

**THE COMPARISON BETWEEN INQUIRY- BASED AND TRADITIONAL
LEARNING APPROACHES ON THE STUDENT PERFORMANCE IN
PHYSICS IN KESSES SUB-COUNTY, KENYA**

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DECLARATION**Declaration by the Candidate**

This thesis is my original work and has never been presented for the award of an academic degree in any other university and should not be copied, or reproduced in any format without written authority from the author and/or University of Eldoret.

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DEDICATION

I dedicate this work to my family led by my wife Regina Waithera, my children Merleen Mwihaki, James Kinyanjui, Tasha Wairimu and my Parents Mr. and Mrs. James Kinyanjui Kimiru. Your patience and support enabled me to complete this task. Indeed, you have been a blessing to me.

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ABSTRACT

Physics is one of the science subjects offered in the Kenyan secondary school curriculum. Despite attracting few learners over the past few years, its performance has been poor as indicated in Kenya National Examinations Council (KNEC) reports from the last decade. This study aims to investigate performance comparison between learners taught using the Exploratory Inquiry-Based Learning (IBL) approach and those taught using Traditional Learning (TL) approaches in Secondary schools within Kesses Sub- County in Uasin Gishu County. The objectives of the study are (i) to compare the performance of students taught Physics using the IBL approach and those taught using TL approaches, (ii), to find out the effect of IBL approach and TL approaches on retention of Physics concept and (iii) to find out challenges faced in using the IBL approach and TL approach in learning of Physics. The study was based on Experiential Learning theory by Carl Rogers (1969). The IBL approach for this study was an exploratory learning approach, which involves learners performing experiments and sharing results. The target population was 1,009 Form Three Physics students from 47 schools and 45 Physics teachers. Stratified random sampling, simple random sampling and purposive sampling were used in this study. Stratified random sampling was used to divide schools into three strata according to their category. From each stratum random sampling was used to select schools from the categories; extra county, County and Subcounty schools. Purposive sampling was used to select schools with only one physics teacher-where there were more than one physics teacher, one was chosen randomly. The sample size comprised 282 physics students and 12 Physics teachers. A quasi-experimental design was employed where sampled students were divided into control and experimental groups. Pre-tests and post tests were then administered and tests results were analyzed. Collected data was analyzed with both descriptive and inferential statistics using SPSS version 25 and the Microsoft Excel 2021 version application programs. The findings showed that performance of learners taught Physics using IBL approach was greater than of those taught using traditional approaches. Teachers of Physics highlighted various major challenges that hindered the implementation of the IBL approach, including inadequate resources, a heavy workload, and limited training of teachers on use of the IBL approach. The researcher recommended that the Ministry of Education implement the use of the IBL in its curriculum policy for teaching Physics in Kenyan Schools. The results of the study are expected to be instrumental to curriculum developers at the Kenya Institute of Curriculum Development (KICD) in designing a Physics curriculum that promotes the IBL approach in delivering instructions. The results will also help school administrators and teachers of Physics in coming up with policies that promote IBL.

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LIST OF ABBREVIATIONS AND ACRONYMS

CBC	Competence-Based Curriculum
CBE	Competence-Based Education
CEMASTE	Centre for Mathematics, Science and Technology Education in Africa
GOK	Government of Kenya
IBL	Inquiry-Based Learning
ICT	Information Communication Technology
KNEC	Kenya National Examinations Council
KUCCPS	Kenya Universities and Colleges Central Placement Service
SCDE	Sub-County Director of Education
SMASSE	Strengthening Mathematics and Science Subjects in Secondary Education
SPSS	Statistical Package for Social Sciences.
STEM	Science Technology Engineering and Mathematics

CHAPTER ONE

INTRODUCTION

1.1 Introduction to Chapter One

This chapter provides background information on the area of study, drawing on previous studies. It also captures the statement of the problem, purpose of the study, objectives of the study, research question, significance of the study, assumptions of the study, scope of the study, limitations of the study, theoretical framework, conceptual framework, operational definition of terms, and a summary of Chapter one.

1.2 Background Information

Many studies have shown that teaching methodologies affect the performance obtained in the Physics Subject, due to this, many nations have developed policies to improve academic performance such as re-designing curriculum. Education empowers the disadvantaged citizens; it liberates them from ignorance (Friedman, Kremer & Miguel, 2026) and therefore the teaching and learning approaches employed are very important. Buabeng (2015) conducted a study in New Zealand and found that physics is often perceived as a difficult subject, with some learners pursuing it only as a requirement for STEM courses at the college level.

What is the Inquiry-based Learning (IBL) approach? According to Aparicio-Ting, Slater and, Kurz (2019), it is a learning approach that provides students with an opportunity to take ownership of their learning while developing critical high order skills for innovative solutions to complex problems. Examples of inquiry skills acquired by learners when IBL approach is used in learning include; engagement, elaboration, exploration, explaining and evaluation. Inquiry Based Learning is also defined as a learning technique of employing hands-on activities that enables learners explore

concepts and instructions that focus on utilizing process skills to increase a deeper comprehension (Langat, Sifuna and Kapkiai, 2022). Therefore, the inquiry based learning enhance understanding and retention of content delivered in the classroom environment.

When a teacher employs traditional teaching methods such as lecture method, question and answer method and rote learning method, the learner is denied the opportunity to become an innovator and ownership of the learning process. Learning autonomy is very important according to Aparicio-Ting, Slater, and Kurz (2019). IBL can be used in designing a student-centered, inquiry-based curriculum because most research studies has shown that learners retain information and learn more effectively through teaching approaches that put them in control (Pesqueira, 2020).

Many countries are yet to formalize the implementation of IBL approach in their curriculum though teachers are trained on using it. This is because no agency has been put in place to supervise the implementation on use of IBL, for instance in Indonesia and Malaysia there is no formal guidance on how to implement IBL in classroom learning hence teachers carry out learning activities that they think align with the philosophy of inquiry-based Learning (Halim, Ramli & Nasri, 2018). This is also the case in most developing nations due to various challenges. Ramnarain and Hlatswayo (2018) while conducting research in a rural school in South Africa, reported that teachers did not implement the IBL, although they had a positive attitude towards the approach; they cited challenges such as inadequate laboratory facilities, time to complete the curriculum, and large classes as the reason for not incorporating the IBL approach. This was in agreement with study conducted by Haug and Mark who alluded that teachers spent a lot of time in rushing to complete the teaching curriculum to be in tandem with the institutions policy.

Sub-Saharan African countries, which comprise all countries south of the Sahara Desert, have always strived to improving Physics learning by emphasizing practical teaching. A study by Babalola and Ojobola (2022) found a significant gap between practices in developed countries and those in sub-Saharan countries, attributed to the following factors; inadequate resources, limited teacher skills, and a lack of interest in inquiry. The Countries must provide resources and skilled manpower to be globally competitive in teaching physics in the 21st century. Little attention has given to practical subjects such as physics in sub-Saharan African countries yet it is an important part of the science learning (Babalola, Lambourne & Swithenby, 2020).

Most of the nation's method of teaching, especially in East Africa, as reported by Bugingo and Yadav (2022), have focused on memorizing content rather than teaching students to understand scientific processes as outlined in the learning objectives.

IBL is not a new concept to most teachers, especially in Kenya. However, most of them have not fully adopted it because it is not part of the existing curriculum, especially in senior secondary schools, where the competence-based Education (CBE) curriculum is yet to be implemented. In primary and Junior schools in Kenya the CBE is effected and running.

It's on record that Physics national performance in Kenya Certificate of Secondary Education (KCSE) has been below average, which is below grade C (KNEC 2015-2022). This is a concerning issue that has drawn the attention of stakeholders in the education sector. In Kenya, teacher-centered approaches are commonly used in teaching and learning, where learners' input is limited and they are only allowed to be recipients of instruction. This method is used due to various challenges faced in Kenya, which are high workload among teachers and the pleasure of completing the syllabus.

Teachers have been encouraged to use IBL approaches in teaching on Practical lessons in the sciences as it is associated with improved attitudes and self-efficacy among the students (Nzomo, 2023). IBL has been proven to influence positive performances not only in Physics but in most subjects. Science has been taught in Kenyan schools since independence in 1963, before then, formal education was not widely available to indigenous Kenyans (Oyoo, 2015), with Physics being among the science subjects offered in secondary curriculum.

Many curriculum reforms and policies have been introduced in Kenya to support science education. In 1985, the 8-4-4 system of education was introduced where learners were to spend eight years in primary education, four years in secondary education and then four years in university education (Oyoo, 2015). However, the system has undergone several changes, like the phasing out of the physical and biological sciences, which led to science subjects being available to only a few students (Oyoo, 2015). Physics has been experiencing a low enrollment rate of less than 30% nationally, as shown in Appendix VII (KNEC Reports, 2013-2022). To improve the performance of science subjects, the Strengthening Mathematics and Science in Secondary Education (SMASSE) program was introduced in 1998 but later changed to Centre for Mathematics, Science and Technology Education in Africa (CEMASTE) in 2003;- however, the objective has not been achieved, as the performance of physics at the KCSE level has been below average (Mulambe, 2017). In-service trainings for science teachers has been offered in Kenya by CEMASTE; however the skills acquired have not yielded positive feedback. A study conducted by Mulambe (2017) found that teachers were not motivated and lacked relevant learning resources, which discouraged them from applying the skills they had learned. It would be important for

the government to evaluate its programs to ensure whether there is positive achievement because this can lead to a loss of time and money channeled to in-service training.

Learners in Primary schools are reported to have a positive attitude towards science despite the low performance (Kamutu, 2018), but when they high school, where science is split into Biology, chemistry, and physics, the attitude tends to change, especially towards Physics, which attracts low enrollment amongst the three sciences at the secondary level. To the performance of Physics, the CEMASTEPA training has emphasized the use of learner-centered approaches, such as experiments, in teaching Physics; however, with the high teaching load, teachers have been performing fewer experiments (Okono, Saiti, & Awuor, 2015). Physics knowledge is acquired in secondary school as a compulsory subject in Forms One and Two.

Physics is an important career subject with numerous career opportunities beyond secondary school, including Data Analyst, Physics teacher, Research Scientist, Sound Engineer, Lab Technician, and Engineering, among many others (KUCCPS, 2022). It has been perceived as a subject reserved for the, as it is evident that many learners opt not to pursue it at the senior secondary level after being selected. (Kihwele, 2014) points out that allowing learners to choose and drop some subjects develops a mentality that these subjects are difficult and reserved for the few intelligent ones. This is evident by the fact that elective subjects like physics tend to attract very low enrollment, and even the learners pursuing it tend to have low performance. (Erinisho 2013) also agrees when he alluded that student regard Physics as a subject for exceptionally gifted and talented pupils.

There has been low enrollment in Physics compared to other sciences, which is attributed to a negative attitude and lower performance (Akweya et al., 2015). Low performance tends to create a fallacy amongst students that the subject is difficult, and

taking the subject earns you a ticket to automatically becoming a low performer. This tends to create an unnecessary negative attitude amongst learners who are about to make a decision of either selecting or dropping the subject.

In Kesses sub-county during the KCSE 2023 exams, out of 47 schools that registered candidates for national exams, two schools did not have any candidates sitting for the Physics exams. This clearly suggests that the subject has not been considered as Biology and Chemistry. It is only 36.96% of candidates who sat for the exams. Out of this small number, girls were 447, while boys constituted the majority, at 769 (Kesses Subcounty KCSE 2023 Analysis). This has been a concerning issue in Kenya, where fewer than 32% of KCSE candidates have taken the Physics exam. This does not mean that the subject is difficult or only preserved for a select few, but researchers have attempted to identify the cause of this problem and suggest possible recommendations that can mitigate this situation. Among the recommendations is the implementation of IBL approaches in the teaching of Physics. Science learning can be well understood if teaching is inquiry-based and practical physics is emphasized as opposed to rote learning. This is in agreement with Ogegbo and Ramnarain (2022), who eluded that inquiry-based activities can be used to improve learners' in-depth knowledge. Poor performance has been attributed to teacher-centered learning methodologies, which hinder the implementation of the IBL approach. The Kenyan government, led by KICD, should train teachers to implement the approach and incorporate it into the curriculum for teacher trainees.

1.3 Statement of the Problem

Physics national performance in KCSE has been reported to be below average as shown in Table 1.1.

Table 1.1: KCSE Performance of Physics Subject (2013-2022)

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Mean Score	44.46	41.44	47.06	40.55	38.38	36.35	36.40	41.37	35.52	38.55

Source: KNEC KCSE Examination Report, 2013-2022

In Kesses Sub-county, performance has also not been any better as shown in Appendix VIII (KNEC Reports, 2012-2022). Studies have shown that teaching methodologies used in schools are a determinant of the achievement obtained in Physics for example the Inquiry-based Learning approach (IBL) has proved to influence positive performances not only in Physics but in most subjects. Van Graan (2020) found out that when the inquiry-based approach was introduced to learners, they became more cooperative and active participants.

African Countries such as Rwanda, Kenya, Tanzania and Uganda have introduced and implemented a Competence-Based Curriculum (CBC) in their education systems. CBC supports the IBL approach; however, most teachers have not fully embraced it because they still use traditional teaching methods at the expense of IBL, despite being familiar with the approach (Dusabimana & Mugabo, 2022).

Inquiry Learning has been shown to assist in cognitive development, reducing students from cramming and instead leading to mastering of content in the History and Government subject (Langat, Sifuna, and Kapkiai, 2022).

1.4 Purpose of the Study

The main purpose of this study was to compare the performance of students taught Physics using an Inquiry-Based Learning approach and those taught using Traditional Learning approaches among secondary school students in Kesses Subcounty, Kenya.

1.5 Objectives of the Study

1.5.1 General Objective

To compare the performance of students taught Physics using an Inquiry-Based Learning approach and those taught using Traditional Learning approaches among secondary students in Kesses Sub-county, Kenya.

1.5.2 Specific Objectives

- i. To compare the performance of student taught Physics using the Inquiry-Based Learning approach and those taught using Traditional Learning approach.
- ii. To investigate the effect of Inquiry-Based Learning approach and traditional approaches on retention of Physics concept.
- iii. To determine the challenges faced in using Inquiry-Based Learning approach and traditional learning approaches in learning of Physics.

1.6 Research Questions

- i. Is there any difference on the performance of Physics between learners taught using Inquiry-Based Learning approach and those taught using traditional learning approach?
- ii. What is the effect of the Inquiry-Based Learning approach and the traditional approach on the retention of Physics concepts?
- iii. What are the challenges faced when using the Inquiry-Based Learning approach and traditional learning approaches?

1.7 Hypothesis of the study

The study was guided by the following null hypothesis.

H₀₁: There is no significant mean difference in the performance of Physics between learners taught using the Inquiry-Based Learning approach and those taught using the traditional learning approach

1.8 Significance of the Study

This study was significant because it shed light on how the Inquiry-Based Learning approach focusing on exploratory learning, influences the performance of the Physics subject in secondary school compared to the traditional approaches widely used in learning. Challenges faced by the Inquiry based learning approach and traditional approaches were studied, and their effects on the retention of Physics concept were examined. The results of the study are expected to be instrumental to curriculum developers at the Kenya Institute of Curriculum Development (KICD) in designing a Physics curriculum that promote an exploratory IBL approach in delivering instructions. The results will also help school administrators, other education stakeholders and teachers of Physics in coming up with policies that promote an exploratory learning approach.

1.9 Assumptions of the Study

The study was based on the following assumptions;

1. All respondents' students are taking physics as a mandatory subject in the study area.
2. The selected schools will cooperate with the researcher
3. The respondents of the study will give an honest and true opinion during the study.

1.10 Scope of the Study

This study focused on the comparison between the Inquiry-based Learning approach and traditional approaches on the student performance in Physics among secondary school students in Kesses Sub-county. The topic of Refraction of Light in Form 3 was studied because KNEC report of 2022 reported that it had been poorly performed in the national examinations. This topic is an experimental topic which requires hand son activities and working in collaboration in the discussion groups among learners. Most schools allow their students to select Physics as an examinable subject when they join Form three (3) class, so our study focused on Form three (3) class only.

