score of the two groups, we note that, the minimum score for the two groups was the same, which is 1 mark out of 30 marks. The maximum mark differed with only two marks between the E1 and the C1 group with 14 marks and 12 marks respectively. This indicate that none of the two groups had students who scored half the total marks and above which concurs with a study by Nantha et al (2024) on improving ICT literacy and students performance using a blended learning instruction in business administration. Further, an independent t-test was conducted with the help of SPSS 16 with $\alpha = 0.05$ between the achievement scores of E1 pre-test and the C1 Electrostatic (I) pre-test scores to test whether the groups were of the same capacity before the treatment and the findings were as shown in Table 4.6

Table 4. 6: Independent Samples Test between E1 and C1 Pre-Test Results

		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
SCORE	EVA	.410	.524	-.251	73	.802	-.17951	.71422
	EVNA			-.247	62.737	.805	-.17951	.72561

EVA -Equal variances assumed

EVNA -Equal variances not assumed

The Table indicates that the t values of the equal variance assumed and that of the equal variance not assumed were -0.251 and -0.247 respectively. The degrees of freedom were 73 and 62.737. The significances of the 2-tailed t tests were 0.802 and 0.805 for equal variance assumed and equal variance not assumed respectively. 0.802 And 0.805 > 0.05, therefore, there was no statistical difference between the pre-test achievement scores on Electrostatic (I) for E1 and C1. To confirm this finding one way ANOVA was conducted on the pre-test achievement test score and the results were as summarized in Table 4.7

Table 4. 7: ANOVA Results between E1 and C1 Pre-Test Results

	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	56.885	4	14.221	1.426	.252
Within Groups	269.333	27	9.975		
Total	326.219	31			

Table 4.7 indicates that the sum of squares between groups was 58.885 while that of within groups was 269.333. The degrees of freedom between groups were 4 while within groups the degrees of freedom were 27. The mean square between and within the groups were 14.221 and 9.975 respectively. Further, Table 4.6 indicates that the F- value was 1.426. The critical value of the one-way ANOVA calculated was 0.252. Since 0.252 > 0.05, therefore, there was no statistical difference between the pre-test achievement scores of E1 and those of C1. Following this, a conclusion was made that the two groups were initially of the same level before the treatment. From The findings of the study, the research concluded that the two groups were initially of the same level before the treatment. The study concurs with a study by Bulus (2021) on non-equivalent pre-test – post-test design.

4.3.2 Effect of Flipped Classroom Strategy on Academic Achievement of Physics

After the pre-test, all the four groups were taught the same topic, electrostatics (I). The two experimental groups were taught using the flipped classroom strategy whiles the control groups were taught using the traditional lecture-based for a period of two weeks.

After the treatment, all the four groups were subjected to a post-test achievement score test. The test was up to 30 marks. Thereafter, the tests were marked and recorded. The post-test scores of the two groups E and C groups were summarized as shown in Table 4.8 and 4.9 respectively

Table 4. 8: A Summary of the E Post-Test Achievement Scores

	Marks	**Frequency**	**Valid percentage**	**Cumulative percentage**
Valid	1-5	6	6.8	6.8
	6-10	14	15.9	22.7
	11-15	15	17.0	39.8
	16-20	26	29.5	69.3
	21-25	23	26.1	95.5
	26-30	4	4.5	100.0
	Total	88	100.0	

Table 4.8 indicates that those who scored 1 to 5 marks were 6 students covering 6.8% of the total class size, those who scored 6 to 10 marks were 14 students which was 15.9%, those who scored 11 to 15 marks were 15 (17.0 %), those who scored 16 to 20 marks were 26 (29.5%) students, and those who scored 21 to 25 were 23 (26.1%) students while those who scored 26 to 30 were 4 (4.5%) students. The descriptive statistics of this data was summarized as shown in Table 4.9

Table 4. 9: Descriptive Statistics of Experimental Groups Post-test Scores

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Marks	88	25	3	28	17.344	6.553	42.943
Valid N	88						

This Table indicates that, the range of experimental group post-test scores was 25 marks. The highest score was 28 marks and the minimum score was 3 marks. The mean mark of the scores was 17.344 with a standard deviation of 6.553 and the variance of 42.943. Based on these findings the researcher concluded that students achieved better after they are taken through the concepts of Electrostatic (I). This concurs with the findings of (Hasanova, Abduazizov, & Khujakulov, 2021).

Moreover, the study did descriptive statistics for the control group as shown on Table 4.10

Table 4. 10: Control group Post-test Score

	Marks	Frequency	Valid Percent	Cumulative Percent
Valid	1-5	13	13.8	13.8
	6-10	29	30.9	44.7
	11-15	38	40.4	85.1
	16-20	11	11.7	96.8
	21-25	3	3.2	100.0
	Total	94	100.0	

From Table 4.10, out of 94 student, students who scored from 1 to 5 marks in the post-test achievement test on Electrostatic (I) were 13 (13.8%), those who scored 6 to 10 marks were 29 (30.9%), those who scored 11 to 15 marks were 38 (40.4%), those who scored 16 to 20 marks were 11 (11.7%) and those who scored 21 to 25 marks were 3 (3.2%) students

Further, an item on the questionnaire sought to establish C1 post-test descriptive statistics as shown on Table 4.11.

Table 4. 11: Control Group Post-Test Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Marks	94	23	2	25	12.97	5.521	30.477
Valid N (list wise)	94						

Table 4.11 indicates that out of the 94 post-test scores, the range was 23 marks as a result of the maximum score being 25 and the minimum score being 2 marks. The mean score of post-test scores was 12.97 with a standard deviation and variance of 5.521 and 30.477 respectively.

Further, the study sought to identify the effect of the flipped classroom strategy to student's achievement in secondary school physics in students in Kauma Sub-County, the post-test achievement scores and the pre-test scores of all the experimental and control groups were analysed and compared using one way ANOVA inferential test to determine their statistical difference with a confidence level of 0.05 with the help of SPSS 16 as shown on Table 4.12

Table 4. 12: One-Way ANOVA between E1 and E2 Post-Test Scores

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1335.814	20	66.791	1.819	.036
Within Groups	2459.958	67	36.716		
Total	3795.773	87			

Table 4.12 indicates that, the sum of squares between and within the groups were 1335.814 and 2459.958 respectively. It also shows that the degrees of freedom between and within the groups were 20 and 67 respectively. 66.791 and 36.716 were the mean squares between and with the groups respectively. F-value for the ANOVA test for E1E2 and C1C2 post-test scores was 1.819. The critical value obtained from the analysis of variance was 0.036. Since 0.036< 0.05 hence the null hypothesis stated earlier was rejected. To confirm this finding, paired t-test was run between the same data and the finding summarized as in Table 4.13

Table 4. 13: Paired Samples Test for E and C Post-Test Scores

					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig (2-tailed)
Pair 1	C1C2 - E1E2	-4.91	8.48	.90	-6.705	-3.11	-5.43	87	.000

Table 4.13 indicate that the standard deviation and the standard mean error were 8.48(2dp) and 0.90 (2dp) respectively. The t-value was -5.432 with 87 degrees of freedom. Further, findings indicate a significance of 0.000 which is less than the α-value of 0.05 leading to a second rejection of the null hypothesis that stated flipped classroom strategy does not significantly improve students' academicachievement in physics. The study therefore concluded that that flipped classroom strategy significantly improved students' academic achievement in Electrostatic (I).

These findings concurs with the findings of a study by Wei et al., (2020) who conducted an experiment to evaluate the effect of flipped classroom to mathematics achievement, their findings indicated that the strategy had a significant improvement to students achievement. The findings were further supported by the findings of Finkenberg & Trefzger (2019) from a quasi-experimental study conducted in German secondary schools and found that the flipped classroom strategy significantly improved students' performance in physics. The experimental group showed improved performance in physics which was attributed to better conceptual understanding and more active learning opportunities in the flipped classroom model.

4.4 Flipped Classroom and Retention of Physics Concepts

Moreover, the study sought to establish flipped classroom on retention of electrostatics (I) concepts. This is because what learners know on the day of final exam is not what matters in education, rather what matters is the ability to retain and apply the concepts later in life (Ng & Lo**,** 2022 **;** Li & Li, 2022). Aguanta et al., (2024) defined retention of concept as the ability to recall information learnt earlier and use it when needed.

The post-test achievement test was re-administered to the four groups seven weeks after they had done the post-test achievement score test. The results of these achievement scores were recorded and analysed. As shown on Table 4.14 and Table 4.16

Table 4. 14: A Summary of Control Group Post- Post-test Scores

	marks	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	1-5	14	14.9	14.9	14.9
	6-10	32	34.0	34.0	48.9
	11-15	34	36.2	36.2	85.1
	16-20	10	10.6	10.6	95.7
	21-25	4	4.3	4.3	100.0
	Total	94	100	100.0	

From Table 4.14 out of the 94 students in the control group who did the post-post-test achievement test, 14 (14.9%,) students scored 5 marks and below, 32 (34.0%) students scored 6 marks to 10 marks, 34 (36.2%) students scored 11 to 15, 10 (10.6%) students scored 16 to 20 marks and 4 (4.3%) students scored 21 to 25 marks. Further, the study sought to establish C2 post-test achievement scores as shown in Table 4.15

Table 4. 15: Descriptive Statistics for Control Group Post-Post-Test Scores

	N	**Range**	**Minimum**	**Maximum**	**Mean**	**Std. deviation**	**Variance**
Marks	94	21.00	1.00	22.00	11.02	3.82	14.58
Valid N	94						

The study established that the mean mark scored by the control group was 11.02 with a standard deviation of 3.81. The maximum score in the achievement test was 22 marks and the minimum score was 1 mark giving a range of 21 marks. This finding shows that, the student's performance in the achievement test increased as compared to their performance in the pre-test achievement test. This concurs with the findings of a study Hussain and Akeem (2021).

Moreover, the study sought to establish the experimental post- post-test achievement score as shown on Table 4.16 which shows a summary of the C2 post-test scores.

Table 4. 16: Experimental Group Post-Post-Test Scores

		Frequency	Valid Percent	Cumulative Percent
Valid	1-5	7	8.0	8.0
	6-10	9	17.0	25.0
	11-15	20	22.7	47.7
	16-20	32	29.7	77.4
	21-25	19	21.6	100
	Total	88	100.0	

From Table 4.16, the experimental group 88 students did the post-post-test achievement score test, 7 (8.0%) students scored 5 marks and below, 9 (10.22%) students scored from 6 to 10 marks, those who score from 11 marks to 15 marks were 20 (22.7%). 32 (36.36%) students scored 16 to 20 marks; 19 (21.6%) students scored from 21 marks to 25 marks. Additionally, the study did E2 post-test achievement score Post-test Descriptive Statistics as shown on Table 4.17

Table 4. 17: E Group Post-Post-Test Score Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. deviation	Variance
Marks	88	23.00	1.00	24.00	15.05	6.53	42.75
Valid N	88						

The study established that the mean mark of the achievement score test for experimental group was 15.05(2dp) with a standard deviation of 6.53(2dp). The maximum score was 24 marks while the minimum score for this group was 1 mark giving a range of 23 marks. Furthermore, the study sought to establish the retention of Physics concepts learnt in electrostatics I.

One way ANOVA was used to compare the concept retention ability between the experimental and control groups as shown on Table 4.18

Table 4. 18: One-Way ANOVA Statistics between E and C Post-Post-Test Scores

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	11.743	25	.470	2.174	.002
Within Groups	33.707	156	.216		
Total	45.451	181			

Table 4.18 indicates that the one-way ANOVA between the experimental and control group achievement scores of the re-administered post-test achievement score test. The sums of squares between and within the groups were 11.743 and 33.707 respectively. The Table also indicates that the degrees of freedom between and within the two groups were 25 and 156. The F-value was 2.174 while the retention significance between the experimental and the control groups was 0.002. The p-value of 0.002 is less than the alpha-value 0.05 hence the null hypothesis was rejected. To confirm this two tailed t-test between E2 and C2 was calculated with the help of SPSS 16 with a confidence level of 95% to test the of the null hypothesis that there is no significant difference in retention of physics between students taught usingthe flipped classroom strategy and those taught using lecture teaching strategy as summarized in Table 4.19

Table 4. 19: Paired Samples T-Test

		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	post-testE2 – post-testC2	3.647	7.252	1.016	1.61	5.687	3.59	50	.000

Table 4.19 indicates that the paired mean difference between the two was 3.647 (4sf), standard deviation was 7.252 (4sf) and a standard error of 1.016 (4sf). The t value was 3.591 with 50 degrees of freedom. The result showed a p-value of 0.000

which is less than the alpha-value 0.05 hence the null hypothesis that there is no significant difference in retention of physics between students taught using the flipped classroom strategy and those taught using lecture teaching strategy was rejected. From these findings the study concluded that students in Kauma Sub County secondary school in Kilifi County that were taught using the flipped classroom strategy retained physics concepts for a longer period of time. These findings replicates a study by Kong (2021) who explored retention rates in flipped classroom physics instruction in tertiary education institutions and reported that students showed higher retention scores in follow-up assessments, as they had more time to revisit video lectures and self-paced learning materials. Furthermore, Meyliana et al., (2021) did a study on instructional strategies and they found out that students who actively participated in instruction had a deep understanding of the concept rather than depending on rote memorization of concepts and superficial understanding hence students tends to retain experiential information for longer periods of time. From this a conclusion was made on flipped classroom and retention of concepts that flipped classroom strategy has a significant statistical difference in retention of concepts between students taught by flipped classroom and those taught using the lecture-based teaching strategies

4.5 Students Perception towards Flipped Classroom Strategy to Physics Instruction

This study sought to establish students' perception in Physics using flipped classroom strategy. Flipped classroom perception questionnaires were administered to the two experimental groups after they had been taught Electrostatics (I) using the flipped classroom strategy for two weeks. The questionnaire had two sections, section one comprised of closed ended statements and section two which comprised of open-ended questions. The closed ended statements were framed into a Likert scaled format (1-5) with a maximum of five choices illustrating the extent of their agreement with the perception statements provided. It also had one general statement where the students were to state whether they perceive flipped classroom as a good strategy for physics instruction, the students were to choose either 'YES' or 'NO'

The open-ended questions were to allow the students to explain their choices in the Likert scale and to state the challenges they experienced while using the flipped

classroom strategy of instruction.

A total of 84 students from E1 and E2 answered the questionnaire and the following results were obtained from their responses. Table 4.20 summarizes the student responses

Table 4. 20: Students' Perception Choices

	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
I find the flipped classroom strategy engaging	2 (2.2%)	9 (10.8%)	16 (19.3%)	36 (43.4%)	20 (24.1%)
The flipped classroom strategy helps me understand the subject matter better	4 (4.8%)	7 (8.4%)	21 (25.3%)	36 (43.4%)	15 (18.1%)
The resources provided for flipped classroom activities are helpful.	0 (0.0%)	4 (4.9%)	20 (24.4%)	35 (42.7%)	23 (28.1%)
I feel more prepared for class discussions in a flipped classroom setting	0 (0.0%)	1 (1.2%)	16 (19.3%)	35 (42.2%)	31 (37.3%)
The flipped classroom encourages me to learn at my own pace	2 (2.4%)	3 (3.7%)	10 (12.2%)	27 (32.9%)	40 (48.7%)
I am satisfied with my learning outcomes in a flipped classroom environment.	0 (0.0%)	3 (3.6%)	14 (16.9%)	40 (48.2%)	26 (31.1%)
I feel motivated to participate in	1 (1.2%)	3 (3.6%)	7 (8.4%)	28 (33.7%)	44 (53.0%)

activities in a flipped classroom					
The flipped classroom strategy improves my problem-solving skills.	3 (3.6%)	5 (6.0%)	13 (15.7%)	31 (37.4%)	31 (37.4%)
I am confident in my ability to succeed in a flipped classroom	0 (0.0%)	3 (3.6%)	5 (6.0%)	38 (45.8%)	37 (44.6%)

From these results, 24.10% (20) strongly agreed and 43.37% (36) agreed that flipped classroom strategy was engaging when used for instruction, 19.28% (16) neither agreed nor disagreed with the statement, 10.84% (9) disagreed and 2.24% (2) strongly disagreed that the flipped classroom strategy was engaging. This concurs with a study by Lo & Chew (2021) in their study on Flipped Classroom and engagement whose findings suggested that this strategy helped learners to increase some level of emotional engagement such as participation, attention and interaction as shown in Figure 4.1.

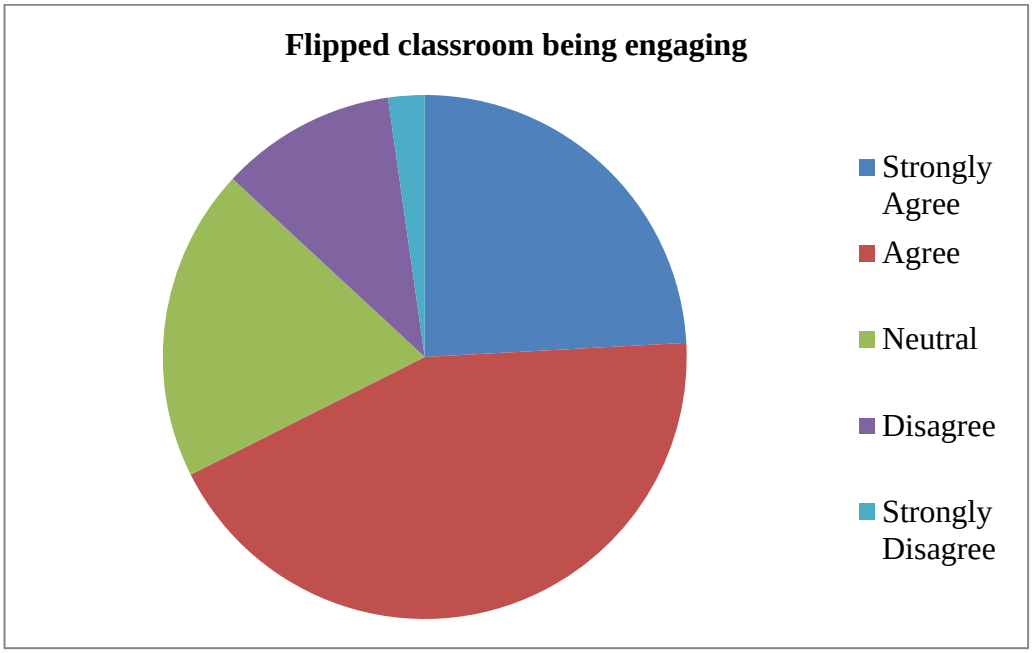


Figure 4. 1: Flipped Classroom Being Engaging

From the findings, the study established that flipped classroom helped students to understand the subject matter, 43.37% (36) and 18.07% (15) respectively agreed and

strongly agreed that the flipped classroom strategy helped them to understand the subject matter. 25.30% (21) had neutral opinions about the ability of the flipped classroom strategy to help them understand the subject matter while 4.81% (4) and 8.43% (7) disagreed and strongly disagreed with the statement. This finding concurs with a study by Marina & Rildo (2021) on impact of flipped classroom to students' concept understanding whose results indicated that not all students understood the concepts well but a bigger percentage of the students showed a significant improvement of concepts understanding. In addition, an item sought to establish how flipped classroom strategy was perceived in terms of the subject matter as shown in Figure 4.2