1.11 Limitations of the Study

There are many schools in Kenya; however, this study was limited only to Kesses sub-county. The sub-county has forty-seven (47) schools. The study will only be limited to Form Three classes of the seven sampled schools and recognizing the fact that we have many teachers and learners. Only a few sampled physics teachers and learners from the entire population were identified for the purposes of the study. The students who participated in the study were from Form Three classes and not across all Forms.

1.12 Theoretical Framework

The study was based on experiential Learning theory by Carl Rogers (1969). He argued that experiential learning is facilitated when the student participates completely in the learning process and has control over its nature. The learner learns to learn while the teacher becomes the facilitator of learning process. This theory is relevant to this study because it supports inquiry-based learning where learners participate completely in learning process, it addresses the needs of the learners, whereby they come up with solutions to problems on their own, since there is personal involvement, self-initiative and collaboration. According to Rogers, the student participates completely in the

learning process and has control over their nature and direction, learning to learn amongst the learners is emphasized, where the teacher becomes the guiding facilitator and not the sole knowledge disseminator.

1.13 Conceptual Framework

The study was conceptualized as shown in Figure 1.1.

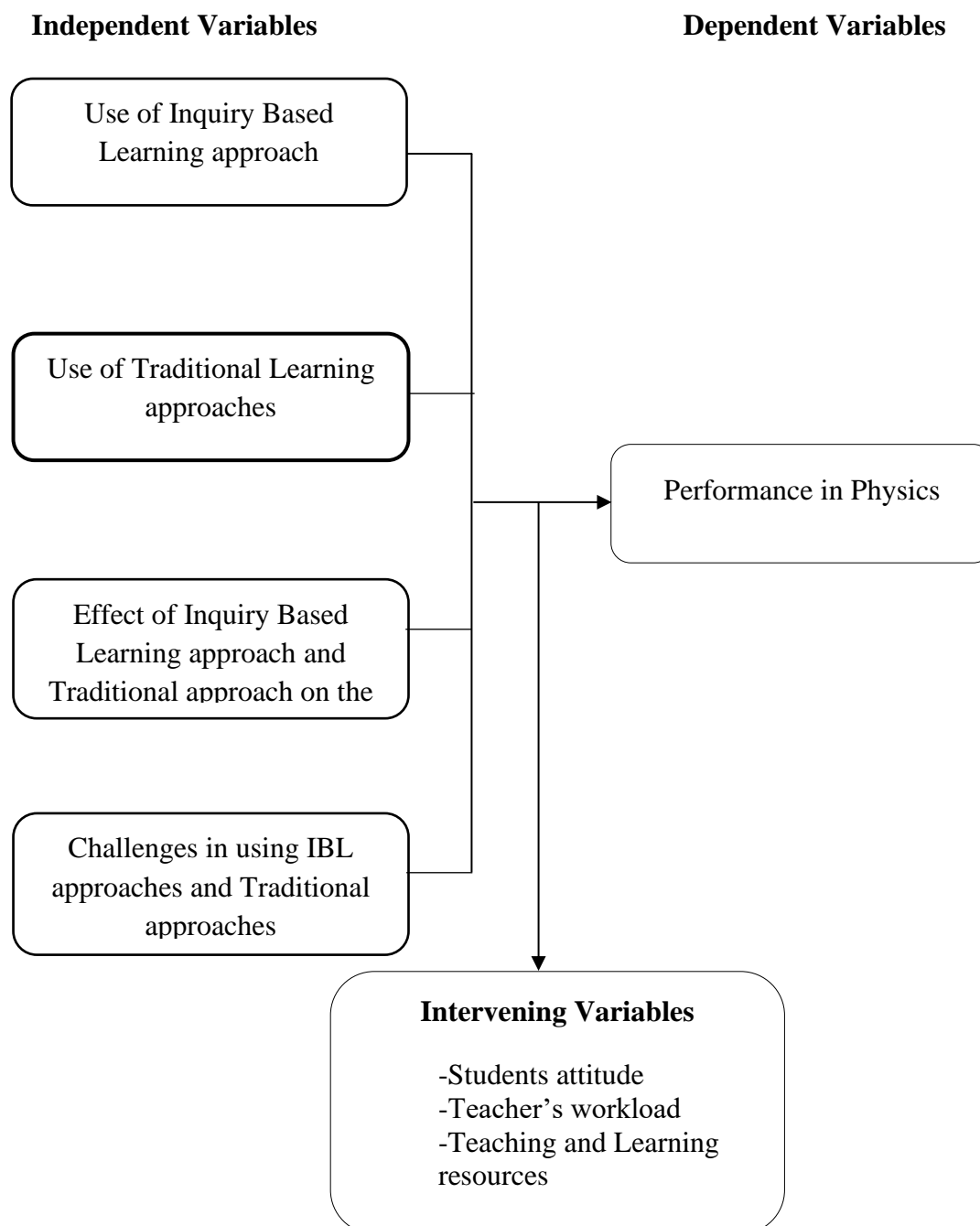


Figure 1.1 Conceptual Framework of the Study

Figure 1.1 shows a conceptual framework. It shows that the independent variables of the study are inquiry-Based learning, traditional Learning approaches and Challenges in implementing the Inquiry-based Learning Approach and Traditional approaches, as well as the effect of the IBL approach and Traditional approaches on retention. Independent variables are expected to influence the performance of Physics and the teaching of Physics, which are the dependent variables. The independent variables were intervened by Students' attitudes, teaching methodology, teacher's workload, and teaching and Learning resources.

1.14 Operational definition of terms

Inquiry-Based Learning- A learning technique approach that is learner-centered where learners use hands-on activities that enable them to explore concepts and instructions that focus on utilizing process skills to increase a deeper understanding. The inquiry skills are engagement, exploration, explanation, elaboration and evaluation.

Traditional Learning Methods- Conventional methods of teaching used by teachers of Physics that is usually teacher-centered for example rote learning and the Lecture method.

Average performance- KNEC grade of C (plain) and C+

Entry behavior- KCPE marks that indicate a learner was admitted to a secondary school.

Performance- The results of the Kenya National Examination Council.

Good performance- KNEC grades of grade C+ and above.

Average performance- KNEC grades of C

Poor performance- KNEC grades below grade C-

Perception- The general view towards a certain phenomenon that may be true or false.

1.15 Summary of Chapter One

This Chapter began with an introduction, highlighting background information on studies of on inquiry-based learning approaches globally, regionally and nationally. The statement of the Problem showed that physics has been performing below average due to the learning approaches used in the learning institutions. The purpose of the study highlighted the main reason in conducting the research. The objectives of the study were stated to act as a guide to the researcher during the study process. Research questions, Significance of the study, Assumptions of the study, Scope of the study, Limitations of the study, theoretical framework, Conceptual framework and operational definitions of terms were widely highlighted.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This Chapter covers literature review from various written thesis and journals, areas covered are Inquiry-Based Learning, Inquiry based Approaches, Inquiry based skills, Traditional Learning approaches, Students' perception and performance where Mathematics, Chemistry and Biology have been looked into, Students perception in physics, Challenges experienced by students towards Physics, enrollment in physics, Critique of reviewed literature and Summary of the chapter.

2.2 Inquiry-Based Learning

Inquiry-Based Learning (IBL) is defined as a learning technique that employs hands-on activities, enabling learners to explore concepts and instructions that focus on utilizing process skills to achieve a deeper comprehension (Langat, Sifuna and Kapkiai, 2022). IBL approach involves most of the learning activities being undertaken by the learner while the teacher assumes the role of a supervisor. It is the best-suited modern approach in teaching approach in sciences such as Physics. In this study performance of learners using IBL was compared to those taught using the traditional learning approaches. Physics is a science subject offered in Kenyan high schools; its national performance in KCSE has been below average (KNEC 2015-2022). The IBL approach promotes skills among learners which can be referred as Inquiry skills which are engagement, elaboration, exploration, explaining and evaluation (Ruiz-Martin & Bybee, 2022).

Many studies have shown that teaching methodologies used in schools is a determinant of the achievement obtained in Physics. Inquiry based Learning approach (IBL) has proved to influence positive performances not only in Physics but in most subjects

learned in Schools. Aparicio-Ting, Slater and Kurz (2019) stipulated, during their study of health college students in Canada, that IBL provides students with an opportunity to take ownership of their learning while developing important high-order skills for innovative solutions to complex problems. This is in contrast to traditional approaches where the teacher is the center of attention; hence, IBL is a fully learner-centered approach. According to Aparicio-Ting, Slater and Kurz (2019), IBL can be used in designing a student-centered, inquiry-based curriculum because most research studies has shown that, learners retain information and learn much more effectively through learning approaches that put them in control (Pesqueira,2020).

In Turkey, Aktamis, Higde and Ozden (2016) reported that Inquiry-based learning method used in science education had a highly significant effects on students' achievement and their attitude increased compared to the traditional teaching methods. This is a clear indication that traditional approaches are not suitable for teaching and learning science education to the modern learner who should be in control of the learning process. This was in agreement with the results of this study, whereby the results of learners using IBL approach was better than for those using traditional approaches. This is indeed an indication that IBL approach should be embraced in our classrooms.

IBL is not a new concept to most teachers especially in Kenya, but most of them have not fully embraced it because it is not part of the curriculum in place, especially in senior secondary schools, where the Curriculum-Based Education (CBE) is yet to be rolled out. This is also the case in Indonesia and Malaysia, where there is no formal guidance on how to implement IBL in classroom learning; hence, teachers carry out learning activities that, according to them, align with the philosophy of inquiry-based Learning (Halim, Ramli & Nasri, 2018).

IBL can be implemented in Physics practical lessons to determine its impact on results for both genders, considering that enrollment in physics has attracted few female learners. Biology which is done by almost all learners, showed that the performance of learners in Nigeria is similar for both male and female learners (Dogo, 2017). This finding is in agreement with Adejo (2015), who reported that the Inquiry method of teaching was effective for both male and females, enhancing their academic performance.

The IBL approach is a student-centered approach that has not been fully embraced but is slowly gaining ground in African classrooms. In South Africa, Van Graan (2020) found out that teachers initially did not embrace the Inquiry-Based approach because they believed that the learners were lazy and could not take responsibility on their own. However, when the approach was introduced in classrooms, it was discovered that learners enjoyed the learning process because they became more cooperative and very active participants than before. This was in agreement with Ramnarain and Hlatswayo (2018) while conducting research in a rural school in South Africa reported that teachers did not implement the IBL although they had a positive attitude towards the approach, they cited challenges such as inadequate laboratory facilities, time to complete curriculum and large classes as the reason for not incorporating IBL approach. Apart from South Africa, other African Countries, such as Rwanda, Kenya, Tanzania and Uganda have introduced and implemented Competence Based Curriculum (CBC) in their education systems. A Competence-based curriculum supports the IBL approach; however, most teachers in Rwanda have not fully adopted it because they still employ traditional teaching methods at the expense of IBL, despite being aware of its benefits. (Dusabimana & Mugabo, 2022).

The IBL approach has also been used in art-based subjects such as History and Geography. Inquiry Learning has been shown to support cognitive development, reducing the need for students to cram and instead leading to a deeper understanding of content in History and Government subject (Langat, Sifuna and Kapkiai, 2022). This suggests that this approach is not only important in science-based subjects but in all secondary school subjects. This may be an alternative to rote learning which involves a lot of cramming the subject content rather than mastering it. Research done in use of Geography by Maonga (2015), implied that students performed better in Geography Mapwork when taught using reflective inquiry-based approach in addition to the traditional methods of teaching mapwork since reflective learning learner acquires the willingness to be engaged in the learning process. The inquiry-based approach has proven to be a motivating learning methodology among students. IBL in teaching Physics makes students find learning enjoyable, and it influences self-concept as one of the learning outcomes. Students engage in more reading on topics they had not previously clearly understood, driven by developed motivation (Gathage, Embeywa & Koech, 2021). This was in agreement to Wabuke (2016), who concluded that Inquiry based learning brought about positive learning outcomes on acquisition of science skills since it provided an environment that encouraged students to be active participants as they took responsibility for their learning.

Poor performance has been attributed to teacher-centered learning methodologies, so teachers have been encouraged to use IBL approaches in teaching Practical lessons in sciences, as it is associated with improved attitudes and self-efficacy among the students (Nzomo, 2023). Gathage, Embeywa and Koech (2021) agreed with this sentiment recommended rewarding teachers who use the Inquiry-based Science Teaching approach, as it improves students' inquiry skills of engagement, elaboration,

exploration, explaining and evaluation. These skills were practiced by the learners using the Inquiry-based approach during this study. The skills were applied in process starting with engagement as the initial process, then exploration, explaining, elaboration and finally evaluation. To enable the implementation of the IBL approach, the government led by KICD, should train teachers to implement the approach and incorporate it into the curriculum for teacher trainees. Capacity building is the best way to train teachers already in the profession, especially those used to traditional teaching and learning methods evident in the 8:4:4 curriculum.

2.3 Inquiry-Based Approaches

Inquiry-based Learning Approach is a learning technique that allow learner be in control of the learning by incorporating hands-on activities. The IBL approach is preferred in modern learning over traditional learning approaches, which include exam-oriented learning, the Lecture method, and chalkboard presentations, whereby the learner is a passive recipient of knowledge (Tularam, 2018). For Inquiry-Based Learning, the process of learning and knowledge is evaluated on an ongoing basis (Khalaf & Zin, 2018). This is in contrast to the traditional method currently common in the 8.4.4 Kenyan curriculum where evaluation is summative. Examples of Inquiry-based Learning approaches are Project-based Learning, Problem-based learning, discovery learning, inquiry circles and exploratory learning. Inquiry circles, on the other hand are an approach common in classrooms; they involve learners holding discussions in groups, which are referred to as circles in this context. Learners discuss, research, and share ideas within their circles, which are preferably created by the teacher based on of their academic strengths. This is common during revision learning where the teacher gives out tasks where learners use the knowledge previously acquired to come up with solutions collaboratively, this collaboration and team work has a positive impact among

learners as it can develop competencies required in real-life situations, according to Fandos-Herrera et al (2023).

From these approaches, very important skills are developed by learners, which are engagement, exploration, explaining, elaboration and evaluation (Bantaokul & Polyiem, 2022). In the context of this study, the approach studied was exploratory learning. In this approach, the learners performed experiments in groups, then discussed the results and then shared their findings. The teacher's role was to facilitate learning while the learner was in charge of seeking answers to the problem.

According to Kokotsaki, Menzies and Wiggins (2016), project-based learning is an active student-centered form of learning. In this case, as the name of the approach suggests, a project is done by a learner, involving investigations where skills of collaboration, communication and reflection are acquired. A learner undertaking a project task will be actively involved in the learning process as most of the activities are performed wholly by the learners with the guidance of an instructor. Project based learning is one of the inquiry-based approach used in learning, it is considered as an alternative to traditional approach as it has shown improved academic performance (Chen and Yang, 2019), this was in agreement with study done by Argaw, Haile, Ayalew and Kuma (2016) who found that project-based learning improved students' achievement.

The project-based Learning approach has been shown to improve students' motivation and improve their problem-solving ability (Chiang & Lee, 2016). This is due to the learner's involvement which, when it yields positive results, encourages more input. Skills such as problem-solving ability is best acquired when the approach is incorporated in learning process.

Discovery learning is another inquiry-based approach in which learners are in control of their own learning. The approach encourages students to discover information. Studies conducted by Martaida, Bukit & Ginting in 2017 showed that cognitive abilities of students taught using discovery learning were better than those of students using traditional approaches. Discovery will enhance thinking skills such as reasoning and using concepts to solve scientific problems. The concepts acquired in the classroom by the teacher are put into practice when learners are led to discover information.

For the Exploratory learning approach, learners are involved in a learning activity that enables them to explore and investigate. For example, in a science class, learners perform an experiment to investigate the outcome of a task independently, and the teacher acts as a facilitator. In this study, an exploratory approach as one of the IBL was used, the results obtained indicated that the performance of learning using the IBL was better in comparison to those learning using the traditional learning approaches. The approach was necessary in this study since all good science is the result of exploratory research (Swedberg, 2020).