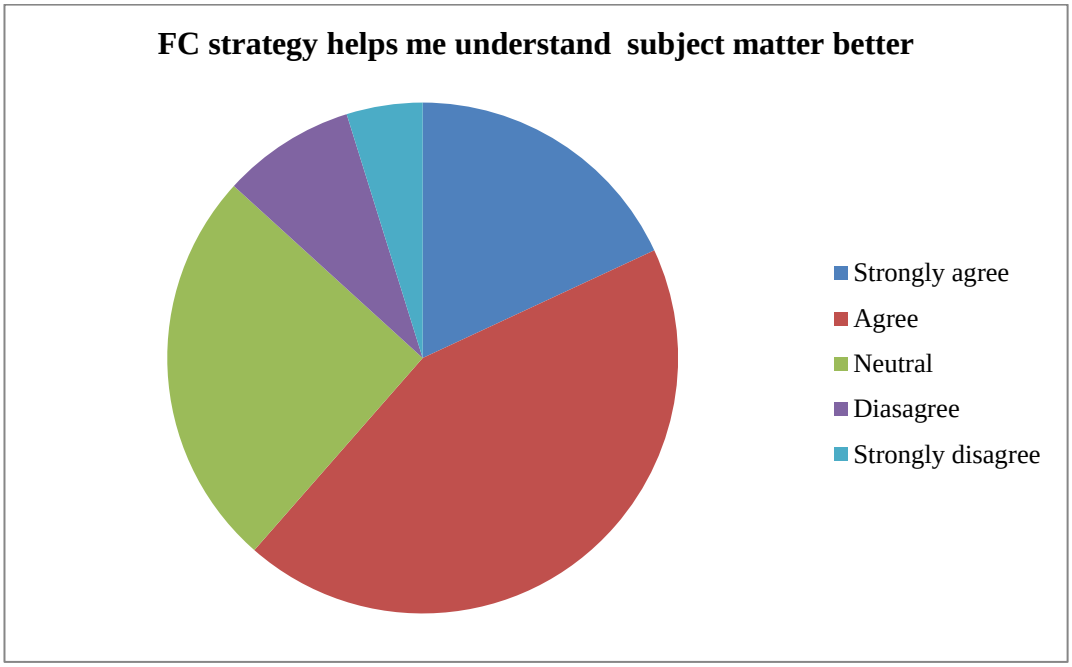


Figure 4. 2: Flipped Classroom Strategy on subject matter

Further, 82 students gave their choices on the helpfulness of the resources provided for the classroom activities pre-determined were as follows, 28.05%(23) strongly agreed that the resources were helpful, 42.68% (35) agreed, 24.34% (20) had neutral opinions, 4.88% (4) disagreed that the resources were helpful and none of them strongly disagreed as shown on Table 4.20. This indicates that majority of learners agreed that the resources are provided were of great help in their learning process as shown on Figure 4.3. This concurs with a study by Xiao & Adnan (2022) on integrating multimodal digital resources with Flipped Classroom. Furthermore, the results indicated that Flipped Classroom allowed integration of a variety of learning

resources such as virtual reality and augmented reality.

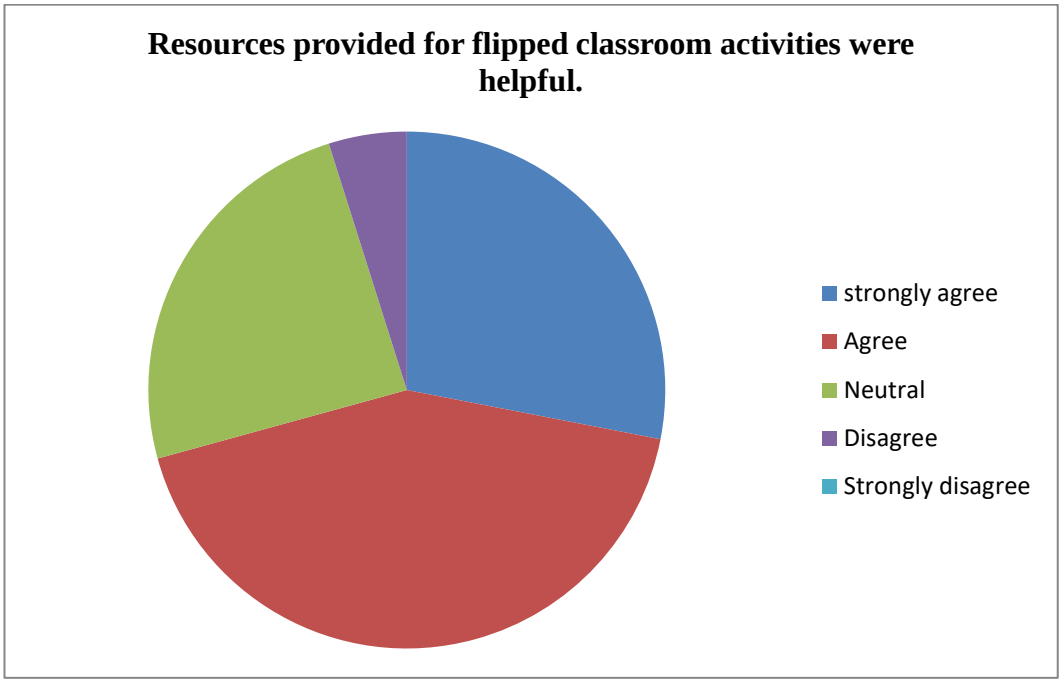


Figure 4. 3: Integration of Resources in Flipped Classroom Activities

Furthermore, the study sought to establish on how prepared students were in classroom discussions. The findings established that 37.34% (31) strongly agreed that they felt more prepared for discussions in the flipped classroom setting, 42.17% (35) agreed with the statement, 19.28% (16) were neutral about the statement and 1.20% (1) disagreed the feeling of more prepared for the discussions in the classroom setting as shown in Figure 4.4. From these findings, it was evident that most learners went to class prepared for the in-class discussion. This concurs with an analysis of the effect of Flipped Classroom and learning performance, flow and concentration on discussion by Li, Huo, Li & Kuo (2022) that most learners were well prepared for discussion after their individualized interaction with the learning materials.

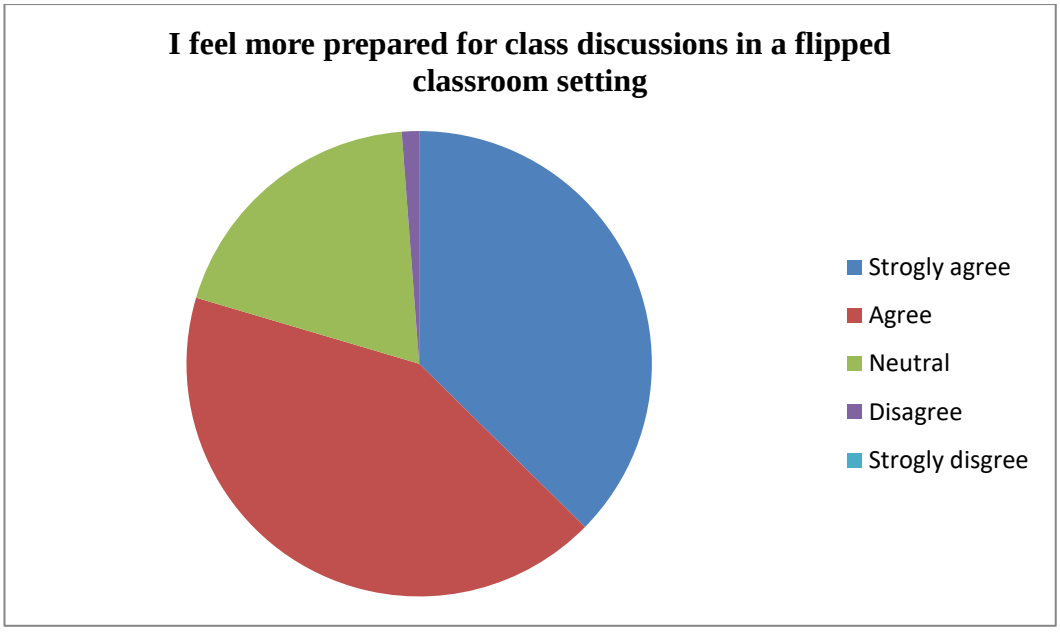


Figure 4. 4: Preparation for Discussions in a Flipped Classroom Setting

Moreover, Table 4.20 indicates that 82 students gave their choices on the ability of FC strategy to improve personalized learning. 2.44% (2) of the respondents strongly disagreed that the flipped strategy allows them to learn at their own free pace, 3.66% (3) disagreed, 12.20% (10) were neutral about the statement 32.93% (27) agreed and 48.70% (40) strongly agreed that this strategy allows them to be learning at their own pace. This concurs with a study by Li, Huo, Li & Kuo (2022) that students perceived Flipped Classroom to help in improving personalized learning. Moreover, the study established how flipped classroom encouraged students to learn at their own pace and the results were as shown on Figure 4.5