2.4 Inquiry-Based Learning Skills

The skills can be summarized by 5Es inquiry model cycle activities according to Bantaokul & Polyiem, (2022) as shown in Figure 2.1

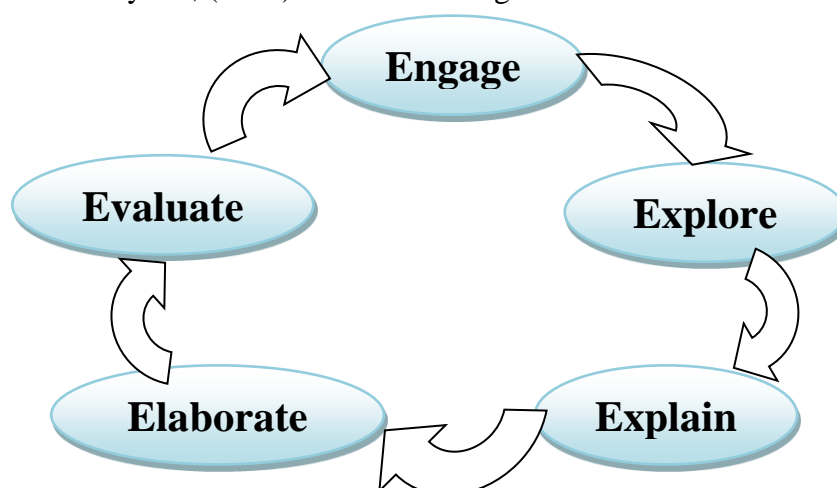


Figure 2.1 5Es Inquiry Model Cycle

The instructional model cycle is used when inquiry-based approaches are used. They include: Engage, explore, explain, elaborate and evaluate. Engage comes first, followed by exploration, then explanation, then elaboration and finally evaluation.

1. Engage

This is the initial phase, where the teacher introduces content to learners by asking questions and providing engaging activities (Kulapian, Polyiem & Chittranun, 2023). At this stage, the teacher captures the learners' attention to the concept being learned, which can be achieved by introducing a challenge to be solved. In this study the task given to the learner involved a practical from the topic on Refraction of Light on determining experimentally the refractive index of a material. Activities given to learners should make a connection between past knowledge and present, and organize learners' thinking towards learning outcomes of the current lesson (Wabuke, 2016) Students can share experiences, or the teacher can introduce a concept to be learned.

2. Explore

During the exploration phase, the learner's attention has already been directed to the current lesson, having been established during the engagement phase. At this stage, the teacher guides the learner in searching for information related to the concept being learned (Bantaokul & Polyiem, 2022). The best way to search for information in a science subject such as Physics is through experiments, so the teacher sets up practical activities where learners get to learn much information to the concepts being learned. During this process, learners collaborate and engage in discussions as they participate

in hands-on activities. In this study learners were placed in groups of five learners, where they collaborated as they performed the experiment.

3. Explain

The third stage involves summarizing the information obtained during the exploration stage. A teacher can provide a forum for group discussion where learners can discuss information collected during experiments. During this study the data collected was recorded in tables, for instance angles of sines of incidence and refraction were recorded.

4. Elaborate

Elaborate is the fourth stage, where students apply the concepts and procedures learned to solve new problems (Ruiz-Martin & Bybee, 2022). Activity during this stage may include group discussions where learners share information. This stage involves the learner taking initiative in solving problems after the practical activity. For instance learners determined the refractive index of a material from the results obtained in the table.

5. Evaluate

The final stage involves evaluation, as noted by Bybee (2019). During this stage, the teacher evaluates students' learning outcomes, assessing their understanding through the administration of tests or by observing the learner's behavior.

2.5 Traditional Learning Approaches

Traditional learning approaches have been employed for a long time in teaching and are gradually being phased out due to their limitations in achieving learning outcomes. In

this approach, mostly the teacher stands in front of the classroom and learners are seated as passive listeners (Tularam, 2018). The input of learners is limited and they only become inactive recipients of knowledge as is mostly the norm in the senior secondary schools still using 8.4.4 curriculum in Kenya. The teacher-centered approach focuses on what the teacher will do as opposed to learners since the teachers is viewed as the supreme source of knowledge (Otukile-Mongwaketse, 2018). These traditional learning approaches may be necessitated by reasons such as; rush to complete the wide overloaded curriculum and the heavy workload, which teachers are accustomed because of the inadequate teaching manpower. These reasons were also reported by teachers of Physics during this study. In the context of this study, Traditional teaching Approaches are methods commonly used by teachers of Physics which include; question and answer method and the Lecture method. The result of the traditional learning approaches has led to rote learning which involves memorization of information and exam-oriented learning. For exam oriented learning attaining of good grades is given priority as opposed to content delivery in line with the established education goals.

Rote learning, which involves memorization of content, is a traditional approach commonly used in most classrooms during learning. Ishartono, Nurcahyo and Setyono (2019) defined rote learning as a method where students learn by memorizing information. Memorized information is not retained for long, and there is a lack of understanding. In this case, the memorization may be solely for sitting an exam. It is only beneficial when information is urgent and temporary; hence, it is ineffective for subjects with mathematical concepts, such as sciences, specifically Physics. Yadav (2022) highlighted rote learning made learners to demonstrate knowledge and correctly remember procedures but majority of them were only satisfied by creative learning that did not involve a lot of memorizations as it made them to be in control of learning

process, from Yadav study its clear that science learners do not prefer rote learning and can love to have an alternative form that make them creative and be in control. Rote learning is more appropriate to other fields of study involving memorization for example in Literature during poem and songs recitation.

The 8.4.4 curriculum, introduced in Kenya in 1985, is being phased out by the Competency Based Education curriculum (CBE). The 8.4.4 curriculum had majorly focused on teacher-centered approaches and was criticized by experts for being mostly exam-oriented and not achieving the current industrial needs. According to Kaviti (2018), the 8.4.4 curriculum guiding Philosophy was education to create a self-reliant student ready for a blue-collar job market; however, education stake holders later realized the weaknesses of the curriculum and recommended its change (Basic Education Curriculum Framework Report, 2019). Most nations worldwide are coming up with changes in their curriculum from traditional teaching approaches to the modern approaches suitable in the 21st century which are mostly learner-centered.

An exam-oriented approach has been the case in Kenya, where too much focus has been centered on achieving good grades. Teachers have been pressured to produce good grades in order to receive rewards, such as rewards, job promotions, among others. Exam-oriented approaches have not effectively addressed the acquisition of practical skills in learners; they have been regarded as a requirement for a brighter future, leading to cheating facilitated by teachers, parents and other education stakeholders, repetition of classes, and high dropout rates (Mackatiani, 2017). Students' unrests have also been the case in situations where learners have been pressurized to outperform beyond their ability. Previously, the ranking of the best-performing schools led to much competition, where topping the list was a priority over quality learning.

2.6 Students' Perception and Performance of Sciences

Students Perception is defined as the general view or feelings towards a certain phenomenon that may be true or false, while Performance is the results obtained after evaluation. In this study, performance refers to the results obtained during the Kenya Certificate of Secondary Education (KCSE) administered by the Kenya National Examination Council (KNEC) released annually. Good performance in the context of this study is the result of a grade of C+ or above, while average performance refers to grade of C and poor performance as the grades below C. Results for science subjects administered by KNEC have not been above average as reported in KNEC Reports of 2013-2022; this may be due to the perception held by some learners. Perception towards a particular subject influence how the performance will be. If the perception towards a particular subject is positive, studies have shown that good performance is produced. Mathematics is a compulsory subject in Kenyan Primary and secondary schools. It is a subject necessary for promoting economic development in developing countries which require skilled technical manpower (Schulze & Bosman, 2018). Technology experts and most professional required to work in industries must have mathematical knowledge, which is why it's an important subject for economic development in developing nations such as Kenya. Students' perception of a learning area affects their academic performance; more specifically, their attitude towards mathematics can impact their overall performance in other learning areas. According to (Daud, Adnan, Aziz & Embong, 2019) they alluded that, those students with positive perceptions towards mathematics, their attitude seemed to have been shaped by how they defined mathematics in their minds and importance they attached to their lives. It seems learners may develop a feeling that the subject is not very important to their future life; this is a fallacy that may have developed from their environment. Indeed, perception may be

judged by the information students get from their senior fellow students. (Chauhan, Bhadouria & Bhakar, 2017) opines that students' attitude and perception towards mathematics can be improved if students understand its usefulness and if parents pay attention to their academic performance. Close monitoring of parents can help dispel incorrect information concerning Mathematics, which leads to poor judgment. Parents' role should be to provide the necessary assistance, such as remedial help to their children to boost their performance. Performance in mathematics is poor if the student's perception of their teachers' characteristics is negative. Schulze and Bosman (2018) suggested that students who preferred mathematics also preferred reading, writing and group learning in the classroom. Hence, learning approaches matter a lot in developing a positive perception among learners. Hence, teachers should use teaching methods that accommodate various learning styles, mostly of which are learner-centered. Langat, (2015) in her study found out that students had positive attitude towards mathematics which they believed it was doable and their level of motivation was affected by competencies in previous performance. Teachers and parents play a crucial role in demystifying the negative perception of mathematics, which can lead to improved performance.

Chemistry is another science subject sat at Kenyan national exams by more than 98% of candidates (KNEC Report, 2013-2022). Its performance has been poor as shown in the Table 2.1. In the context of this study, a performance below a mean of C plain is considered poor performance. Various studies have eluded the negative perception developed by learners as a result of the poor performance.

Table 2.1: Subject Means for Sciences in KCSE 2021-2023 in Kesses Subcounty

Subject	2023	2022	2021
Physics	2.85 (D plain)	2.61 (D Plain)	2.60 (D Plain)
Chemistry	2.29 (D-)	2.11 (D-)	2.03 (D-)
Biology	2.77 (D)	2.66 (D)	2.90 (D)
Mathematics	2.20 (D-)	1.61 (D-)	2.17(D-)

Source: Kesses S.C.D.E

Negative perception may result due to the teaching methodology used in classroom learning. Folounrunso and Sunday (2017) in their study found out that students performed better when taught by guided discovery method compared to demonstration teaching method. Guided discovery method is learner centered while the teacher guides the learner in the learning process, in this process the learner feels motivated because he or she is in control of the learning. This is in agreement with the adopted Competency-based curriculum (CBC) in Kenya, whose one core competence is critical thinking and problem solving that enhance discovery learning (KICD, 2019). Competence-Based Education (CBE) encourages the learner be in control of the learning process as opposed to the traditional approaches where the teacher was in control and learner was just a passive recipient of knowledge. This was in agreement with Chepkwony (2019), who opined that experimental learning in laboratories enhanced positive perception in learning areas. This was in agreement with results obtained in this study, whereby, performance of learners using IBL approach during the experimental topic on Refraction of Light was better in comparison to those using traditional learning approaches. A part from learning methodology used in teaching; students' performance is also caused by other factors for example shortages of trained teachers these results to overloaded workload among the available teachers. This limits teacher from reviewing students work as opined by Hassan et al (2015).

Chemistry requires practical lessons hence a school must have a fully equipped laboratory. Therefore, it is recommended that sufficient resources must be provided in schools to enhance chemistry teaching and learning. (Mwangi, 2016) found in his study that Chemistry practicals improved performance, as they made learning more enjoyable. In Kenya, Chemistry teachers are highly trained, but due to the dynamic nature of the world, more regular in-service training of science teachers should be encouraged to enable them to conform to emerging technologies in pedagogy (Musau and Abere, 2015).

2.7 Students Perception in physics

Perception is defined by Karuru, Anshari and Gani, (2021) as a process of observation that creates knowledge obtained, interpreted through vision and experience to produce a view on something. Students have different perceptions globally towards physics. They can either have a positive or a negative perception. A form of learning may influence the perception learners have. The extent to which students perceive physics concept as difficult or not depends on the manner in which it is taught and students' performance. (Taangahar & Okwori, 2022). Akogun, Nwona and Obo (2020) reported in their study that the perception of physics concepts as difficult was due to their abstract nature, complexity and the teaching methodology adopted by teachers. From the study, its clear that teaching approaches used in learning Physics have an impact on the perception. Male students have been reported to perform better than girls in Physics, which is attributed to their greater numerical proficiency compared to females (Uwem & Mcmillan, 2016). It's believed that male students are better at mathematical concepts than their female counterparts. This should not be the case since both males and females are taught the same way, and neither is accorded special treatment. Many topics are taught in physics subject, concept areas in physics perceived as difficult by students

tend to result in poor performance in those areas, this was found out by Akogun et al (2020) and agreed by Bello, Opaleye & Olatunde, (2018), who alluded that a concept considered difficult by students will result to poor understanding of such concept. Some of these areas that are poorly performed may not be difficult, but the methodologies used by teachers may make them appear difficult. Akogun, Nwona and Obo (2020) recommended the use of experiments in learning and suggested that sufficient time should be allocated for students to engage in the activities. This is because Physics, being a science, requires a lot of practical activities, as this improves performance and attitude among learners. Difficult learning areas leading to poor perception are those considered abstract, with symbolic representations, lacking concrete examples, and requiring numerous calculations (Bello, Opaleye & Olatunde, 2018). Mollel, Minani, Mbwile and Wakumire (2022) reported that few students had a positive attitude towards physics in Tanzania. They recommended that teachers use a variety of teaching methods to increase learner's interest. The teaching methods to be used should be student-friendly, hence the learner's interest is very important in designing curriculum instructions. College students pursuing physics have also been reported to have a negative perception. Rufus, Daniel and Asarhasa (2021) found out that college students developed this due to the abstract nature and teacher-centered learning approach, as opposed to a learner-centered approach. They recommended that the remedy for the situation is the improvement in teaching methodologies. (Asare, Mabee, Haruna & Salifu 2021) opined that student who did physics as an elective subject should be the only ones allowed to pursue it in tertiary institutions; this should be the case even if it's offered as a basic unit to prevent poor performance. Learners, at times, can consider physics, boring if they think it is irrelevant; they may be wrong or right. Students in basic education considered physics boring because they

believed it did not relate to real-world experience and the effort required for learning. (Mbonyiryivuze¹, Yadav & Amadalo, 2021). The back stops with the teachers of physics in improvement of perception of student towards positivity, according to (Humphrey, Nartey, Appiah, and Aidoo, 2023) they allude that regardless of how well-resourced a school is teaching strategies employed by physics teachers determine the good performance this is also agreed by Asare, Mabee, Haruna & Salifu (2021) who suggested that physics tutors should use innovative strategies to make learning of the subject interesting and attractive. This is the main reason why the Kenyan curriculum learning methodology, as advocated by the newly rolled CBE is learner-centered. (Kiruki & Orodho, 2015) recommended in-service training for physics teachers was important to improve their skills, periodically retooling has been conducted by the Ministry of Education in conjunction with CEMASTE A to improve the teaching and learning methodologies in sciences in Kenyan Secondary Schools. In Kenya Physics was made a compulsory subject in Form 1 and Form 2 in 1984 (Kiptum, 2015), but it is an optional subject in Form 3 and Form 4 classes. It is reported to have attracted about 30% of the candidature, despite its performance being better than that of Biology and Chemistry over the last decade. (KNEC Report, 2013-2022). Physics is closely related to Mathematics and often involves solving problems; success in mathematics tends to foster a positive attitude towards other subjects that require mathematical solutions. On the other hand, negative attitude can also distort the perception of information and affect the degree of retention, leading to poor performance of the subject.

In psychology, attitude is a collection of feelings, thoughts, and behavior towards a specific thing, person, or event. (Assem et al 2023). These feelings may have originated from those students interact with on a daily basis, such as teachers, other learners and parents. For instance, some of these students may have received negative comments

from the society they are in, for example, parents can negatively comment about the subject, hence learners justifying their failures.