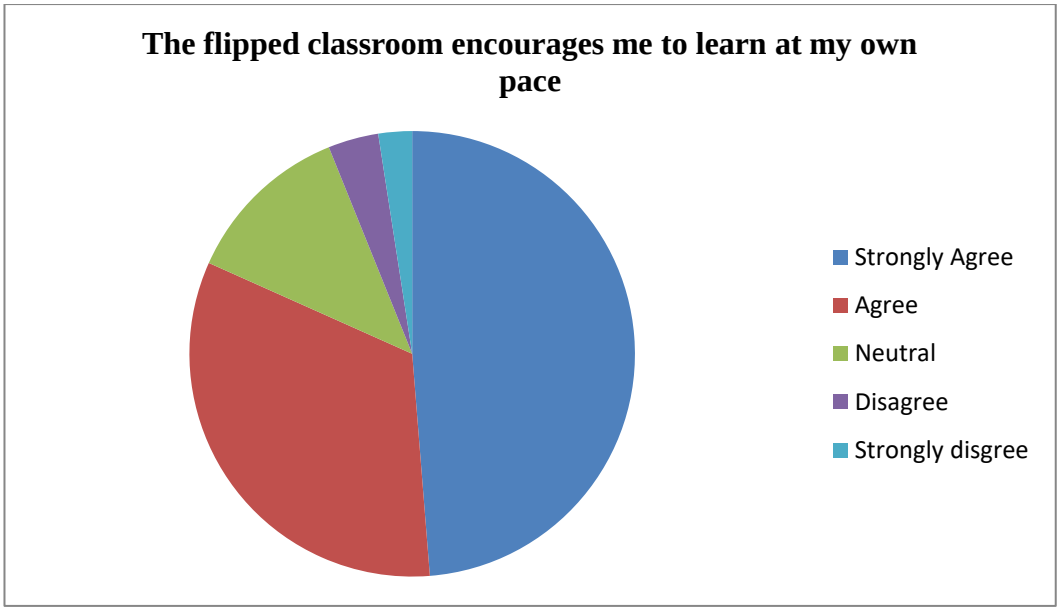


Figure 4. 5: Flipped Classroom and Encouragement

Each lesson had learning objectives that the students were expected to meet by the end of the lesson. Concerning this, a general statement was given where the learners were to state their level of satisfaction with the flipped classroom strategy towards meeting the stated learning outcomes and their response were recorded. From Figure 6, 31.33% (26) strongly agreed that the flipped classroom strategy helped them to meet the learning objectives, 48.19% (40) agreed with the statement, 16.87% (14) had neural opinions, 3.61% (3) disagreed with the statement and none of them strongly disagreed with the statement as shown in Figure 7. This indicated that 80% of the respondents agreed that the Flipped Classroom strategy helped them meet the stated learning outcomes. This concurs with a study by Chen (2021) on Flipped Classroom and learning outcomes that students were satisfied with the level of meeting the expected learning outcomes in the Flipped Classroom as compared to those in traditional teaching strategy.

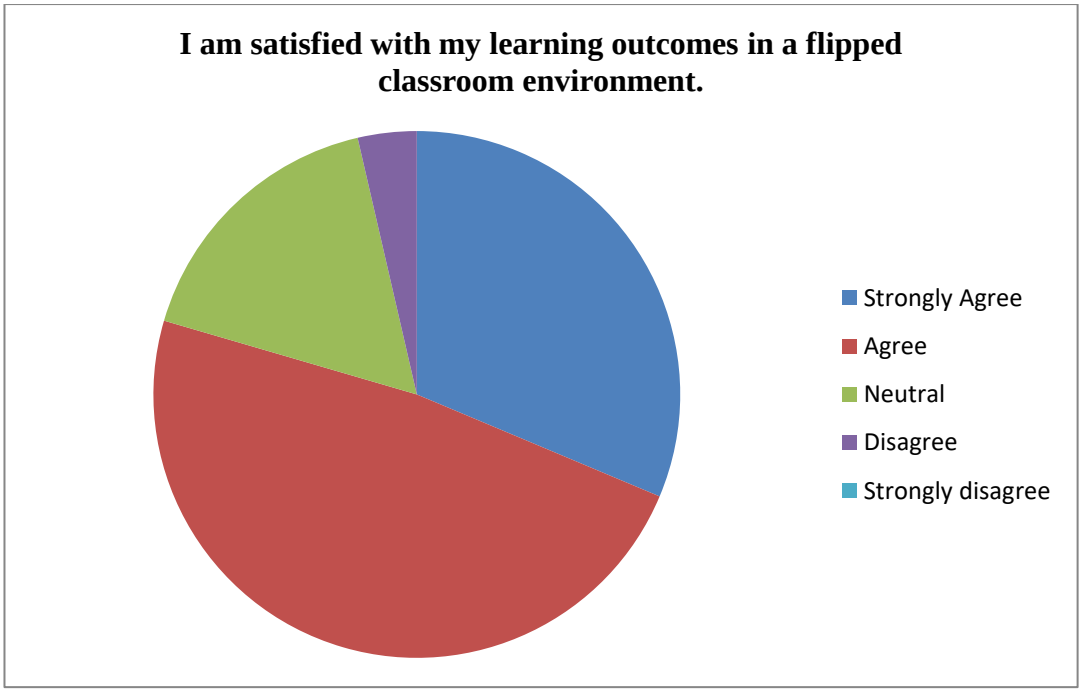


Figure 4. 6: Satisfaction with Learning Outcome in FC

All the lessons had several learning activities therefore a general statement was made that flipped classroom made the students to feel motivated to participate in the activities. From their responses, 1.20% (1) and 3.61% (3) respectively strongly disagreed and disagreed that flipped classroom strategy motivated them to participate in the learning activities, 8.43% (7) neither agreed nor disagreed with the statement while 33.74% (28) and 53.01% (44) respectively agreed and strongly disagreed with the statement as shown on Figure 4.7. This concurs with a study by Lo & Chew (2021) that Flipped strategy motivated learners to participate in learning activities

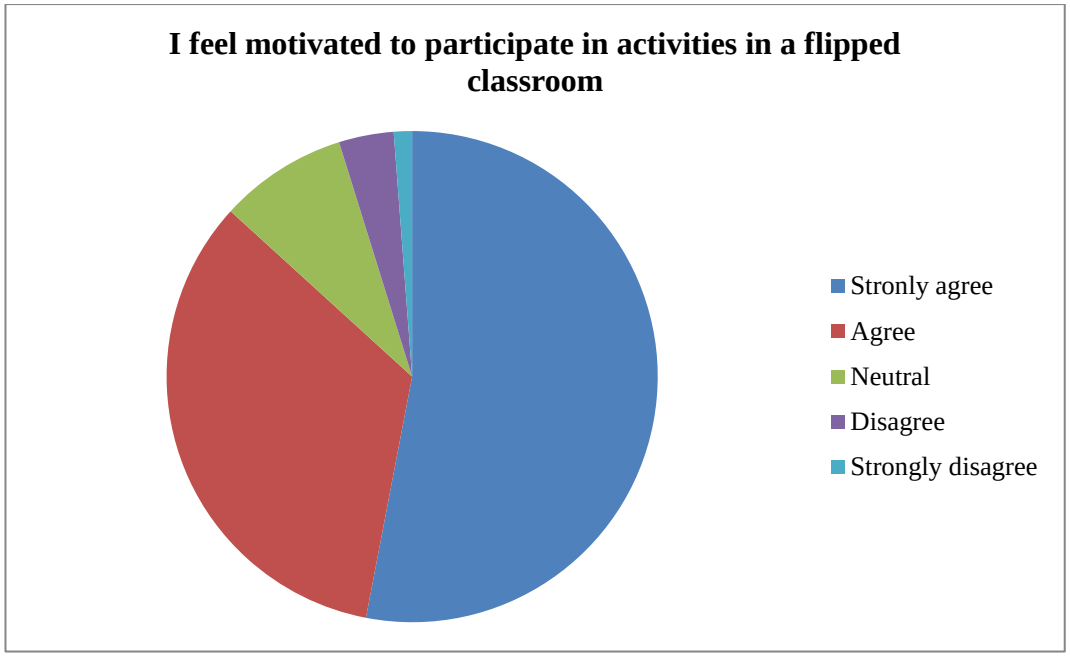


Figure 4. 7: Motivation to Participate in Flipped Classroom

Table 4.20 indicates that, 37.35% (31) and 37.35% (31) strongly agreed and agreed the flipped classroom strategy improved their problem-solving skills respectively, 15.66% (13) were neutral, and 6.02% disagreed while 3. 61% strongly disagreed with that this strategy improved their solving problem skills as shown in Figure 4.8. This concurs with a study by Mudlofir, (2021) that flipped classroom strategy improved their problem-solving skills.

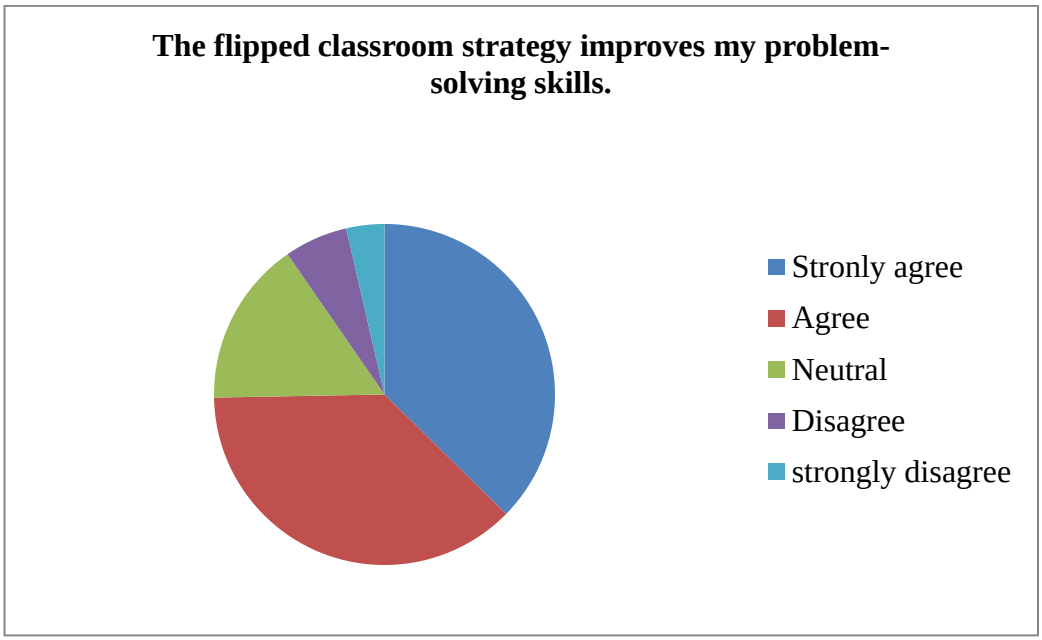


Figure 4. 8: Flipped classroom strategy improves my problem solving

On the confidence of the ability of the flipped strategy to help the learners to improve their performance, Table 4.20 shows that, 44.57% (37) and 45.78% (38) respectively strongly and agreed that this strategy gave them a confidence that when it is used for physics instructions it can help them succeed. 6.02 (5) neither agreed nor disagreed, 3.61% (3) disagreed with the statement but none of the respondents strongly disagreed with the statement that they had a strong confidence with the flipped strategy to help them perform better in physics as shown in Figure 4.9. This concurs with a study by Dogan, Badt & Yasar (2023).

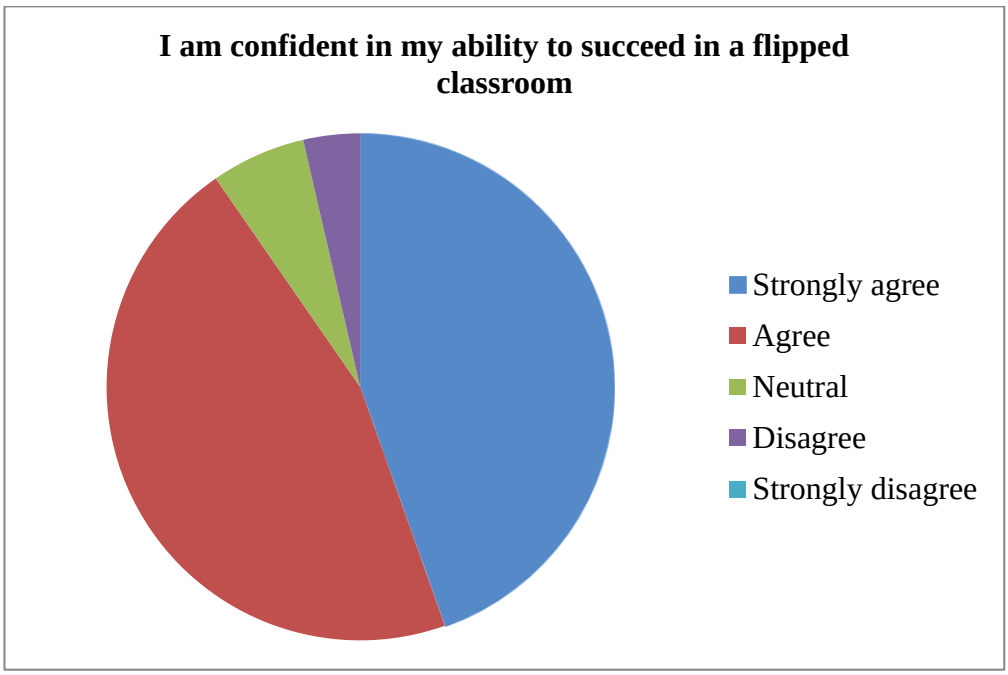


Figure 4. 9: Flipped classroom strategy improves my problem solving

Furthermore, an item in the questionnaire also had a closed ended question where the students were to choose whether they perceived flipped classroom strategy to be a good strategy for physics instruction. 75% (63) of the students agreed that they perceived it to be a good strategy, 22.62% (19) disagreed and 2.38% (2) did not choose any answer as shown on Table 4.21.

Table 4. 21: A Summary of Perception Fixed Variable Choices

Between-Subjects Factors			
		Value Label	**N**
I perceive flipped classroom strategy as a good strategy for physics instruction	1	yes	63(75%)
	2	no	19(22.2%)

MANOVA test was conducted between the perception responses of the students and the students' responses on the Likert- scaled statements with the help of SPSS 16 and a confidence level of 0.05 to test $H0_3$. As shown on Tables 4.22, 4.23, and 4.24.

Table 4. 22: Tests of within Subjects Effects

	F	**df1**	**df2**	**Sig.**
I find the flipped classroom strategy engaging	53.787	1	80	.000
The flipped classroom strategy helps me understand the subject matter better	8.338	1	80	.005
The resources provided for flipped classroom activities are helpful.	24.821	1	80	.000
I feel more prepared for class discussions in a flipped classroom setting	17.864	1	80	.000
The flipped classroom encourages me to learn at my own pace	56.025	1	80	.000
I am satisfied with my learning outcomes in a flipped classroom environment.	22.356	1	80	.000
I feel motivated to participate in	25.428	1	80	.000
activities in a flipped classroom	31.871	1	80	.000
The flipped classroom strategy improves my problem-solving skills.	12.086	1	80	.001

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

Table 4. 23 Tests of within Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	engagement	39.019[a]	1	39.019	69.984	.000
	resources	29.791[b]	1	29.791	75.831	.000
	preparedness	18.540[c]	1	18.540	47.870	.000
	understanding	32.099[d]	1	32.099	47.890	.000
	personalization	15.539[e]	1	15.539	20.741	.000
	satisfaction	21.806[f]	1	21.806	60.386	.000
	participation	11.126[g]	1	11.126	17.457	.000
	PSS	27.202[h]	1	27.202	34.761	.000
	improvement	12.803[i]	1	12.803	32.263	.000
perception	engagement	39.019	1	39.019	69.984	.000
	resources	29.791	1	29.791	75.831	.000
	preparedness	18.540	1	18.540	47.870	.000
	understanding	32.099	1	32.099	47.890	.000
	personalization	15.539	1	15.539	20.741	.000
	satisfaction	21.806	1	21.806	60.386	.000
	participation	11.126	1	11.126	17.457	.000
	PSS	27.202	1	27.202	34.761	.000
	improvement	12.803	1	12.803	32.263	.000

a. R Squared = .467 (Adjusted R Squared = .460)
b. R Squared = .487 (Adjusted R Squared = .480)
c. R Squared = .374 (Adjusted R Squared = .367)
d. R Squared = .374 (Adjusted R Squared = .367)
e. R Squared = .206 (Adjusted R Squared = .196)
f. R Squared = .430 (Adjusted R Squared = .423)
g. R Squared = .179 (Adjusted R Squared = .169)
h. R Squared = .303 (Adjusted R Squared = .294)
I. R Squared = .287 (Adjusted R Squared = .278)

Table 4. 24 Multivariate Tests

	Value	F	Hypothesis df	Error df	Sig.
Pillai's trace	.745	23.328[a]	9.000	72.000	.000
Wilks' lambda	.255	23.328[a]	9.000	72.000	.000
Hoteling's trace	2.916	23.328[a]	9.000	72.000	.000
Roy's largest root	2.916	23.328[a]	9.000	72.000	.000

Each F tests the multivariate effect of perception. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

From these results, the significance level of the MANOVA test was 0.000 for Pillai's trace, Wilks' lambda, Hoteling's trace and Roy's largest root. Since 0.00 <0.05, the null hypothesis that students' do not perceive flipped classroom as an effective strategy for physics instruction was rejected and therefore the study concluded that students in Kauma Sub-County in Kilifi County perceived flipped classroom as an effective strategy for physics instruction. This objective assessed students' perceptions of the flipped classroom strategy in physics instruction. Initially, the learners were observed to have hard time trying to adopt the flipped strategy. However, over time, students recognized the benefits of the interactive approach, improved performance, and self-directed learning. Students perceived flipped classroom strategy as a good strategy for physics instruction. Schwichow (2021) studied students' perceptions of flipped learning in teacher education and found that while students initially struggled to adjust to the strategy, they later reported higher engagement and deeper understanding. This supported the observation. The findings of this study were that, students perceive flipped classroom as an effective strategy for physics instruction. This finding concurred with those of Ahmed & Asiksoy (2021) on their study on the effect of gamified flipped learning strategy on student's innovation skills and perceptions GFC. According to their findings students positively perceived gamified flipped classroom strategy as a helpful strategy of educational instructions. These studies backed up the conclusion that flipped classroom is a good strategy for physics instruction.