2.8 Challenges experienced by Students towards Physics

There are many challenges perceived by students that hinder most of them from performing well in Physics or achieving higher enrollment rates compared to other subjects. Physics is a crucial subject in a world where technology is continually advancing. All college students must have studied physics in secondary education, as it is a prerequisite for advanced STEM courses at the Tertiary level of education, such as engineering and technological fields. With the increased integration of technology in teaching and learning, schools have begun to utilize technology in their instruction, and this has presented some challenges to learners. It can make science learning more authentic for learners familiar with technology, but can be frustrating for those who are not (Hamerski, McPadden, Caballero & Irving, 2022). Hamerski et al. (2022) go on to list the challenges of computation in physics among learners in the United States of America as follows: Stress and frustration, feeling worse in physics class and interpreting codes. Technology can make physics learning more relevant and linked to real life; the challenge is preparing teachers to use technology in teaching effectively (Ellermeijer & Tran, 2019), but are all teachers fully conversant with the use of Technology in teaching and learning of Physics? A well-trained technology teacher will deliver the content effectively in a manner that is friendly to the learners. Djudin (2018) after realizing low declining enrollment as learners advanced to high levels of learning conducted a study to find out factors causing learners to be disinterested in physics in senior high schools, he found out the reasons were: Lack of familiarity with the subject, most learners regarded physics as the most difficult science subject; it was also found out that rote learning was used in teaching and learners were afraid of studying physics

and then fail, in rote learning, rote learning is a traditional learning approach which involves memorization of content possibly for sitting for exams. In South African, students face challenges in learning physical sciences, which include Physics and Chemistry. The challenges, as highlighted by Ogegbo, Gaigher and Salagaram (2019), included an inadequate number of physics teachers and insufficient support from school management, which hindered effective lesson delivery to students. Inadequate teaching staff seems to be a challenge in most African countries, this is due to increased number of students as a result of introduction of universal primary education, however this increase has led to rapid expansion of educational facilities which in turn has led to compromising the quality of science teaching in many African countries (Ogunniyi & Rollnick, 2015).

Since the independence of most African nations, the majority of them have had the challenge of a shortage of qualified teaching staff in their schools. To mitigate the challenge of teacher shortages, some African countries are developing policies to integrate Information and Communication Technology (ICT) into teaching and learning. Many countries in Africa are now adopting the mastery and understanding of ICT skills and concepts (Barakabitze et al, 2019). In this era of information age, the use of technology to solve challenges faced by physics students is inevitable.

In Kenya, the Teachers Service Commission (TSC) rolled out a pilot virtual lesson that would allow schools to share tutors and allow learning to continue even during a pandemic like COVID-19. Mwambela, Mondoh and Thoruwa (2019) in their study on challenges of ICT in teaching Mombasa students highlighted that the biggest threat to the implementation is that most teachers are not well trained to teach using ICT and they lack the time to prepare ICT-integrated lessons because it requires much time. The schools were also reported to lack resources to support learning using ICT.

Good health is paramount in school environment and learners will be only be able to attend lesson if they are well fed, proper nutrition increase cognitive development as reported by UNESCO (2025) report. Therefore, there is need to have a sufficient government policy that supports healthier learning populations such as school feeding programs in schools located in less privileged areas.

In a study conducted by Nteere, Kwaria and Kirimi (2017), the physics students claimed that the subject was challenging to them due to the difficult mathematical concepts taught. This needs to be addressed by teachers teaching physics to deliver content in a learner-friendly manner that motivates instead of discouraging them. Secondary school physics has forty-one topics in total from form one to form four, however there are some topics considered more difficult by learners in comparison to others, according to Kiptum (2015), students considered Electrostatics I, Waves I, Electrostatics II, Waves II and Sound as some of most challenging topics because they lacked concrete examples and required a lot of mathematical calculations. Kiptum (2015) went on to recommend that curriculum developers introduce topics handled through practical methods to encourage hands-on activities, rather than relying too heavily on abstract theoretical knowledge, and utilize psychologists to help students develop a positive attitude towards physics. When learners are taught in a learner-friendly approach, their attitude towards Physics is positive, which can positively, which can positively impact their performance.

2.9 Challenges experienced by the Teachers.

Teachers joining the teaching profession are reported to be inadequately prepared while those already in the service have received little support of professional development (Bett, 2016). Teachers grow professionally when they collaborate with colleagues (Wambugu, Stutchbury & Dickie, 2019). Workshops and seminars organized by

education stakeholders are very important as this serves as a socialization opportunity. Teacher's bond, share their experiences and challenges. Through this collaboration they also share possible solutions amongst themselves. There are numerous challenges which teachers experience during the teaching and learning processes. Many studies have identified challenges which most seem to be common in most teaching environments. For example, in Kenya English is used as a secondary language and this has posed a great challenge to the education setup. A learner who has another primary language which mostly likely is an indigenous one has negative attitude towards English language. This has posed a great challenge to teachers of English subject (Anyiendah, 2017). Comprehension of the content has been a daunting task for learners to fathom. Okoth (2016) went on to highlight challenges of implementing the English language as; Inadequate resource materials, inadequate teacher professional development, content overload and overemphasis on examination whereby teachers taught only for learners to pass the examination instead of achieving learning objectives. The current modern education policies encourage creativity and critical thinking among learners as opposed to the rote learning and memorization of facts (Urbani, Roshandel, Michaels & Truesdell, 2017). In the current 21st Century an effective teacher is changing from being the only one active in class to allowing the learner be in charge of learning activities. This method is referred to as student centered method of learning and has been highly encouraged by experts.

The current CBE education system which is learner centered currently implemented at Primary and Junior schools has brought its own share of challenges such as resistance from stakeholders. This resistance is due to inadequate resources to prepare teachers for the new curriculum, Genvieve (2017) asserted that failure to effectively prepare teachers affected learning. Mandillah (2019) asserts cost of teaching and learning materials and Inadequate teachers in schools affects learning. This has been the case in Kenyan Junior schools where inadequate teaching staff is still a challenge experienced

by the government of Kenya. Review of curriculum from time to time is essential as it helps the curriculum experts review the design for the best interest of the learner. Teachers have previously reported to have spent a lot of time in implementing the teaching curriculum (Haug & Mork, 2021). This is a major challenge especially to nations with inadequate manpower and learning resources as it can compromise quality of education.

In modern times, the ever-changing technology which becomes sophisticated as the days continue is another challenge. Information Communication Technology (ICT) infrastructure is expensive to install and maintain, due to this, most learning institutions lack internet connectivity. Challenges due to technology include lack of competent teachers in digital literacy, inadequate ICT infrastructure and lack of e-learning policies, (Kibuku, Ochieng & Wausi, 2020). As Malik (2018) puts it, we can never have the future with the education of the past. ICT infrastructure to be introduced in learning should be equitable and sustainable ensuring safety of learners (UN Education Report, 2023), this is essential cognizant to the emerging issues such as cyberbullying which is rampant in the 21st Century.

To secure the future which shall have advanced technology, the system of education must resonate with it because we cannot run away from the new advanced technology. Some teachers are not conversant with Information communication and technology (ICT) devices. This may be due to challenges such as inability of schools to install latest ICT infrastructure or lack of interest among the teaching fraternity. In the current 21st century, the teacher must be equipped with knowledge of technology and use it in teaching. Improved technology has helped transform teaching from teacher-centered to learner centered (Jan, 2017).

African schools have unique challenges in comparison to western nations. Du Plessis and Mestry (2019) reported that rural schools failed to attract trained teachers due to the poor environmental infrastructure. This has resulted to unqualified teachers being employed by school management to fill the gap, this is a serious issue because the rural school cannot compete fairly with developed ones in urban areas. Teachers have low morale and lack motivation due to their low pay in Africa, in some cases people who fail to find other jobs end up becoming teachers as a default career opportunity (Du Plessis & Mestry, 2019). African governments need to review teachers' salaries so that the job becomes competitive attracting highly qualified educated populations with high grades as is the case in countries whose education systems have succeeded such as Finland, Singapore, South Korea and Japan. These countries enroll graduates for teaching courses who have the best grades, control the enrollment number and pay teachers very high salaries. This has made education earn the highest respect in those nations. (Malik, 2018).

2.10 Enrollment in Physics

Physics subject in Kenyan secondary schools is introduced in Form One, but it becomes an elective, examinable subject from Form three to Form Four. In Forms one and two, it's pursued by the majority of learners. Towards the end of form two class, most learners decide to either continue with the subject or drop it. In Kenya, over the last decade, physics enrollment has been low. Though the enrollment is low in comparison to other sciences the number has been increasing annually. Kenyan government reported an overall increased annual enrollment of KCSE candidature by 17.42% (Education Sector Report, 2023), from this KNEC reports indicate that approximately 30% of candidates sat for physics exams over the last decade. This low enrollment has been a cause of concern to many researchers, who have sought to identify the cause of

this situation and recommend possible solutions. This is not only a national concern but also a global issue, as indicated by the previous studies on enrollment in Physics by learners. Chang, Kohler, Ard and Mathis (2018) found that high school physics enrollment in the United States of America was low compared to other science disciplines, primarily Chemistry and Biology. Parents' education level was also another factor affecting enrollment. They found that students from a background of educated parents, especially those with a father, were positively impacted by enrollment. Parents with advanced education levels offered guidance to their children, who had the option of choosing to drop or continue pursuing the subject. Fathers became role models influencing their children to pursue Physics, which has traditionally been male-dominated field. In Nigeria, Adolphus (2016) conducted a study to determine the school-based factors that influence enrollment. It was found that teachers' qualifications, resource availability and teaching strategies used by teachers influenced the enrollment of physics at senior secondary schools. Qualified teachers are skilled in content delivery; however, the same teachers should also undergo capacity-building workshop training, as this helps to improve their teaching and motivates learners to pursue Physics at advanced levels. Adolphus (2016) recommended provision of facilities such as equipped laboratory facilities because many learners opted to drop physics due to few practical sessions. From this study, it's clear that learners can learn effectively if the school environment is adequately equipped with the required teaching and learning resources. To improve Physics enrollment, Adolphus (2019) recommended making physics a compulsory subject at all levels of high school, and this was to be made possible by designing a 'science for art' module to accommodate art students. This was in agreement with Omar (2017), who also opined that resource availability and pedagogical approaches determined enrollment of physics in Wajir,

Kenya. From the studies discussed above, students whose Physics lessons are frequently done in the laboratory, which has adequately available resources, perform better. This demonstrates that practical lessons are crucial for physics students.

The teaching style of the physics teacher is critical to the future enrollment. Delivery of the content should be in a manner that encourages and motivates learners to enjoy the subject. Teaching with an attitude that Physics is a subject reserved for a few elite learners makes the weak ones feel out of place. Physics is an science subject which requires practical session on weekly basis. If learners are not having sufficient practical sessions in their schools, performance will be poor. This in the long run could lead to low future enrolment. Having practical classes and establishing Physics clubs will encourage learners gain 'hands-on experience', leading to more learners liking the subject. According to the studies conducted, it's a fact that enrollment in physics is lower compared to other science subjects, and this can be corrected if the teaching methodology is improved by teachers of physics. This study examined the IBL teaching approach, will advocated for practical learning sessions.

2.11 Critique of the Literature reviewed

This chapter aimed to examine the studies conducted by researchers in the area of Physics teaching approaches, Student's perception, Performance and challenges experienced by students. Most researchers agreed that the methodology of teaching science subjects has a profound impact on retention and performance. Folounrunso and Sunday (2017) found in their study that students performed better when taught using the guided discovery method compared to the demonstration teaching method. Many studies have shown that experimental learning in laboratories enhances a positive perception of chemistry. Rote learning has been widely used, especially in Kenyan

schools, due to various challenges, such as a high workload and limited availability of qualified science teachers. To improve the skills used by teachers, in-service training was introduced through the CEMASTEIA program. In-service training enables teachers to conform to emerging technologies in pedagogy (Musau & Abere, 2015). This was in agreement with Kiruki and Orodho (2015), who opined that in-service training for physics teachers improved their skills. On the contrary the objectives of the training have not been achieved as reported by Okono, Saiti and Awuor (2015) who eluded that CEMASTEIA training has been emphasizing use of experiments in teaching of Physics; however, with the high teaching load among the inadequate available teachers, they have been performing fewer experiments. In-service training improves the skills of teachers, but they may not utilize the skills due to the unresolved challenges experienced in the secondary schools. The performance of Physics in National examinations has also been below average, as reported by Mulambe (2017). Encouraging experimental methods of teaching is the best way to enhance learning since the extent to which students perceive physics concept as difficult or not depends on how they are taught and students' performance (Taangahar & Okwori, 2022). This literature shows that little study has been done on IBL approach in Kenya on Physics, Gathage & Koech (2021), did a study in physics but did not narrow to a specific topic, they find out that Inquiry approach is effective in improve students' academic performance, A study that was conducted to a specific topic was done by Njoroge & Changeiywo (2014) who found out that students attained higher scores in the topic of Magnetic Effect of Electric current when IBL was used in Learning. This study focused on comparing the performance of learners using the IBL approach, specifically the exploratory approach, to that of learners using Traditional Learning approaches in a topic on Refraction of Light a topic covered in form three.

2.12 Summary of Chapter Two

This Chapter consisted Literature review. The review was conducted under the following subthemes: Inquiry-Based Learning, Inquiry-Based Approaches, Inquiry-Based Learning skills, Traditional Learning Approaches, Students' Perception and Performance in Sciences, Students' Perception in Physics, Challenges Perceived by Students towards Physics, Challenges experienced by teachers and Enrollment in Physics. On Inquiry-Based Learning, studies on IBL approaches were highlighted. Students' performance was highlighted where most studies were in agreement that a negative attitude towards Physics resulted in poor performance. Various challenges faced by learners, such as the use of abstract concepts and difficult mathematical concepts were discussed under the subtheme of challenges. Challenges faced by teachers in their profession were also highlighted such as heavy workload, inadequate teaching and learning resources, inadequate teacher professional development on modern teaching methodologies, low teachers' salaries and ever dynamic sophisticated technology. On enrollment, it was increasing annually but most studies showed that enrollment of physics students was low in comparison to other science subjects, such as Biology and Chemistry. Finally, the Chapter ends with a Critique of the literature reviewed.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter covers the research methodology to be used in the study, it consists of the following; research design, research methodology, study area, target population, Sampling procedure and size, variables, data collection instruments, validity and reliability of research instruments, piloting and ethical considerations.

3.2 Research Design

Research design is a framework or a structure to be followed in conducting research (Ayiro, 2024). This research adopts a quasi-experimental pre-test, posttest non-equivalent group design method. The sampled students were split into two groups, one is a control group and the other an experimental group. Pretests was administered to both groups because it helps the researcher to determine the equivalence of the control and experimental group (Chepkwony, 2019). If the two groups are of equal ability the research continues. After the pretest the control group was taught using the traditional approaches which are usually teacher centered approaches such as rote learning and Lecture method while experimental group taught using the Inquiry Based Learning (IBL) approach, IBL approaches are numerous such as Project based Learning, Problem-based learning, discovery learning, inquiry circles and exploratory learning. In the context of this study the IBL approach used was exploratory approach. In Exploratory IBL learning approach learners are involved in a learning activity that makes them to explore and investigate using hands on activities such as Practicals. For example, in a science class learners perform an experiment to investigate the outcome

of a task on their own and the teacher acts as a facilitator. In this study exploratory approach was studied since all good science is the result of exploratory research (Swedberg, 2020). The experimental group in this case undergoes treatment which is learning the topic on refraction of Light using the IBL approach, after the treatment both groups were given posttest and the results between the two groups analyzed to see their difference. This method is appropriate because tests was administered to students of physics, then questionnaires administered to teachers of physics then the results analyzed quantitatively. This design is explained by the table below.

Table 3.1: Research Design Depiction

Group	Pre-test	Treatment	Post-test
Control group	O ₁	C	O ₃
Experimental group	O ₂	X	O ₄

Key:

C- Traditional teaching Method

X- Exploratory Inquiry Based Learning Approach.

O₁ and O₂ - Pretest

O₃ and O₄- Posttest

3.3 Research Methodology

Research Methodology is defined by Mishra & Abok (2011) as the approach in which research troubles are solved thoroughly. The study employs mixed method approach which includes both quantitative and qualitative research methods. Quantitative research is related to object that can be expressed in terms of quantity (Mishra & Abok, 2011). Tests was administered to both control and experimental groups and the

performance of the two groups analyzed quantitatively to identify their difference. Means and Standard deviations of the performance was obtained and presented in tables. The questionnaires which had structured and open-ended questions were analyzed qualitatively.

3.4 Study Area

The Study area Kesses is a subcounty is located in Uasin Gishu County in Kenya, the subcounty is one of the six sbcounties located in the County. It is a cosmopolitan area constituting of both rural and urban areas. Kesses subcounty boarders Ainabkoi subcounty to the east, Kapseret subcounty to the north, Nandi County to the west and to the south it boarders Baringo county. According to Kenya National Bureau of Statistics, (2019) Report census the area had a population of 148,798. There are 47 secondary schools in the area; five of these are private schools while the remaining 42 are public schools. The area geographically lies at Latitude $0^{\circ} 18' 7''$ North, Longitude $35^{\circ} 18' 51''$ E. The climate is usually cool and temperate conducive for agriculture. This area was suitable for the study because its performance in Physics has been below average as shown in Appendix VIII.