4.6 Challenges Faced When Using Flipped Classroom Strategy for Physics Instruction

4.6.1 Challenges faced by teachers

The three physics teachers from the two experimental schools filled the observation checklist. The checklist was used for triangulation as the findings produced from the Likert scaled statements could not produce robust findings and conclusions as stated by Donko & Mensa (2023). The checklist had statements where the teachers were to choose answers from a list of predetermined level of observations. The first thing that they were to observe was the noise level during the in-class activities. From their observations, two teachers indicated that the noise level during class time was moderately high while one indicated that the noise level in the classroom was very high. Secondly, they were to make an observation on the frequency and quality of interaction between teacher and students, one teacher indicated that the interaction frequency was very high while the other two indicated that the frequency and quality if student-teacher interaction was moderately high. Furthermore, the teachers were to make observations on the students' level of participation. It was noted to be moderately high by all the three teachers. Student engagement with learning materials was highly focused and students asked and answered questions in a moderately highly welcoming manner and the feedback was provided on time.

Time management was observed to be ineffective by one teacher and lowly effective by the other two teachers. Two teachers indicated that transition between activities was highly disruptive while one teacher indicated that the transition of activities was highly disruptive. Also, it was noted that the amount of time allocated for student practice was moderately inadequate as students came for classes with unfinished assignments.

The observation checklist had open ended question where the teachers were to indicate the challenges they faced when preparing and using the flipped classroom strategy. The question was, 'What were the challenges you encountered when adopting flipped classroom strategy of teaching?' the following were the responses that were not related to the close ended statements in the observation checklist from the three teachers:

"Some students had no skills and access to technological gadgets which disadvantaged them from watching the pre-recorded videos before the class time." *(PTE1-2025)*

"It was not easy to determine how prepared the students were for the discussions and in-class activities before the class time." (PTE2-2025)

"It was hard to convince the learners to change their perspective of understanding some abstract concepts due to the information they had consumed earlier to the class time. It required lots of explanations and corrections which took a lot of time. This led to covering a smaller work as compared to what was planned for a lesson." (PTE3-2025)

4.6.2 Challenges Faced by Students

The students' perception questionnaire had an open- ended question where the students were to indicate the challenges they encountered when using the flipped classroom strategy. The question was 'Basing on your experiences, what are the challenges you encountered when using the flipped classroom strategy?'

80 students answered this question. Their responses were classified into themes and the number of students who answered the question in each theme was summarized as shown in Table 4.25

Table 4. 25 A Summary of Challenges Faced Using FC Strategy

Theme	No. of respondents
Technology issues	25 (31.25%)
Lack of parental support with pre-class activities	6 (7.5%)
Time for pre-class activities being limited	48 (60%)
Flipped classroom being confusing due to many opinions given by colleagues	4 (5%)

Table 4.25 indicates the themes of the challenge that students from Kauma Sub County encountered when using the flipped classroom strategy of instruction. Technology was a major concern as 25 (31.25%) students stated that they could not access computers, phones or internet to watch the pre-recorded videos. Some had no

digital skills on how to operate the technological gadgets to reach the videos and animations. These students had to depend solely on the handouts and textbooks issued in schools. The table also indicates that 6 (7.5%) students indicated that their parents and guardians did not give them the required support for them to do the pre-class activities. some explained further that, their parents overwhelmed them with house chores when at home such that they were not able to finish their pre-class activities in time. Further, basing on the table 48 (60%) students indicated limited time for pre-class activities as a great challenge. Some indicated that, going to the physics lab individually to do a practical pre-activity was challenging because the available break times that was there could only allow a small number of students to do the individual practical. This made some of the students to show up for in-class activities without conducting the practical. Lastly, 4 (5%) students gave answers explaining that the flipped strategy was confusing. To them, this was a result of the different worldview that the learners had during the discussions. Some of them indicated that it was discouraging as in most in-class discussions, other students' opinions were considered correct and for those whose were considered wrong made them feel inferior in lowering their engagement in the in-class activities. From these responses obtained, conclusion was made that both teachers and students faced challenges when adopting the flipped classroom strategy. Just like Jong, et al (2022) and Kong (2021), the challenges identified when adopting flipped classroom strategy in secondary schools located in Kauma Sub County, Kilifi County, Kenya were technology issues, lack of parental support with pre-class activities, time for pre-class activities being limited and flipped classroom being confusing due to many opinions given by colleagues.

4.7 Chapter Summary

This chapter focused on the demographic information of the sample obtained, findings and their discussions for flipped classroom strategy and achievement, retention and how students in Kauma Sub County perceived the flipped classroom strategy. It aslso focused on the specific challenges faced by both teachers and students when using the strategy for physics instruction.

CHAPTER FIVE
SUMMARY, CONCLUSION AND RECOMENDATIONS

5.1 Summary of the Study

This study aimed at finding out whether flipped classroom strategy of instruction can be a suitable approach for secondary school students who perform dismally in physics to achieve higher in the subject. A flipped classroom teaching module was prepared on a form 1 physics topic. A pilot study was conducted to test the appropriateness of the module and the stated activities. The pilot physics teachers approved it to be appropriate. The module was put into practice in secondary schools located in Kauma Sub-County in Kilifi County Kenya.

The first objective of the study was to determine the effect of the flipped classroom strategy on academic achievement of physics. In this study four groups were randomly selected where two of them were experimental groups while the other two control groups. One experimental group and one control group did a pre-test achievement test, their performance were recorded. An independent t-test was conducted with the help of SPSS 16 with $\alpha = 0.05$ between the scores of E1 pre-test and the C1 pre-test scores to test whether the groups were of the same capacity before the treatment The significances of the 2-tailed t tests indicated that there was no statistical difference between the pre-test achievement scores of E1 and those of C1hence the conclusion that the groups were initially of the same level before the treatment.

To test the effect of flipped classroom strategy to students' achievement in Kauma Sub County, one-way ANOVA test was done to compare the variance between all the experimental groups and the control groups' post-test achievement scores to determine their statistical difference with a confidence level of 0.05 with the help of SPSS 16. The critical value obtained from the analysis of variance indicated that flipped classroom strategy significantly improve students' academic achievement in physics.

The second objective was to compare the retention of physics concepts on students taught using the flipped classroom strategy and those taught using traditional teaching strategies. The post-test achievement test was re-administered to all the four

groups three weeks after they had done the post-test achievement score test. one way ANOVA inferential test was conducted between experimental and control with the help of SPSS 16 with a confidence level of 95% to test the of the $H0_2$ null hypothesis. The p-value obtained was less than the alpha-value used concluding that there was a significant statistical difference in retention of concepts between students taught by flipped classroom and those taught using lecture-based teaching strategies.

The third objective was to assess students' perceptions towards flipped classroom strategy to physics instruction. Perception questionnaires were administered to the two experimental groups after they had undergone the treatment. The questionnaire comprised of closed ended statements and of open-ended questions. The closed ended section had two sets of statement. The first set was a general statement asking student to indicate whether they perceive flipped classroom to be a good strategy for physics instruction. The second set comprised of statements that were framed into a Likert scaled format with a maximum of five choices illustrating the extent of their agreement with the perception statements provided. These statements acted as factors that helped to determine the learners' perception of flipped classroom towards physics instruction. The findings obtained indicated that Students' perceived flipped classroom as an effective strategy for physics instruction.

The fourth objective of the study was to investigate the challenges faced by the learners and teachers when implementing the flipped classroom strategy in physics instruction. Three teachers filled an observation checklist of predetermined challenges. They all indicated that they faced challenges like high noise levels during class time, inability to assess how prepared the students were before the class time, transition between activities was disruptive, some students were disadvantaged due to inadequate resources, lengthy discussions trying to change the students perception of the earlier concepts making time management to be ineffective. Students were given an open ended question where they were to state the challenges they faced when adopting the flipped classroom strategy for physics instruction. 83 students answered this question. Their responses grouped into themes. According to their responses, the challenges faced by the students were technology issues, lack of parental support with pre-class activities, time for pre-class activities being limited and Flipped classroom being confusing due to many opinions given by colleagues

during discussions.

5.2 Conclusion

The study established that flipped classroom strategy improved the student achievement in physics and the retention of physics concepts learnt. Further, flipped classroom strategy was well perceived by students for physics instruction in secondary schools in Kauma Sub County. The study also identified technology issues, lack of parental support with pre-class activities, time for pre-class activities being limited and Flipped classroom being confusing due to many opinions given by colleagues during discussions as the specific challenges faced when using flipped classroom strategy for physics instruction in Kauma sub county Kilifi county, Kenya.

The following conclusions were made based on the study findings: flipped classroom strategy improves student achievement, enhance retention of physics concepts, and is positively perceived by students despite the challenges they face when using it for physics instruction. However, successful implementation requires addressing barriers related to technology, teacher preparedness, and student adaptation. Lastly, the study established that implementing a flipped classroom strategy in Kauma Sub County in Kilifi County, requires educators to use locally available learning resources for the outside class personalized learning to make the learning experiences meaningful and effective in learning Physics.

5.3 Recommendations

5.3.1 Recommendations for Policy and Practice

Based on the findings of the study the following recommendations are made:

i. Teachers should use flipped classroom strategy as an instructional strategy when teaching learners who achieve dismally in physics as this help them improve their performance.
ii. When adopting flipped classroom strategy for physics instruction, physics teachers should use resources that are locally available to ensure that no student is disadvantaged.
iii. Physics teachers to use a variety of innovative strategies for physics instruction to improve students physics performance

iv. Schools should to come up with awareness programs explaining the role of a parent in the students' learning process.

5.3.2 Recommendations for Further Research

Based on the study findings the following suggestions for further study were made:

i. A study may be conducted on the effect of flipped classroom strategy to students' achievement of physics in secondary school students in other subjects other than physics.
ii. A study to be done on the impact of flipped classrooms on students' anxiety levels, and self-efficacy in physics learning.
iii. A study may be conducted to test the teacher perceptions and preparedness in implementing flipped learning in physics.

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APPENDICES

Appendix 1: Introduction Letter

MWACHAMBI LILLIAN MERE

P.O.BOX 75-10200,MURANG'A. APRIL, 2024.

Dear sir/ madam,

I am Mwachambi Lillian Mere, a postgraduate student at Murang'a University of Technology in the School of Education, department of Education and Technology. I'm doing a research study on **effects of flipped classroom strategy to student's achievement of physics in Kauma sub-county** for partial fulfillment of a master's degree. I would like to involve your school especially form ones in the study for data collection purposes.

The data collected from your school will be treated with utmost confidentiality only the final results will be communicated in general without mentioning the individual respondents. I'm looking forward to a positive response from you. Thank you.

Yours faithfully,

Mwachambi Lillian Mere

EH401/5850/2022

TEL: +254797775829

Appendix 2: Students' Achievement Score Test

Instruction

Answer all the questions below

TOTAL MARKS 30

1. Define electrostatics (1mk)

……
……
……
……

2. Name the three constituents of an atom (3mks)

……
……
……

3. (I) state the basic law of charges (1mk)

……
……

ii) Briefly describe an experiment that can be used to demonstrate the law of charges (3mks)

……
……
……

4. (I) List any three ways of charging a conductor (3mks)

……
……
……

(ii) Briefly explain what will be happen when a positively charged glass rod is brought close to aneutral pith ball placed on a flat table. (3mks)

……

……

……

5. a) List any three ways of charging an electroscope (3mks)

……

……

……

b) Explain why it is not possible to charge an electroscope by following the steps below:

Bring a charged rod near to, but not touching the cap.

Touch the cap with a finger.

Remove the charged rod.

Remove the finger. (3mks)

……

……

6. Name any two parts of a electroscope and state their functions (4mks)

……

……

……

7. Describe how to charge an electroscope positively using a positive rod. Name the otherapparatus needed. (4mks)

.....

.....

.....

8. State any two applications of electrostatics. (2mks)

……
……
……

9. A positively charged rod is brought near the cap of a lightly charged electroscope. The leaf first decreases in divergence but as the rod is brought nearer, it diverges. State the charge onthe electroscope and explain the behavior of the leaf. (3mks)

.....
.....
.....

10. State why a gold-leaf electroscope casing is made of metal. Why is the casing earthed?(2mks)

……
……
……

11. An uncharged metal rod brought close to, but not touching the cap of a chargedelectroscope causes a decrease in the divergence of the leaf. Explain. (3mks)

……
……
……
……

Appendix 3: Student's Perception Questionnaire

Section 1: Introduction

This questionnaire is designed to collect information on how you as a student perceive the flipped classroom strategy towards physics instruction. The information you provide will be keptconfidential. Please respond honestly.

Section 3: Instructions: Please indicate your level of agreement with each statement by selecting one of the following options: Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree

Statement	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
I find the flipped classroom strategy engaging					
The flipped classroom strategy helps me understand the subject matter better					
The resources provided for flipped classroom activities are helpful.					
I feel more prepared for class discussions in a flipped classroom setting					
The flipped classroom encourages me to learn at my own pace					
I am satisfied with my learning outcomes in a flipped classroom environment.					
I feel motivated to participate in activities in a flipped classroom					
The flipped classroom strategy improves my problem-solving skills.					
I am confident in my ability to succeed in a flipped classroom					

I perceive flipped classroom strategy as a good strategy for physics instruction

YES☐ NO ☐

In your experience, how does this teaching strategy impact your understanding of the material?

……

……

……

…….....

Briefly describe any difficulties you have faced while learning using this strategy

……

……

……

How would you describe the classroom environment when using this instructional strategy?

……

……

Thank you for your participation

Appendix 4: Teacher's Observation Checklist

Section 1: Observation checkpointsInstructions

Kindly indicate your observations during instruction honestly by ticking in the brackets

Noise level during class time

No Noise at all ( ) Very low ( ) Moderately Low ( ) Moderately high ( ) Very High ( )

Frequency and quality of Interaction between teacher and students

No interactions at all ( ) Low ( ) Moderately Low ( ) Moderately High ( ) Very high ( )

Students' level of participation

Passive ( ) Moderately Passive ( ) Active ( ) Moderately Highly Active ( ) Highly Active ( )

Student engagement with learning materials

No Engagement ( ) Highly Distracted ( ) Lowly Distracted ( ) Moderately Focused ( ) HighlyFocused

Encouragement of student questions

Very Discouraging ( ) Lowly Discouraging ( ) Welcoming ( ) Moderately Highly Welcoming ( )Very Highly Welcoming ( )

Provision of feedback

Timely ( ) takes time ( )

Time management

Ineffective ( ) Lowly Effective ( ) Effective ( ) Moderately Effective ( ) Highly Effective

Transition between activities

Highly Disruptive ( ) Moderately Disruptive ( ) Moderately Smooth ( ) Smooth ( )

Recommendable Smooth ( )

Adequacy of amount of time allocated for student practice.

Inadequate ( ) Moderately Adequate ( ) Adequate ( ) Highly Adequate ( ) Excess time

Level of preference of employing the flipped classroom in teaching physics Not prefer ( ) lowly prefer ( ) moderately prefer ( ) prefer ( ) highly prefer ( )

In your opinion, what challenges do you encounter during the adoption of flipped classroom

……
……
……
……

Thank you for your honest observations

Appendix 5: Flipped Classroom Teaching Module

Week One Lesson One

Sub-Topic: **Origin of Charges and Conservation of chargesELOs**

By the end of the lesson, the learner should be able to:

i. Define electrostatics

ii. Demonstrate an understanding of the origin of charges

iii. State the nature of charges (types of charges, conservation of charges)

Time	Content	Learning activities	Teaching Activities	Learning resources	Reference materials
5 Min	Introduction On electrostatics	Brainstorming	Guiding the brainstorming process		Kb physics book 1 Secondary physics book 1 Links to relevant videos, online articles, animations and simulations
30 Min	The Nature of Electric Charge	Rubbing plastic and rubber materials on their hair and pieces of clothes	Provide an overview of the concept of electric charge	Pieces of Clothes, plastic Ruler and rubber	
10 Min	Origin of charges	Interacting with charts illustrating the structure of an atom	Explore the atom of an element	Charts illustrating the structure of an atom	
10 Min	Conservation of charges	Watching a video on how electric charges are conserved	Explain the law of conservation of electric charge and its implications for interactions between	A video on conservation of electric charges	

			charged objects
5 Mins	conclusion	Reviewing what has been learnt	Formative assessment

Lesson Two

Sub Topic: The law of charges ELOs

By the end of the lesson, the learner should be able to:

i. State the law of charges

ii. Conduct a practical to demonstrate the law of charges

iii. Appreciate the application of law of charges in real life situation

Time	content	Learning activities	Teaching activities	Learning resources	Reference materials
5 min	introduction	Recapping on the origin of charges and conservation of charges	Leading the recap process	Chart illustrating the structure of an atom	KLB physics book 1 Secondary physics book 1
30 min	Law of charges	In groups of four, sharing their understanding of	Controlling the discussion	Handouts with summary	KLB physics book 1 Secondary
20 min		the law of charges after interacting with the learning materials		notes on the law of charges A piece of cloth, polyethene, plastic and rubber materials	physics book 1 Links to relevant videos, online articles, animations and simulations
10 min	Law of charges	Observing the demonstration Asking questions on the law of charges	Demonstrating a practical on the law of charges Clarify and emphasize on the important concepts under the law of charges		
5 min	Conclusion	Reviewing what has been learnt	Summarizing the lesson. Formative assessment.	Links to videos, interactive simulations, or online articles on charging a conductor	KLB physics book 1 Secondary physics book 1 Links to supplementary resources

Lesson Three and Four

Sub Topic: Charging a ConductorELOs

By the end of the lesson, the learner should be able to:

i. To demonstrate an understanding on charged and uncharged conductors

ii. To charge conductors using different methods

iii. To explain what happens to conductors in the charging process

Time	content	Learning activities	Teaching activities	Learning resources	Reference materials
5 min	introduction	Recap Law of charges	Leading the recapping process	Handouts with summary notes on thelaw of charges	KLB physics book 1 Secondary
70 min 20 min	Charging a conductor	In small groups discussing	Controlling the discussion Facilitating the discussion	Handouts with summary on methods of charging a conductor	physics book1
40 min	Experiments on charging conductors	In their groups conducting the experiments on how to charge conductors Noting down the observations	Giving instructions andmonitoring the experimentation process	experimentson charging conductors Charts illustrating the parts of an electroscope.Links to videos, interactive simulations, or	
10 min	Experiments on charging conductors	Asking questions	Demonstrating and explain the observations made by studentswhile conducting the experiment	online articles on parts and functions of an electroscope	
5 min	conclusion	Answering questions	Summarizing the lesson. Conducting a formative assessment.		

Week Two Lesson One

Sub Topic: The Electroscope ELOs

By the end of the lesson, the learner should be able to:

Define an electroscope

i. Name the parts of an electroscope

ii. State the functions of each part of the electroscope

iii. Use an electroscope to determine the type and strength of charges in charged conductors

Time	content	Learning activities	Teaching activities	Learning resources	Reference materials
5 min	introduction	Reviewing the lessonon charging conductors	Guiding the reviewing process	Handouts with summary notes on charging conductors	KLB physics book 1 Secondary physics book 1 Links to relevant
30 min 20 min	The electroscope	In groups of four interacting with the electroscope as they share their understanding, discoveries and observations made	Facilitating and controllingthe discussion	Charts illustrating the parts of an electroscope and their functions	videos, online articles, animations and simulations
10 min	The electroscope	Interacting with theelectroscope	Playing a video explaining the parts of an electroscope with demonstration of their function	A link to the video on partsof an electroscope and their function Clarifying some abstractconcepts to students	
5 min	conclusion	Answering questions on parts of an electroscope and theirfunctions	Summarizing the lesson. Conducting a formative assessment.		