3.5 Target Population

Population is the entire mass of observations, which the parent group from which a sample is to be formed (Pandey & Pandey, 2015). The study targets 1009 form three students who study Physics within the 47 schools in Kesses subcounty. Public schools are 42 while the remaining 5 schools are private. From the 42 Public schools, there is no national school in the subcounty, five are extra county schools and 36 subcounty schools. There are no County schools in the areas as of 2025. From the 47 schools 6 are

boys only school, 5 girls only school and 36 mixed gender secondary schools. 3 of the mixed gender schools have been both day and boarding schools.

3.6 Sampling Procedures

Stratified random sampling, simple random sampling and purposive sampling was used in this study. Stratified random sampling was used to divide schools into three strata, Private schools, extra county schools and Subcounty schools. From each stratum random sampling was used to select schools to participate in the study. Purposive sampling was used to select teachers to be involved in the study in schools with only one physics teacher, where physics teachers are more than one a teacher was selected randomly.

3.7 Sample size

According to Cohen, Manion and Morrison (2017) a sample is a smaller group or subset which is a representative of the total population under study. A sample is a small proportion of a total population (Pandey & Pandey, 2015). Kesses subcounty consists of 47 secondary schools with a target population of 1,009 form three learners taking Physics as an examinable subject. Out of these school only 45 managed to register candidates to sit for Physics exams in K.C.S.E in year 2024. According Krejcie and Morgan formula (Chaokromthong & Sintao, 2021) a Population of 1009 requires a minimum sample size of 279.

$$S = \frac{X^2 \times N \times P(1-P)}{d^2 \times (N-1) + x^2 \times P(1-P)}$$

Where S= sample size

X^2 =chi square for one degree of freedom at 95% confidence level. =3.841

N=Population size which is 1009

P=population proportion assumed to be 0.5 for maximum sample which is 0.5

d=degree of accuracy which is 0.05

$$S = \frac{3.841 \times 1009 \times 0.5(1-0.5)}{0.05^2 \times (1009-1) + 3.841 \times 0.5(1-0.5)}$$

$$= 279$$

The table below indicates the sampling framework of the study.

Table 3.2: Sampling Framework of the Study.

Strata	Number of schools	Sampled schools
Private school	6	1
Extra-county	5	2
Sub county	36	4
TOTAL	47	7

Source: S.C.D.E, Kesses Subcounty

During the study respondents consisted of 282 students and 12 teachers of Physics.

3.8 Variables of the Study

Variable refers to a characteristic of an individual or an organization that can be measured or observed and varies among the people or organization being studied (Creswell, 2013).

3.8.1 The independent variable

The independent variable for this study was Inquiry Based learning, traditional Learning approaches and Challenges in Implementing Inquiry based Learning Approach and Traditional approaches and effect of IBL approach and Traditional approaches on retention. The independent variables were intervened by teaching methodology, teacher's workload, teaching and Learning resources.

3.8.2 The Dependent Variable

Dependent Variable for this study was Performance of Physics

3.9 Data Collecting Instruments

Data collection happens when you gather and analyze valuable information (Ayiro, 2024). For the sake of this study data collecting instruments were tests and questionnaires. Tests comprised of Test 1 as pretest and Test 2 as Posttest administered to the learners. Tests administered were the same, Test 1 was first administered to both control and experimental group then within a month control group was taught using the traditional learning approaches while the experimental was learning using the IBL approach. Later Test 2 was administered to both groups. Questionnaires which were closed and open ended were administered to the teachers of Physics only.

3.9.1 Tests

During the research Pretest and Post-tests was administered to the students. Pretest was administered to both experimental and control group and results analyzed to test their difference. The experimental group undergone treatment by being taught using Exploratory Inquiry Based Learning Approach while the control group was taught using the traditional methods normally used by the teacher of Physics. Post-tests was administered to the control and experimental group after the treatment of the experimental group. The researcher during the initial visit to the sampled schools trained the teachers of Physics to act as research assistants during the period of data collection because they issued the tests. This study is focusing on comparison of IBL approach to traditional Learning approaches on performance of students in a topic of Refraction of Light a topic in form three.

3.9.2 Questionnaire

Questionnaire refers to a method of data collection where the respondent is expected to respond to a set of questions provided. According to Pandey and Pandey (2015), questionnaires have the following merits, its economical, saves a lot of time, can cover a wide research area and it is very reliable. The teachers of physics were issued with a questionnaire to fill which was both open ended and close ended. Questions in the questionnaire were to investigate the knowledge of IBL among teachers and challenges experienced in the teaching and Learning of Physics using the IBL and TL approaches.

3.10 Piloting

Piloting is defined as a process of conducting preliminary trial tests which helps to make instruments of data become perfect. (Pandey and Pandey, 2015). According to Cohen, Manion and Morrison (2017). Piloting helps to uncover some of the challenges of the research in advance. Piloting assists to improve the reliability of the research instruments because areas that need improvement are identified before conducting the actual research. Schools to be sampled were not be piloted hence piloting of this study was conducted in Milimani Secondary School in Kiminini Subcounty in Transzoia County, the school was selected because it was located in a cosmopolitan area similar to Kesses and the learners were of the same ability as the sampled ones in Kesses Subcounty. The school performance was found to be below average. The sampled school mean for KCSE Physics exams was 3.74 (D+) in 2023 and 3.98 (D+) in 2024. The piloted school performance was a school to learners and teachers with similar characteristics to the schools to be sampled in the study area.

3.11 Validity and Reliability of the Research Instruments

3.11.1 Validity of the Research Instruments

According to Pandey and Pandey (2015) an instrument is said to be valid when it measures what it is expected to measure. The validity of the research instruments was determined by the research supervisors who scrutinized the research instruments to determine their content validity while tests used for data collection were validated by KNEC Physics examiners. Their comments facilitated revision and necessary improvements to the research instruments.

3.11.2 Reliability of the Research Instruments

Reliability refers to the degree to which a measuring procedure gives consistent results (Ayiro, 2024). A pilot study was conducted in the piloted school which was not among the sampled ones in the study area to ensure the instruments are reliable. The reliability of the tests was determined using Cronbach alpha which was 0.787 for Test 1 (Pretest) and 0.758 for Test 2 (Posttest) and questionnaire was 0.741. According to Cohen, Manion and Morrison (2017) an alpha coefficient of above 0.7 is acceptable, hence the instruments were deemed acceptable to be used in the study.

3.12 Administration of Research Instruments

During the research process a letter of approval was obtained from the University of Eldoret, then a permit obtained from National Council for Science, Technology and Innovation (NACOSTI) which is a body issuing permits to conduct research in Kenya. Letter of Authority was then obtained from County Director of Education of Uasin Gishu and Subcounty Director of Education (SCDE) before visiting schools for data collection. Letters of authorization was also obtained by the researcher from Uasin

Gishu County Government to conduct the research. Before collection of data in the schools sampled, the researcher obtained authorization from the school Principal. Physics learners and teachers of physics were inducted by the researcher before data collection for them to familiarize with the data collection instruments.

3.13 Data Analysis Techniques

Descriptive and inferential statistics was used to analyze data by use of data analysis software which were Microsoft Excel 2021 and SPSS version 25. The data collected was presented in tables and graphs analyzed by Microsoft Excel 2021 version. The difference of means obtained from control and experimental group was analyzed using t test using a Statistical Package for Social Sciences (SPSS) version 25.

3.14 Ethical Considerations of the Study

While conducting research it's the responsibility of a researcher to do his study work honestly with a lot of integrity (Adams, Khan & Raeside, 2014). During the research established conventions on ethical considerations was adhered to. The ethical conventions were Informed consent, Voluntary Participation and Confidentiality. Consent letters were obtained from relevant bodies such as County Education office, County commissioner, County Government and TSC offices. This was in line with the legal frameworks in place and regulations of University of Eldoret. Permission was obtained from the school administration from where the study was conducted. Information from respondents which involved tests was adhered to was treated with high level of confidentiality, the students did not write their names on the test nor teachers on questionnaire to maintain confidentiality.

3.15 Summary of the Chapter

This chapter discussed the research methodology to be used during the study. Quasi-experimental design was used involving quantitative and qualitative approaches. Tests were to be analyzed quantitatively and questionnaires qualitatively. The study area the Kesses subcounty in Uasin Gishu Kenya. Pretests and posttests were administered to the sampled students of Physics while questionnaires administered to the sampled teachers of Physics. Research instruments were validated by research supervisors and reliability of research instruments determined using Cronbach alpha. Data analysis was done using SPSS data analysis computer software and finally ethical considerations to be adhered were discussed.

CHAPTER FOUR

DATA PRESENTATIONS, ANALYSIS, INTERPRETATION AND DISCUSSIONS OF THE FINDINGS

4.1 Introduction to chapter four

This chapter presents the data from the study, analyzes of the data, and discusses the findings. The treatment administered to the experimental group is also explained in relation to the analyzed results of the tests. Collected data is presented in charts, figures and tables. Descriptive statistics is obtained by calculating means of tests whereas Inferential statistics independent t test samples are used to test hypothesis at $\alpha=0.05$ significance level. During analysis the collected data is described based on the objectives of the study, while answering the research questions. The hypothesis is tested by discussion of the results of t test. The challenges faced by teachers when implementing the inquiry-based learning approach was also explained. The Summary of chapter four is also explained. The analysis in this topic will answer the following questions

1. Is there a significant mean difference in the performance of Physics between learners taught using the Inquiry-Based Learning approach and those taught using the traditional learning approach?
2. What is the effect of the Inquiry-Based Learning approach and the traditional approach on the retention of Physics concepts?
3. What are the challenges faced when using the Inquiry-Based Learning approach and traditional learning approaches?

The following hypothesis guided the researcher during the study

H_{01} : There is no significant mean difference in the performance of Physics between learners taught using the Inquiry-Based Learning approach and those taught using the traditional learning approach

4.2 Research Respondents

The total number of respondents in the research was 294; from this number, 282 students were sampled, and 12 were physics teachers. The control group consisted of 133 students, and the experimental group had 149 learners. The control and experimental groups did not have the same number of respondents since the students were taken as an intact group from the particular school participating in the study. The number of boys was higher than that of girls; there were 172 boys and 110 girls.

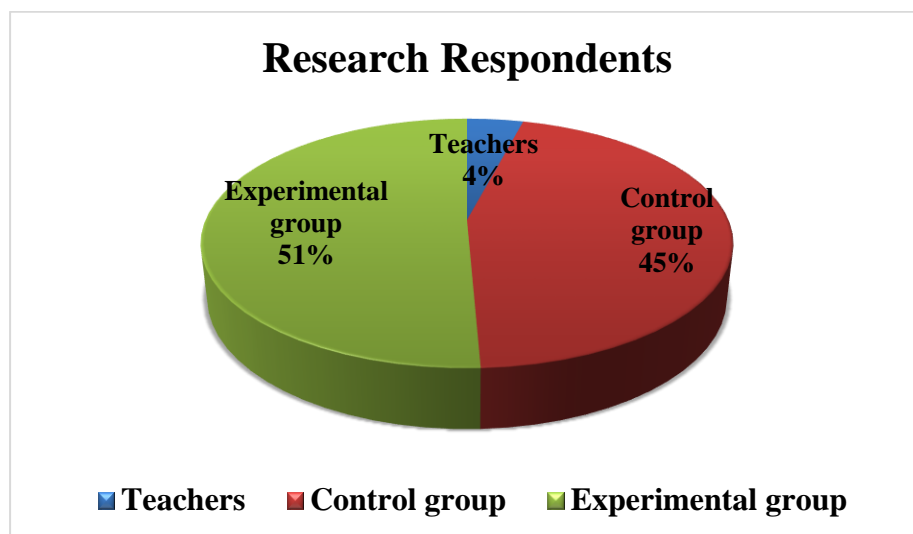


Figure 4.1 Research Respondents

From figure 4.1 shown, the teachers were 12, constituting of 4% of research respondents, the control group had 133, which translates to 45% of the research respondents, and the the experimental group consisted of 149 research respondents, which is 51% of the respondents.

4.3 Performance of Physics

The first objective of the research study was to compare the performance of student taught Physics using an Inquiry-Based Learning approach and those taught using Traditional Learning approach. The objective resulted in the research question: Is there a significant difference in the performance of Physics between learners taught using Inquiry-Based Learning approach and those taught using the traditional learning approach? And a hypothesis: There is no significant mean difference on the performance of Physics between learners taught using Inquiry Based Learning approach and those taught using traditional learning approach. From this objective, the study was conducted in the sampled schools by the researcher, from the results obtained discussion shall be based on the following stages of research.

- i. Administering of a Pre-test to test ability of learners
- ii. Treatment to experimental group
- iii. Administration of the Post-test to test the difference in performance and retention

To answer the research question from the first objective, tests were administered to the sampled learners in Form Three. Physics being an elective subject in secondary schools the sampled learners had already selected the subject as an examinable subject. The tests administered were based on a form 3 topic, namely Refraction of Light. The respondents were divided into two groups: a control group and an experimental group. The same tests were administered to both groups. Treatment was administered to the experimental group while the control group was taught using the traditional learning approaches. After treatment was administered the post test was administered to both groups.

4.3.1 Pre-Test Scores

A Pre-test was administered to both the control and experimental groups with the help of research assistants. This test was administered to test the cognitive ability of the learners. The following were the results of the Pre-tests.

Table 4.1 Students Mean and Standard Deviation in Pre-tests Scores.

Type of Group	N	Mean	Std. Deviation
Control	133	32.1805	10.79379
Experimental	149	34.6085	15.38103

The results in Table 4.1 show that the mean for the control group was 32.1805% while that for the experimental group was 34.6085%. From the results, the difference in the mean is 2.428%. The researcher subjected the control and experimental group to a t-test to determine the equality of their means and the results are presented in Table 4.2.

Table 4: 1 T test for Equality of Means in Pretest Scores.

Table 4.2: T-test for Equality of Means in Pretest Scores

	t-test for Equality of Means						
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Pretest	-1.517	280	.130	-2.42805	1.60032	-5.57824	.72214

Table 4.2 presents the results of the t-test comparing the means from the control and experimental groups. According to the table, the p-value is 0.130 which is greater than

the alpha value ($\alpha=0.05$). This shows that there was no difference between the means obtained by control and experimental groups in the pretests; therefore, the study continued as planned.

4.3.2 Treatment

After the pretest, the experimental group was subjected to a treatment in which the topic on Refraction of light was learned using an inquiry-based learning approach. The IBL approaches are diverse; in this study, an exploratory IBL approach was used. The exploratory IBL approach involves the use of hands-on activities and learner exploration during the learning process. The topic on Refraction of Light being an experimental topic the learners were involved in Practical hands-on activities. The control group learned the same topic using traditional learning approaches commonly used by teachers which are basically teacher-centered. Inquiry-based learning is a learning that employs hands-on activities that enables learners explore concepts and instructions that focus on utilizing process skills to increase a deeper comprehension (Langat, Sifuna and Kapkiai, 2022). The learners in the experimental group during learning process obtained inquiry-based skills which are engagement, exploration, explaining, elaboration and evaluation. The topic was learned according to KICD syllabus with the teacher of Physics using the Lesson Instruction Guideline provided by the researcher. In a week the learners had five lessons which consisted of three single lessons and one double lesson making the total number of lessons to be 20 lessons. After the period of four weeks both groups were subjected to post test.

4.3.3 Post-test Scores

Posttest was then administered to the control group and experimental group after a month of learning. After the pretest the Control group was taught the topic on retraction

of light using traditional learning approaches which are teacher centered methods such as lecture method, while experimental group learned using the inquiry-based learning approach specifically on exploratory IBL approach method whereby learners were involved on hands on activities which are experimental in nature. The results of the pretest are presented in Table 4.3.

Table 4.3: Students Mean and Standard Deviation in Post-Test Scores

Group	N	Mean	Std. Deviation
Control	133	36.1404	14.24794
Experimental	149	53.2438	14.70912

Source: Researcher 2025

Table 4.3 shown displays the Means and standard deviations of the posttest scores for the two groups. The mean of the control group was 36.1404% while that of the experimental group was 53.2438%. A difference of about 17.1037%. From the results, the mean for the experimental group was greater than the mean for the control group.

4.3.4 Hypothesis testing

The First hypothesis of the research study stated that: there was no significant mean difference in the performance of Physics between learners taught using Inquiry Based Learning approach and those taught using traditional learning approach. The hypothesis was tested by conducting a t test on the Post test results. The results of the test is shown in the table 4.4.

Table 4.4: T-test for Equality of Means in Posttest Scores

	t-test for Equality of Means						
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Post test Scores	-9.892	280	.000	-17.10350	1.72894	-20.506	-13.700

Source: Researcher 2025

Table 4.4 shows the t-test results for mean comparison between control and experimental results. From the results shown, the degree of freedom from the sample of 282 learners was 280, Confidence interval of 95% provided an alpha value of $\alpha=0.05$. The probability value (p-value) as indicated in the fourth column obtained was 0.00, which is below the alpha value ($\alpha=0.05$); hence the null hypothesis was rejected. From the results, it was concluded that there was a significant difference between the posttests means of the control and experimental groups.

4.3.5 Discussions of Results

The results obtained show that learner's performance on Physics was better for those who learned using the IBL approach than for those who learned using traditional approaches. Learners taught through traditional approaches are often disadvantaged, which can lead to failure in their learning process. In contrast those learning using IBL approaches tend to increase their knowledge and skills (Khalaf and Zin, 2018). Some researchers have found contrary findings during the study of the inquiry-based learning approaches, for instance In Canada; Scott, Chu and Friesen (2018) found out that IBL

approach met a lot of opposition from stakeholders since it has limited value to the education process. This was also agreed by Frezell (2018) who argued that students were frustrated when left on their own to do some activities with little instruction from their teachers, this in turn affected their attitude towards learning.

4.4 Retention of Physics Concepts

The second objective of the study was to investigate the effect of Inquiry-Based Learning approach and traditional approaches on retention of Physics concept. Control group did two tests, the posttest was administered after the group was taught using traditional teaching approaches by their teachers in the topic on refraction of light. The experimental group which also sat for two tests had its Posttest administered after the topic on Refraction of light was taught using the inquiry-based exploratory learning approach. The table 4.5 shown indicates the summary of test mean scores administered.

Table 4.5: Summary of Test Mean Scores

	Control	Experimental
Pretest	32.1805	34.6085
Posttest	36.1404	53.2438
Difference in Mean Score	3.9599	18.6353

Source: Researcher 2025

The table 4.5 shown indicates there was a mean difference between the test administered to Control group as 3.9599 while for experimental group it was 18.6353. The difference for experimental group was higher than control group, it was concluded that retention of physics

concept was higher for learners taught physics on topic on refraction of light using the inquiry-based learning approach as opposed to those taught using the traditional learning approaches.

4.4.1 Discussions of results

The results showed that there was higher retention of Physics concepts to learners taught physics using the inquiry-based learning approach. This was in agreement with study conducted by Njoroge & Changeiywo (2014) who found out that students attained higher scores in Physics when IBL was used in Learning. This was also agreed by Duran and Dokme (2016) and (Firman et al 2019) who asserted that IBL involved asking questions, coming up with answers and new ideas related to the inquired task hence the approach was instrumental in developing skills which impacted the learning positively

4.5 Challenges faced in using Inquiry Based Learning approach in teaching Refraction of Light

During the study, the researcher wanted answers to a research question on the challenges faced by teachers in using the Inquiry-Based Learning approach in teaching the topic of Refraction of Light. A questionnaire was developed for physics teachers to answer this research question, comprising the following questions.

1. How do your students perform on questions from the topic on Refraction of Light?
2. Are you familiar with exploratory Inquiry-Based Learning approaches?
3. Have you ever taught a topic on Refraction of Light using Exploratory Inquiry-Based Learning approaches?
4. Did the performance of your student(s) improve when exploratory inquiry-based learning approaches were used?

5. What challenges hinder you from applying Inquiry-Based Learning approaches in teaching?
6. Name any other challenge(s) not among the ones above

4.5.1 Teacher's Response on Performance on the topic of Refraction of Light.

From the twelve teachers of Physics who filled the questionnaire, they were required to provide a response where they performed, excellent, Good, Fair or poor.

Table 4.6: Teachers Response on Performance on the topic of Refraction of Light

		Frequency	Percentage
Valid	Excellent	1	8.33
	Good	3	25.0
	Fair	3	25.0
	Poor	5	41.67

Source: Researcher 2025

Table 4.6: Shows that the 8.33% of students perform excellent in the topic on refraction of light, the performance is good for 25% of students, 25% perform fairly while majority who are 41.67% perform poorly. The results show that that majority of students do not perform correctly full marks in the topic of refraction of light.

4.5.2 Teacher's Response on their familiarity with exploratory Inquiry Based Learning approaches.

Table 4.7: Teachers Response on their familiarity with exploratory Inquiry Based Learning approaches

		Frequency	Percentage
Valid	Yes	7	58.33
	No	5	41.67

Source: Researcher 2025

Table 4.7 showed that majority of teachers constituting of 58.33% were familiar with exploratory inquiry-based approach of learning. Only a few which was 41.67% were not familiar with the learning approach.

4.5.3 Teacher's response on whether they have ever taught topic on Refraction of Light using Exploratory Inquiry Based Learning approaches.

Table 4.8: Teachers Response on whether they have ever taught topic on Refraction of Light using Exploratory Inquiry Based Learning Approaches

		Frequency	Percentage
Valid	Yes	4	33.33
	No	8	66.67

Source: Researcher, 2025.

Table 4.8 shows that majority of teachers were not teaching the topic of Refraction of light using exploratory inquiry-based learning approach, this constituted of 66.67% while only 33.33% taught the topic using the exploratory IBL approach.

4.5.4 Teacher's Response on whether the performance of students improved when exploratory inquiry-based learning approach was used.

Table 4.9: Teachers Response on whether the performance of students improved when exploratory inquiry based learning approach was used

		Frequency	Percentage
Valid	Yes	9	75
	No	3	25

Source: Researcher 2025

Table 4.9 above shows the response on performance of students improved when exploratory inquiry-based learning approach was used. 75% of respondents indicated that the performance improved when learners were taught using Inquiry based approach.

4.5.5 Teacher's Response on Challenges that hinder them from applying Inquiry Based Learning approaches in teaching.

The researcher asked the teachers to indicate the challenges that hindered them from applying IBL approaches in teaching. Three challenges were listed in the questionnaire which the teacher was supposed to select. Indicated challenges were;

- i. Heavy workload
- ii. Overpopulated classrooms
- iii. Inadequate Teaching and Learning resources

The figure below indicates the summary of the response from the teachers.

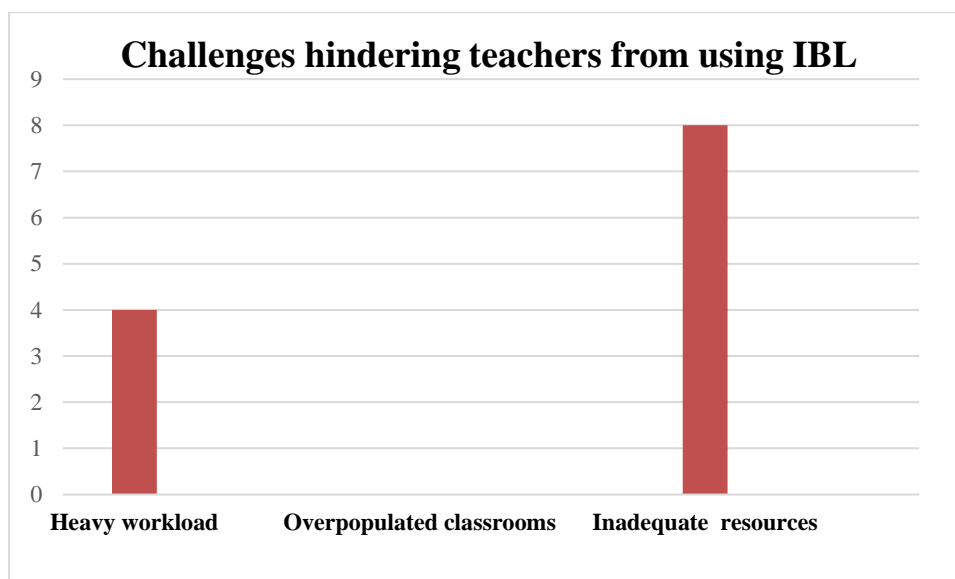


Figure 3.2 Challenges hindering teachers from using IBL

The figure 4.2 shows that majority of teachers who fail to apply IBL teaching approach due to Inadequate teaching and learning resources, this was followed by those who indicate heavy workload as the reason. Overpopulated classrooms could not hinder the use of IBL in teaching and learning. This was in agreement with Haug and Mork (2021) who reported that teachers spent a lot of time in implementing the teaching curriculum hindering better teaching and learning.

4.5.6 Other Challenges listed by teachers of Physics.

The teachers of Physics were asked to list other challenges they face apart from the ones listed in the questionnaire. The following were the challenges listed; they are summarized in table 4.9.

Table 4.10: Other Challenges listed by teachers of Physics

Challenge	Number of teachers who highlighted	Percentage
Time consuming	3	25%
Lack of seriousness from learners	2	16.67%
Inadequate training on IBL among teachers	4	33.33%
Rush to complete the Syllabus	3	25%

According to table 4.10 shown, four challenges were identified by the teachers involved in the study. The challenges listed by most teachers were inadequate training of teachers on the use of inquiry-based approaches in learning, with the second and third challenges listed by 25% of respondents as time-consuming and rush to finish the syllabus. The last challenge was lack of seriousness from learners listed by 16.67% of respondents only. From the table majority of teachers highlighted other challenge as inadequate training on IBL among teachers. Similar findings were reported by Okoth (2016) who highlighted; Inadequate teacher professional development and wide and overloaded content as challenges experienced by teachers in the profession. School heads of institution in Kenya also reported to have received training only on administration and not on professional development on newly rolled out CBE curriculum (UN Education Report, 2023). The Competence Based Education (CBE) curriculum intends to promote wellbeing of an individual who shall acquire skills and ability to be meaningful to the society (Akala, 2021). Akala (2021) goes on to propose that for the realization of CBE

objectives the teachers should be reskilled, all other education stakeholders should be engaged and schools well resourced.

4.4.1 Discussions

The researcher, through the questionnaire to teachers of Physics, inquired whether the teachers were familiar with the exploratory Inquiry-Based Learning approaches. The teacher's response showed that 58.33% of them were familiar with it with only 41.67% not familiar, although most of them were familiar with the learning approach only 33.33% reported to have taught the topic on refraction of Light using the approach while 66.67% do not use the IBL approach in teaching Physics on the topic of Refraction of Light. Most teachers constituting 75% indicated that the performance improved when the method was used, and 25% indicated that the performance did not improve. There were various challenges reported by teachers of Physics which hindered the use of the approach; the majority indicated inadequate resources, and a minority reported heavy workload. Okono, Saiti and Awuor (2015) who eluded that CEMASTEAs training has been emphasizing use of experiments in teaching of Physics however with the high teaching load the teachers have been performing fewer experiments. Challenges not in the questionnaire listed were Lack of seriousness from learners, inadequate training on use of IBL among teachers, the use of the approach was time consuming and teachers were in a rush to complete syllabus. Teachers have previously reported to have spent a lot of time in rushing to complete the teaching curriculum (Haug & Mork, 2021). This is still a major challenge especially to countries which struggles to increase manpower to sufficient levels and with inadequate teaching and learning resources. This in turn affects negatively quality of education. The challenges identified are similar to those in other studies such as inadequate learning resources, time on implementation of IBL in

teaching (Walan, Ewen & Gericke, 2016), Mumba, Banda and Chabalengula (2015) indicated inadequate training on use of Inquiry based instruction as a major challenge especially when handling different types of learners, however some studies differed with these findings, for instance Mkimbili, Tiplic and Odegaard (2017) stipulated that there was no need for sufficient resources in school for implementation of IBL , teachers just needed to be motivated since a motivated teacher could teach without sufficient learning resources. It is clear that the IBL approach is the best learning strategy for physics learners because they are able to retain information and learn much more effectively when put in control (Pesqueira, 2020).

4.6 Summary of the Chapter

The chapter began by listing the subchapters, results were discussed as per the listed research questions, the research questions were obtained from the research objectives. The tests results indicated that there was a significant difference in means of the post-test results obtained from experimental and control group. Retention of content was reported to be higher among learners taught using Inquiry based learning approach as opposed to traditional approaches. The challenges highlighted by teachers of physics were also presented in graphs and tables, inadequate leaning resources and heavy workload were indicated as major challenges hindering teachers from implementing Inquiry based learning approaches. From the result of each objective discussions of the results obtained were highlighted.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary of the findings from the research questions, along with conclusions drawn from the results. The researcher also provides recommendations based on the findings. The chapters end with suggestions made by the researcher for further research.

5.2 Summary of the Findings

5.2.1 Performance of Physics between learners taught using Inquiry Based Learning approach (IBL) and those taught using traditional learning approach

The primary objective of this study was to find out the comparison between the performance of student taught Physics using Inquiry Based Learning (IBL) approach and those taught using Traditional Learning approaches. To achieve this objective a research question was formulated to determine whether there is any difference on the performance of Physics between learners taught using Inquiry Based Learning approach and those taught using traditional learning approaches, the researcher findings established that learners taught physics on the topic of refraction of light using Inquiry based learning approach performed better than those taught using traditional learning approaches. This objective was guided by a null hypothesis which stated that there is no significant mean difference on the performance of Physics between learners taught using Inquiry Based Learning approach and those taught using traditional learning approach. The null hypothesis was rejected because it was found out that the

performance of Learners taught using IBL approach was greater than those learners taught using traditional approaches.

5.2.2 Effect of Inquiry Based Learning approach and traditional approach on the retention of Physics concepts

The objective to find out the effect of Inquiry Based Learning approach and traditional approaches on retention of Physics concept was answered by a response to a research question on the effect of Inquiry Based Learning approach and traditional approach on the retention of Physics concepts. This findings from the difference in tests administered to individual groups answered the question on retention. The tests administered to experimental group had a higher difference compared to control group. Therefore, the retention of physics concepts was higher to learners taught using the Inquiry-based learning approach while retention was lower to learners taught using the traditional learning approaches. Similar responses were indicated by the questionnaires administered to teachers of Physics, who reported improved performance when inquiry-based learning approach was used. The researcher findings were that retention of Physics concept was high when exploratory inquiry-based learning approach was used as opposed to traditional approaches.

5.2.3 Challenges faced when using Inquiry Based Learning approach and traditional learning approaches

The third objective was to find out challenges faced in using Inquiry Based Learning approach and traditional learning approaches in learning of Physics. In response to a question on the challenges faced when using Inquiry Based Learning approach and traditional learning approaches, the researcher developed a questionnaire to the teacher

of physics, the questionnaire had structured and open-ended questions. The researcher findings are summarized as shown.

Challenges faced when using Inquiry based Learning approach

1. Heavy workload
2. Inadequate teaching and learning resources.
3. Time consuming
4. Lack of seriousness from learners
5. Inadequate training on IBL among teachers
6. Rush to finish Syllabus hindered use of IBL

5.3 Conclusions

From the research findings of this study, it can be concluded that an inquiry-based leaning approach, narrowing to an exploratory approach, is the most suitable teaching approach on the topic of Refraction of Light. This is an experimental topic which requires hands on activities where the learner is in control of learning process and the teachers assumes the supervisory role. The research findings showed that IBL approach not only improved the learner's performance but also enhanced retention. Lastly teachers were in agreement that IBL approach is an effective method in learning of the topic on Refraction of Light but various challenges such as heavy workload, Inadequate training among teachers on use of IBL, Inadequate teaching and learning resources and Lack of serious from Learners as challenges hindering effective implementation on use of IBL. These challenges made most teachers result in using traditional approaches which are teacher centered such as rote learning and lecture methods in delivering content on the topic on refraction of light.

5.4 Recommendations

From the research findings and recommendations, the researcher came up with the following recommendations.