Lesson Two and Three

Sub Topic: Charging an Electroscope ELOs

By the end of the lesson, the learner should be able to:

i. State the methods used to charge an electroscope

ii. Explain the behavior of the gold leaf when charging an electroscope

iii. Charge an electroscope (both positively and negatively) using the different chargingmethods

Time	content	Learning activities	Teaching activities	Learning resources	Reference materials
5 min	introduction	Answering questions on	Reviewing the lesson onparts and functions of an electroscope	Handouts illustrating parts of an electroscope	KLB physics book 1 Secondary physics book 1 Links to relevant videos, online articles, animations and simulations
70 min 20 min	Charging an electroscope	In small groups, discussing their understanding of the different types of charging an electroscope	Facilitating the discussion	Handouts with notes on methods of charging electroscopes	
40 min		Watching videoson the various methods of charging an electroscope	Playing the video to students	Links to the videos on charging electroscopes	
10 min		Asking for clarifications on abstract concepts	Clarifying the abstract concepts		
5 min	conclusion	Summarizing the lesson	Summarizing the lesson Conducting a formative assessment on charging electroscopes		

Lesson Four
Sub Topic: Uses Of an Electroscope: Applications of Electrostatics ELOs

By the end of the lesson, the learner should be able to:

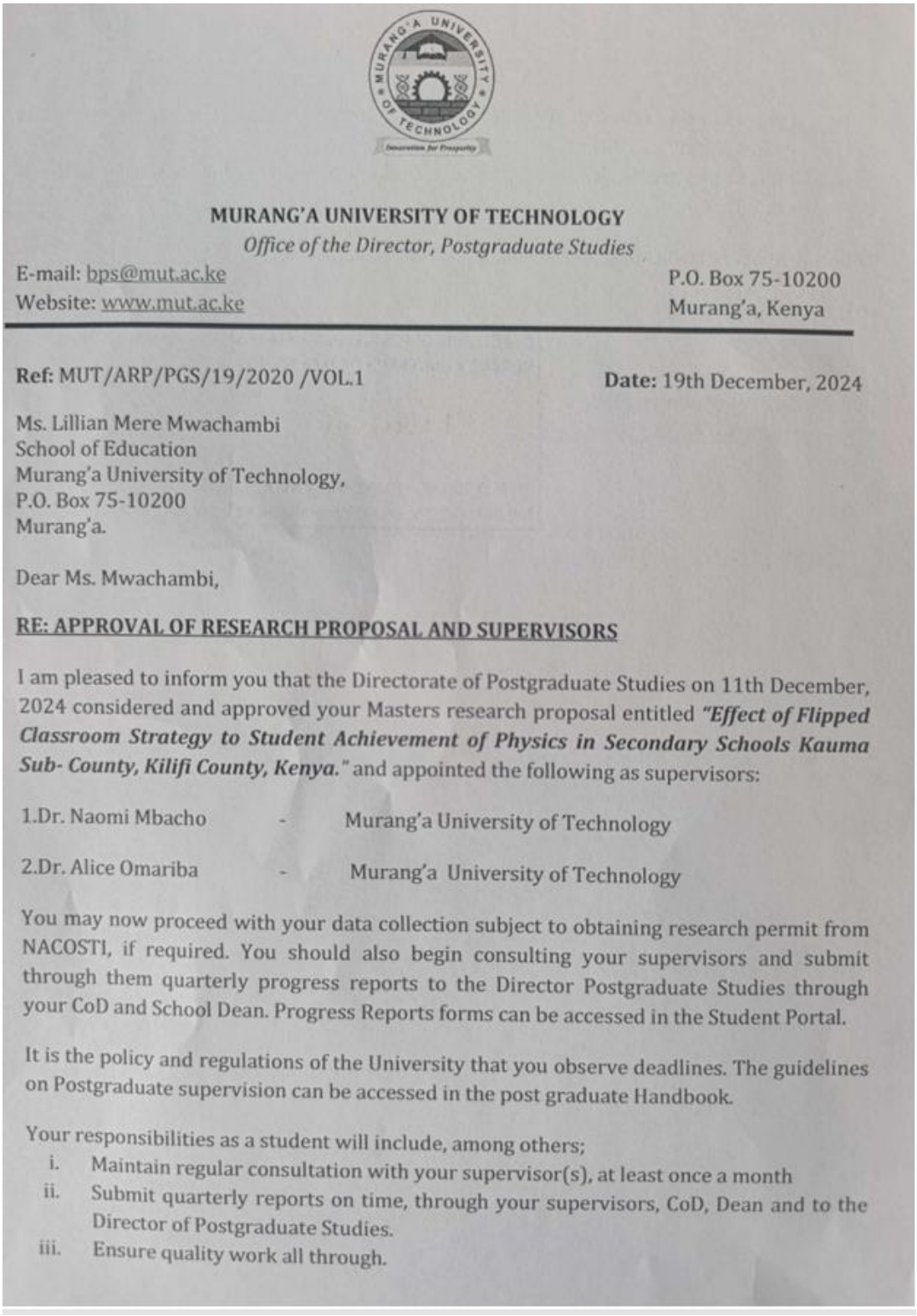
i. state the uses of an electroscope

ii. demonstrate the uses of an electroscope in the laboratory

iii. explain the applications of electrostatics in real life situations

Time	Content	Learning Activities	Teaching Activities	Learning Resources	Reference Materials
5 min	introduction	Recap on the charging an electroscope	Asking question on charging an electroscope	A chart illustrating the parts of an electroscope	KLB physics book 1
30 min	Uses of an electroscope	Brainstorming Discussions in pairs	Guiding the brainstormingand discussions		
10 min	Uses of an electroscope	Watching a video onthe several uses of the microscope	Explaining the video to the learners Demonstratingthe uses of the electroscope	Electroscope Charged conductors Projector/ computers Link to the video	Handouts on uses of an electroscope
10 min	Applications of electrostatics	Watching videos onthe applications of electrostatics Discuss the observed applications in the video	Explaining the video to the learners	Projector/ computersLink to thevideo	

Appendix 6: Approval of Research Proposal and Supervisors



MURANG'A UNIVERSITY OF TECHNOLOGY

Office of the Director, Postgraduate Studies

E-mail: bps@mut.ac.ke
Website: www.mut.ac.ke

P.O. Box 75-10200
Murang'a, Kenya

Ref: MUT/ARP/PGS/19/2020 /VOL.1

Date: 19th December, 2024

Ms. Lillian Mere Mwachambi
School of Education
Murang'a University of Technology,
P.O. Box 75-10200
Murang'a.

Dear Ms. Mwachambi,

RE: APPROVAL OF RESEARCH PROPOSAL AND SUPERVISORS

I am pleased to inform you that the Directorate of Postgraduate Studies on 11th December, 2024 considered and approved your Masters research proposal entitled ***"Effect of Flipped Classroom Strategy to Student Achievement of Physics in Secondary Schools Kauma Sub- County, Kilifi County, Kenya."*** and appointed the following as supervisors:

1.Dr. Naomi Mbacho - Murang'a University of Technology

2.Dr. Alice Omariba - Murang'a University of Technology

You may now proceed with your data collection subject to obtaining research permit from NACOSTI, if required. You should also begin consulting your supervisors and submit through them quarterly progress reports to the Director Postgraduate Studies through your CoD and School Dean. Progress Reports forms can be accessed in the Student Portal.

It is the policy and regulations of the University that you observe deadlines. The guidelines on Postgraduate supervision can be accessed in the post graduate Handbook.

Your responsibilities as a student will include, among others;

i. Maintain regular consultation with your supervisor(s), at least once a month
ii. Submit quarterly reports on time, through your supervisors, CoD, Dean and to the Director of Postgraduate Studies.
iii. Ensure quality work all through.

iv. Present your research findings at 2-3 seminars/conferences prior to thesis examination.
v. Publish two articles from your research findings in a refereed journal prior to thesis examination.

For any further clarification please contact the undersigned.

Yours Sincerely,

Prof. Geoffrey Muchiri, PhD
Director, Postgraduate Studies
GM/MMK

DIRECTORATE OF POSTGRADUATE STUDIES
MURANG'A UNIVERSITY OF TECHNOLOGY
15 DEC 2024
P. O. Box 75 - 10200, MURANG'A
Tel: 0771463515, Email: info@mut.ac.ke

Copy to:
1. Registrar, Academics, Research and Students Affairs
2. Dean, School of Education

Appendix 7: NACOSTI Research Permit



REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Ref No: 386449

Date of Issue: 23/January/2025

RESEARCH LICENSE

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Appendix 8: Publications

The following journal articles were published from this thesis;

Mwachambi, L. M., Omariba, A., & Mbacho, N. (2025). Effect Of Flipped Classroom Strategy to Physics Achievement Among Secondary School Students' in Kauma Sub-County, Kilifi County Kenya. https://doi.org/10.37284/2707-3947

Mwachambi, L. M., Omariba, A., & Mbacho, N. (2025). Perception of Flipped Classroom Strategy for Physics Instruction in Secondary Students in Kauma Sub-County Kilifi County, Kenya. https://www.noveltyjournals.com/issue/IJNREL/Issue-3-May-2025-June-2025