1. Inquiry based Learning approach (exploratory approach) should be adopted by the teachers of Physics in teaching of the topic of Refraction of Light, this approach is effective since results improved when used as opposed to traditional approaches.
2. The Kenya Institute of Curriculum Development should introduce policy framework on implementation of Inquiry Based Learning approach in learning of the topic on Refraction of Light.
3. Ministry of Education should adequately provide learning resources that support full implementation of IBL approaches.
4. Ministry of education to organize training of teachers of Physics on use of IBL approaches in teaching and Learning.
5. Teachers Service Commission to employ required teachers of Physics to reduce heavy workload among the inadequate teachers available.

5.5 Suggestions for Further Research

The following are the suggestions for further studies:

1. Other Inquiry Based approaches should be studied in the same topic of Refraction of Light.
2. Similar studies to be conducted in other sub counties in Kenya.
3. Studies on use of exploratory Inquiry based Learning approach to be done in other fields.

5.6 Summary of the Chapter

The chapter highlighted on the summary of the findings of the research study with each objective being discussed from the research questions. The Conclusions of the study findings have been discussed with major one being that IBL approach is improved Student's performance in physics. Recommendations based on the findings were also discussed. The researcher concluded by making suggestions for further research such conducting research in other topics of physics using similar IBL approach.

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APPENDICES**Appendix I: Letter of Introduction**

Godfrey Kimiru Kinyanjui

P.O. Box 2024-30100

Eldoret

12th March 2025

To

The Principal

.....

Dear Sir/Madam

RE: RESEARCH DATA COLLECTION

I am a postgraduate student in the department of Centre for Teacher Education, University of Eldoret. I am carrying out a research study entitled; **“The Comparison Between Inquiry- Based and Traditional Learning Approaches on the Student Performance in Physics in Kesses Sub-County, Kenya”**. This research is purely academic and any information provided will be treated with confidentiality. I am requesting for permission to collect data for this study in your school between March to May 2025. During the time of data collection, I will administer tests to Physics students and questionnaire to teachers of Physics. Your cooperation will be highly appreciated.

Yours faithfully,

Godfrey Kimiru Kinyanjui

Masters Student

University of Eldoret

SEDU/CTE/M/003/22

Appendix II: Consent Letter to the Participant

Godfrey Kimiru Kinyanjui

P.O. Box 2024-30100

Eldoret

12th March 2025

Dear Participant

RE: RESEARCH DATA COLLECTION

I am a postgraduate student in the department of Centre for Teacher Education, University of Eldoret. I am carrying out a research study entitled; **“The Comparison Between Inquiry- Based and Traditional Learning Approaches on the Student Performance in Physics in Kesses Sub-County, Kenya”**. I am requesting you to spare your time and fill the provided questionnaire. This research is purely for academic purposes and any information provided will be treated with confidentiality. Please do not write your name on the questionnaire. Thank you in advance for your cooperation.

Yours faithfully,

Godfrey Kimiru Kinyanjui**Masters Student****University of Eldoret****SEDU/CTE/M/003/22**

Appendix III: University of Eldoret Authorization



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

UNIVERSITY OF ELDORET

SCHOOL OF EDUCATION CENTRE FOR TEACHER EDUCATION

Ref: UOE/B/CTE/REF/034

Date: February 14th, 2025

To
 The Executive Secretary,
 National Commission for Science, Technology & Innovation
 P.O. Box 30623-00100,
NAIROBI.

Dear Sir/Madam,

SUBJECT: RESEARCH PERMIT FOR: KINYANJUI GODFREY KIMIRU
REG. NO: SEDU/CTE/M /003/22

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

He is currently preparing for a Field Research Work on his thesis entitled: *The comparison between enquiry-based and traditional learning approaches on the student performance in physics in Kesses sub-county.*

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

Yours Faithfully,



DR. JOSEPH MUBICHAKANI
HEAD, CENTRE FOR TEACHER EDUCATION



Appendix IV: NACOSTI Research Permit with County Commissioner Authorization

 **REPUBLIC OF KENYA**

 **NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION**

Ref No: 557848 Date of Issue: 06/March/2025

RESEARCH LICENSE



Approved
07/03/2025
COUNTY COMMISSIONER
UASIN GISHU COUNTY

This is to Certify that Mr. GODFREY KIMIRU KINYANJUI of University of Eldoret, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Uasin-Gishu on the topic: **THE COMPARISON BETWEEN INQUIRY-BASED AND TRADITIONAL LEARNING APPROACHES ON THE STUDENT PERFORMANCE IN PHYSICS IN KESSES SUB-COUNTY, KENYA** for the period ending : 06/March/2026.

License No: NACOSTI/P/25-416247

557848
Applicant Identification Number

W. K. Kimani
Director General
NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Verification QR Code



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

See overleaf for conditions

Appendix V: County Director of Education Authorization



REPUBLIC OF KENYA
MINISTRY OF EDUCATION
 State Department for Basic Education

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

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

Ref: No. MOE/UGC/TRN/9/VOLL.V/91


7th March, 2025

Mr. Godfrey Kimiru Kinyanjui
 University of Eldoret
 P.o Box 1125- 30100
ELDORET

RE: RESEARCH AUTHORIZATION.

In reference to your License Ref no. **NACOSTI/P/25/416247** dated 6th March,2025 from National Commission for Science, Technology and Innovation (NACOSTI), you are hereby granted the authority to carry out research on **"The comparison between inquiry – based and traditional learning approaches on the student performance in physics in Kesses Sub County", Period Ending 6th March, 2026,"** Within Uasin Gishu County.

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


 FOR: COUNTY DIRECTOR OF EDUCATION
 UASIN GISHU COUNTY
07 MAR 2025
 P.O. Box 9843 - 30100, ELDORET
 053-2063342 / 0719127212
 For: County Director of Education
UASIN GISHU.

Appendix VI: County Government of Uasin Gishu Authorization

**REPUBLIC OF KENYA
COUNTY GOVERNMENT OF UASIN GISHU**

Tel. NOs: direct line: 053-2016215
053-2016659
053-2016631

Fax: +254-053-2062884
Website: www.uasingishu.go.ke
Email: countysecretary@uasingishu.go.ke



When Replying, Please Address to:

County Secretary
Uasin-Gishu County
P.O. Box 40 – 30100
Eldoret, Kenya.

REF: UGC/ADM.1/31/GEN/2025/VOL.1/(38) DATE: 10 March, 2025

Mr. Godfrey Kimiru Kinyanjui,
University of Eldoret,
P.O Box 1125 - 30100,
ELDORET.

**AUTHORITY TO CARRY OUT RESEARCH
WITHIN UASIN GISHU COUNTY GOVERNMENT**

Your letter of 7 March, 2025 on the above subject is in reference.

We acknowledge with thanks receipt of your communication and are pleased to inform you that your request was considered and authority is hereby granted to you to carry out your research on “*The Comparison between Inquiry-based and Traditional Learning Approaches on the Student Performance in Physics in Kesses Sub-County, Kenya*” within Uasin Gishu County, for academic purposes.

You are requested to share your findings with the Office of the undersigned.

**Ambrose Tarus
AG. COUNTY SECRETARY/
HEAD OF COUNTY PUBLIC SERVICE**

Appendix VII: KCSE Candidature Enrollment in Sciences (2013-2022)

Year	Biology	Chemistry	Physics	Total Candidature
2013	397,319 (88.95%)	439,847 (98.47%)	119,819 (26.82%)	446,696 (100%)
2014	432,977 (89.53%)	476,582 (98.54%)	131,410 (27.17%)	483,630 (100%)
2015	465,584 (89.04%)	515,888 (98.66%)	139,100 (26.60%)	522,870 (100%)
2016	509,982 (88.83%)	566,836 (98.73%)	149,790 (26.09%)	574,125 (100%)
2017	545,663 (89.17%)	606,515 (99.11%)	160,182 (26.18%)	611,952 (100%)
2018	589,900 (89.35%)	656,163 (99.38%)	172,676 (26.15%)	660,204 (100%)
2019	618,730 (88.74%)	691,802 (99.22%)	184,559 (26.47%)	697,222 (100%)
2020	651,236 (87.16%)	740,831 (99.15%)	217,126 (29.06%)	747,161 (100%)
2021	710,533 (85.94%)	820,765 (99.27%)	253,963 (30.72%)	826,807 (100%)
2022	752,154 (85.33%)	875,555 (99.33%)	276,296 (31.35%)	881,416 (100%)
2023				899,453 (100%)

Source: KNEC KCSE Examination Report, 2013-2022

Appendix VIII: Sciences in KCSE 2021-2023 in Kesses Subcounty

Subject	2023	2022	2021
Physics	2.85 (D plain)	2.61 (D Plain)	2.60 (D Plain)
Chemistry	2.29 (D-)	2.11 (D-)	2.03 (D-)
Biology	2.77 (D)	2.66 (D)	2.90 (D)
Mathematics	2.20 (D-)	1.61 (D-)	2.17(D-)

Source: SCDE Kesses Subcounty

Appendix IX: Categories of Schools in Kesses Subcounty

Strata	Number of schools	Sampled schools
Private school	6	1
Extra-county	5	2
Sub county day	36	4
TOTAL	47	7

Appendix X: Instructions and Sampled Lesson Plan for Physics Teachers.

EXPERIMENTAL GROUP AND SAMPLED LESSON PLAN TO BE USED

- Lessons will be exploratory inquiry based where learners shall learn by hand on activities by conducting experiments.
- Start each lesson with introduction by reviewing previous lesson.
- After introduction put learners in groups of five learners in the Laboratory.
- Provide learners with required apparatus in each lesson.
- Learning shall be learner centered where they shall perform hands on activities under the supervision of the teacher.

General Objectives

By the end of the topic the learners should

1. Describe simple experiments to illustrate refraction of light
2. State the laws of refraction of light.
3. Verify the laws of refraction experimentally.
4. Determine refractive indices of media.

LESSON 1

Lesson Topic: Introduction to Refraction

Objective of the lesson.

By the end of the lesson the learner should;

1. Describe simple experiments to demonstrate refraction
2. Define the term refraction.

Introduction

- Introduce the lesson by reviewing Form 1 and 2 topics on light through question-and-answer method.
- Review the meaning of rectilinear propagation of light in a medium.
- Define the meaning of refraction of light.
- Encourage every learner to participate in the experiment.
- Highlight the procedure to be followed in the experiments

Lesson Development

- Put learners in their groups.
- Guide the learners in the demonstration of refraction by dipping a pen in a beaker of water.
- Supervise learners in viewing the appearance of the dipped pen in water.
- Let learners engage themselves in explaining the phenomenon.
- The teacher asks and answers questions raised.
- Explain to the learners the refraction of light in water.

Conclusion

- Teacher summarizes the lesson.
- Learners given assignment.

LESSON 2

Lesson Topic: To investigate the path of light through a glass block using optical pins or Ray box.

By the end of the lesson the learner should;

1. Explain the behavior of light as it travels from one media to another.

Introduction

- Introduce the lesson by reviewing the previous lesson.
- Ask learners to define refraction of light.

Lesson Development

- Guide the learners in fixing white sheet of paper on a soft board.
- Using an incidence angle of 20° supervise learners in determining and drawing refracted ray and emergent ray out of the glass block by using optical pins or ray box.
- Ask learners to explain in groups the relationship between angle of incidence and angle of refraction and then present their findings to the rest of the class.
- Explain to the learners the behavior of the path of light when passing from air to glass block and then from the glass block to air.
- The teacher asks and answers questions raised.

Conclusion

- Teacher summarizes the lesson.
- Learners given assignment.
- The assignment to be marked before next lesson.

LESSON 3-4

Lesson Topic: To investigate the relationship between angle of incidence and angle of Refraction

By the end of the lesson the learner should;

1. State the Laws of refraction.
2. Determine the refractive index of a medium.

Introduction

- Introduce the lesson by reviewing the previous lesson

Lesson Development

- Guide the learners in fixing white sheet of paper on a soft board.
- Using an incidence angle of 20° supervise learners in determining the refracted ray and let them record in a table.
- Guide the learner in repeating the procedure above for different values of angle of incidence which are 30° , 40° , 50° , 60° and 70° . The learner to record obtained values of different refracted rays, sine of angle of incidence and sine of angle of refraction in a table

- Ask learners to explain the relationship between angle of incidence and angle of refraction and then present their findings to the rest of the class.
- Explain to the learners the laws of refraction from the experimental results using a graph of $\sin i$ against $\sin r$.
- Explain to the learners the laws of refraction from the experimental results.

Conclusion

- Teacher summarizes the lesson.
- Give learners assignment on calculating refractive index of glass block with respect to air.
- The assignment to be marked before next lesson.

LESSON 5

Lesson Topic: To Determine refractive index of a medium with respect to air using water and velocities of light.

By the end of the lesson the learner should;

1. Determine the refractive index of a medium using real and apparent depth
2. Define absolute refractive index.
3. Calculate the refractive index of a material using velocities of light in media.

Introduction

- **Introduce the lesson by reviewing the previous lesson.**

Lesson Development

- Guide the learner in determining identifying real and apparent depth using a coin in the beaker containing water
- Guide the learner in determining refractive index of water with respect to air using real and apparent depth of a coin.
- Ask learners to explain their finding in groups then to the rest of the class.
- Explain to the learners how to find refractive index of a material using velocities of light in media.
- Explain to the learners the meaning of absolute refractive index.

Conclusion

- Teacher summarizes the lesson.
- Learners given assignment.
- The assignment to be marked before next lesson.

**INSTRUCTIONS FOR TEACHERS OF PHYSICS IN CONTROL GROUP
AND SAMPLED LESSON PLAN TO BE USED**

By the end of this topic, the learner should be able to;

1. Describe simple experiments to illustrate refraction of light.
2. State the Laws of refraction of light.
3. Verify laws of refraction
4. Define the refractive index
5. Calculate the refractive index of a medium.

LESSON 1

Lesson Topic: Introduction to Refraction

Objective of the lesson.

By the end of the lesson the learner should;

3. Describe simple experiments to illustrate refraction
4. Define the term refraction.

Introduction

- Introduce the lesson by reviewing Form 1 and 2 topics on light through question-and-answer method.
- Review the meaning of rectilinear propagation of light in a medium.
- Define the meaning of refraction of light.

Lesson Development

- Put learners in groups of five learners.
- Conduct experiments with learners demonstrating refraction by dipping a pen in a beaker of water.
- Supervise learners in viewing the appearance of the dipped pen in water.
- The teacher asks and answers questions raised.
- Define to the learners the refraction of light in water.

Conclusion

- Teacher summarizes the lesson.
- Learners given assignment.

LESSON 2

Lesson Topic: To investigate the path of light through a glass block using optical pins or Ray box.

By the end of the lesson the learner should;

2. Explain the behavior of light as it travels from one media to another.

Introduction

- Introduce the lesson by reviewing the previous lesson.
- Ask learners to define refraction of light.

Lesson Development

- Guide the learners in fixing white sheet of paper on a soft board.
- Using an incidence angle of 20° supervise learners in determining and drawing refracted ray and emergent ray out of the glass block by using optical pins or ray box.
- Explain to the learners the behavior of the path of light when passing from air to glass block and then from the glass block to air.
- The teacher asks and answers questions raised.

Conclusion

- Teacher summarizes the lesson.
- Learners given assignment.
- The assignment to be marked before next lesson.

LESSON 3-4

Lesson Topic: To investigate the relationship between angle of incidence and angle of Refraction

By the end of the lesson the learner should;

3. State the Laws of refraction.
4. Determine the refractive index of a medium.

Introduction

- Introduce the lesson by reviewing the previous lesson.

Lesson Development

- Guide the learners in fixing white sheet of paper on a soft board.
- Using an incidence angle of 20° supervise learners in determining the refracted ray and let them record in a table.
- Guide the learner in repeating the procedure above for different values of angle of incidence which are 30° , 40° , 50° , 60° and 70° . The learner to record obtained values of different refracted rays, sine of angle of incidence and sine of angle of refraction in a table
- Explain to the learners the laws of refraction from the experimental results using a graph of $\sin i$ against $\sin r$.
- Explain to the learners the laws of refraction from the experimental results.

Conclusion

- Teacher summarizes the lesson.
- Give learners assignment on calculating refractive index of glass block with respect to air.
- The assignment to be marked before next lesson.

LESSON 5

Lesson Topic: To Determine refractive index of a medium with respect to air using water and velocities of light.

By the end of the lesson the learner should;

4. Determine the refractive index of a medium using real and apparent depth
5. Define absolute refractive index.
6. Calculate the refractive index of a material using velocities of light in media.

Introduction

- Introduce the lesson by reviewing the previous lesson.

Lesson Development

- Guide the learner in determining identifying real and apparent depth using a coin in the beaker containing water
- Guide the learner in determining refractive index of water with respect to air using real and apparent depth of a coin.
- Explain to the learners how to find refractive index of a material using velocities of light in media.
- Explain to the learners the meaning of absolute refractive index.

Conclusion

- Teacher summarizes the lesson.
- Learners given assignment.
- The assignment to be marked before next lesson.

Appendix XI: Questionnaire to the teachers of Physics

Dear teacher

I am Godfrey Kimiru Kinyanjui, a postgraduate student from the University of Eldoret pursuing Masters of Education Science (Physics option). I kindly request you to provide information asked in this questionnaire. Information provide will strictly be confidential and used for research purposes.

Please tick where appropriate.

1. How do your students perform questions from the topic on Refraction of Light?

Excellent

Good

Fair

Poor

Excellent means student(s) scoring all the marks

Good means student(s) scoring from 55% but not all the marks

Fair means student(s) scoring 40%-54%

Poor means student(s) scoring below 40%

2. Are you familiar with IBL teaching approaches?

Yes

No

3. Have you ever taught topic on Refraction using Inquiry Based Learning approaches?

Yes

No

4. Did the performance of your student(s) improve when IBL approaches were used?

Yes

No

5. What challenges hinder you from applying IBL teaching approaches in teaching?

Heavy workload

Overpopulated classrooms

Inadequate Teaching
and Learning resources

Name any other challenge(s) not among the ones above

a)

b)

Appendix XII: Pretest Items

Instructions to the students

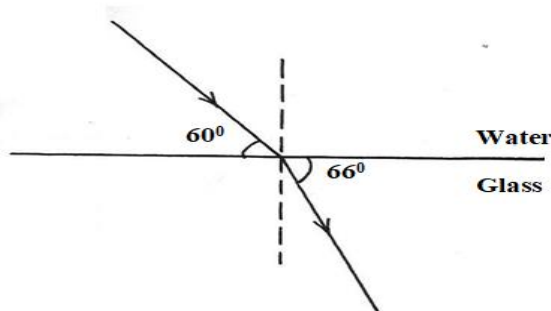
- Do not write your name or admission number on this paper
- Attempt all the questions
- Time allowed is 1 hour
- Information obtained is purely for research purposes
- Scientific calculator or mathematical tables may be used where appropriate.
- Total marks are 30

1. Define the term *refraction of light*. (1 mark)

.....

 ...

2. The figure below shows a ray of light travelling through water and glass.



- (a) Determine the refractive index of glass with respect to water. (2 marks)

- (b) Calculate the refractive index of water with respect to glass. (2 marks)

3. The velocity of light in water is $2.26 \times 10^8 \text{ms}^{-1}$. Determine the velocity of light in glass. (2 marks)

- (a) Define critical angle. (1 mark)

.....

- (b) The figure below shows the interface between glass and air

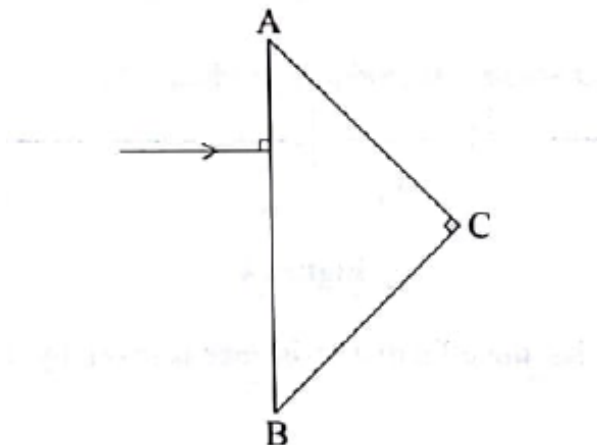
Air



Glass

- Draw on the figure a ray diagram to illustrate the critical angle. (2 marks)

4. The figure below shows a ray of light incident at right angles to face AB of a right-angled glass prism of refractive index 1.62



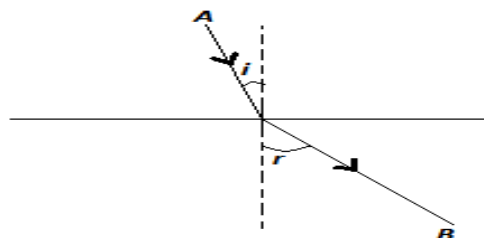
- (i) Determine the critical angle of the material. (2 marks)

- (ii) Complete the ray diagram to show the path of light until it leaves the prism. (1 mark)

5. State two conditions necessary for total internal reflection to occur. (2 marks)

.....

6. The figure below shows how refraction occurs.



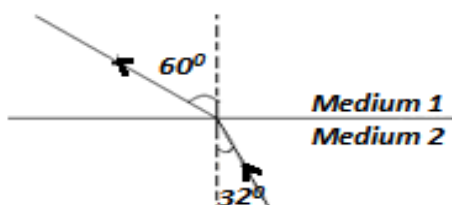
Which of the two media is optically denser? Explain. (2 marks)

.....

7. With the help of a diagram show how pencil placed in water will appear. (1 mark)

8. Calculate the refractive index for light travelling from glass to air given that ${}_a n_g = 1.572$. (2 marks)

9. A ray of light striking a transparent material is refracted as shown below.



Calculate the refractive indices:

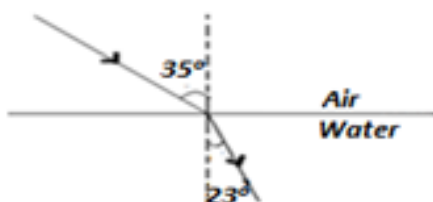
- a) ${}_1 n_2$ (2 marks)

b) $2n_1$

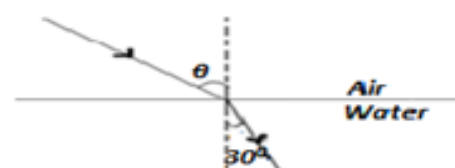
(2 marks)

10. Use the information given in the figures (a) and (b) below to calculate the Refractive index and the angle θ (2 marks)

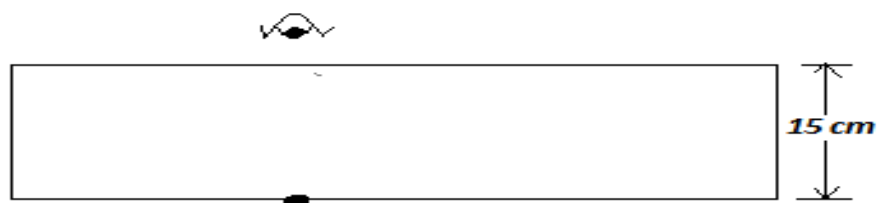
(a)



(b)



11. A mark on a paper is viewed normally through a rectangular block of a transparent material as shown below



If the speed of light in the material is $1.25 \times 10^8 \text{ ms}^{-1}$ calculate:

- a) The apparent depth of the mark (2 marks)

- b) The vertical displacement of the mark (*speed of light in air = $3.0 \times 10^8 \text{ ms}^{-1}$*) (2 marks)

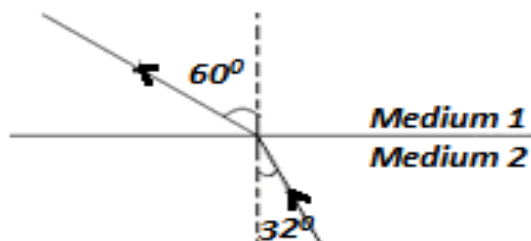
Appendix XIII: Posttest items**Instructions to the students**

- Do not write your name or admission number on this paper
- Attempt all the questions
- Time allowed is 1 hour
- Information obtained is purely for research purposes
- Scientific calculator or mathematical tables may be used where appropriate.
- Total marks are 30

1. State any one application of prisms. (1 mark)

.....

2. A ray of light striking a transparent material is refracted as shown below.



Calculate the refractive indices:

- a) ${}_1n_2$ (2 marks)
- b) ${}_2n_1$ (2 marks)
3. Given that the refractive index of diamond is 2.51 and the velocity of light in air is $3.0 \times 10^8 \text{ ms}^{-1}$, calculate the velocity of light in diamond. (2 marks)
4. Define the term absolute refractive index of a material. (1 mark)

.....

5. (a) Define critical angle. (1 mark)

.....

- (b) The figure below shows the interface between air and glass

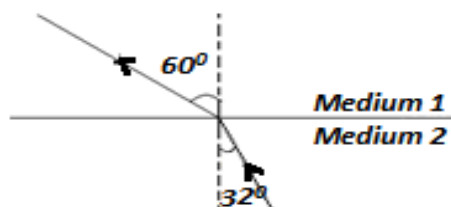
Glass



Air

- Draw on the figure a ray diagram to illustrate the critical angle. (2 marks)

6. A ray of light striking a transparent material is refracted as shown below.



Calculate the refractive indices:

- c) ${}_1n_2$ (2 marks)

- d) ${}_2n_1$ (2 marks)

7. State the two laws of reflection observed during total internal reflection. (2 marks)

.....
.....

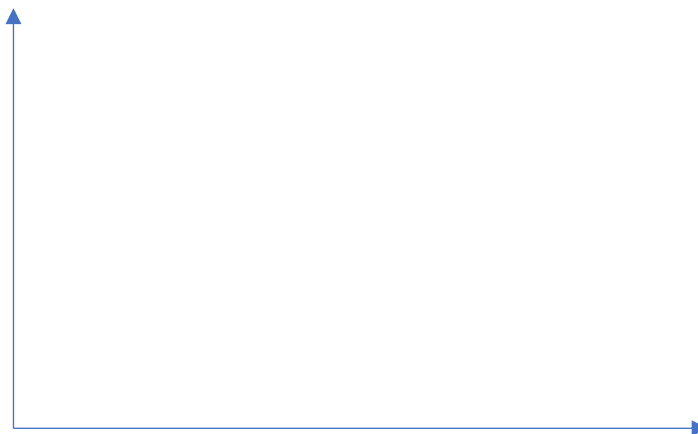
8. The critical angle for a ray travelling from glass to air is 42° . Determine the refractive index of the glass. (2 marks)

9. State Snell's Law. (1 mark)

.....
.....

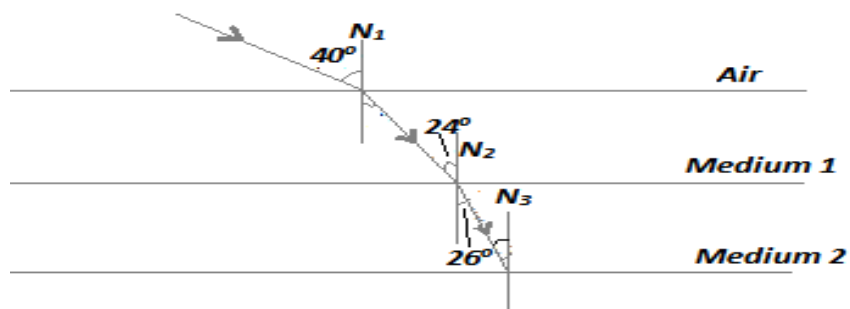
10. During an experiment to investigate the relationship between the angle of incidence i , and angle of refraction r for a ray of light travelling from air to glass, the values of $\sin i$ and $\sin r$ were obtained.

- (a) On the axis provided sketch the graph for $\sin i$ against $\sin r$ for the values obtained. (2 marks)



- (b) State how the refractive index of the glass can be obtained from the graph. (1 mark)

11. A ray of light travels from air into medium 1 and 2 as shown.



Calculate;

- The refractive index of medium 1 (2 marks)
- Critical angle of medium 1 (2 marks)
- The refractive index of medium 2 relative to medium 1 (${}_1n_2$) (2 marks)

12. State one use of optical fibre (1 mark)

.....

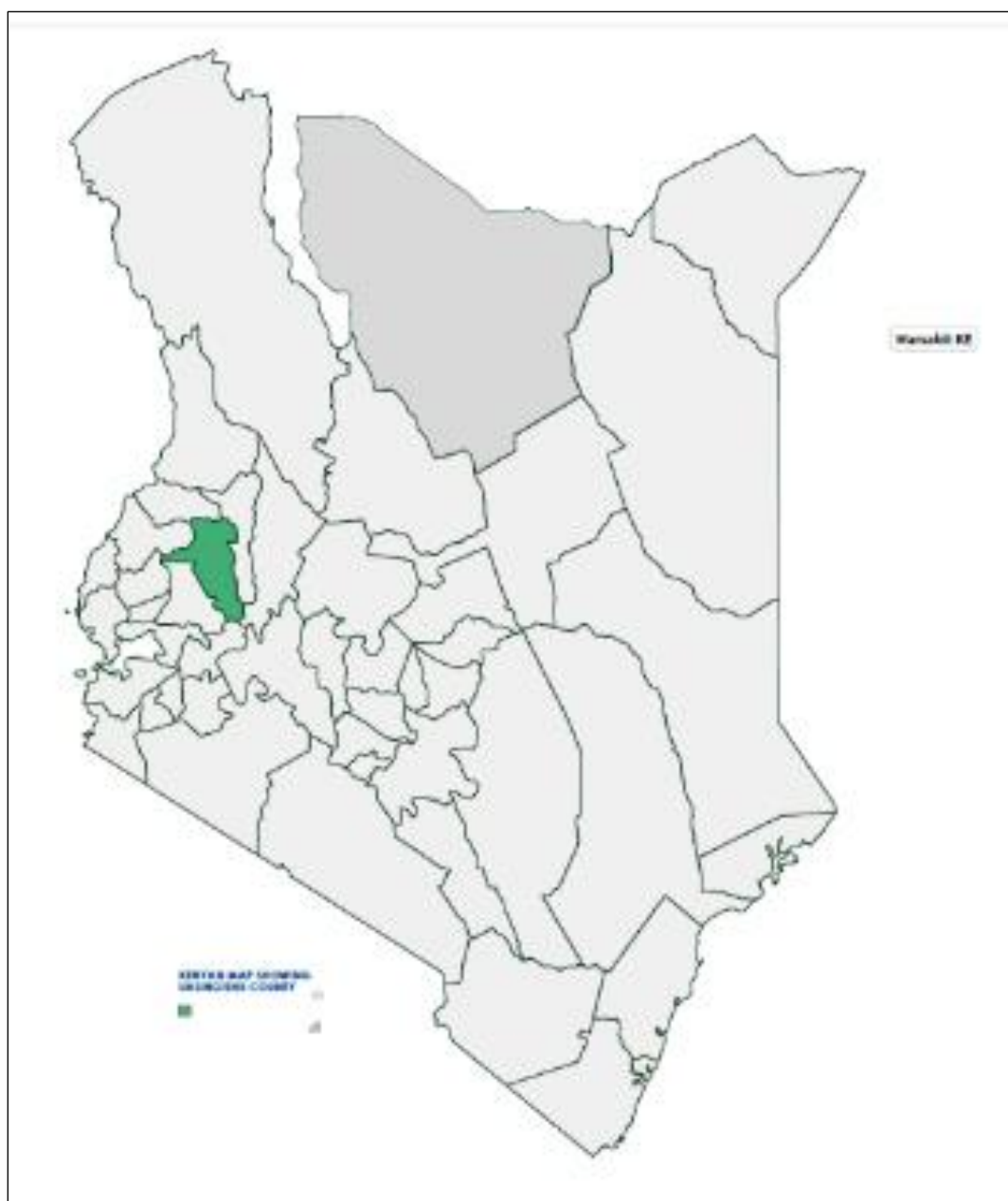
Appendix XIV: Budget

No	Votehead	Amount
1	Travelling expenses	45,000
2	Printing costs	5,000
3	Writing material (pens, reams)	2,000
4	Research Permit	1,500
5	Airtime/Internet costs	5,000
6	Food and Drinks	5,000
7	Miscellaneous	2,000
	TOTAL	65,500

Appendix XV: Time Schedule for activities during the study

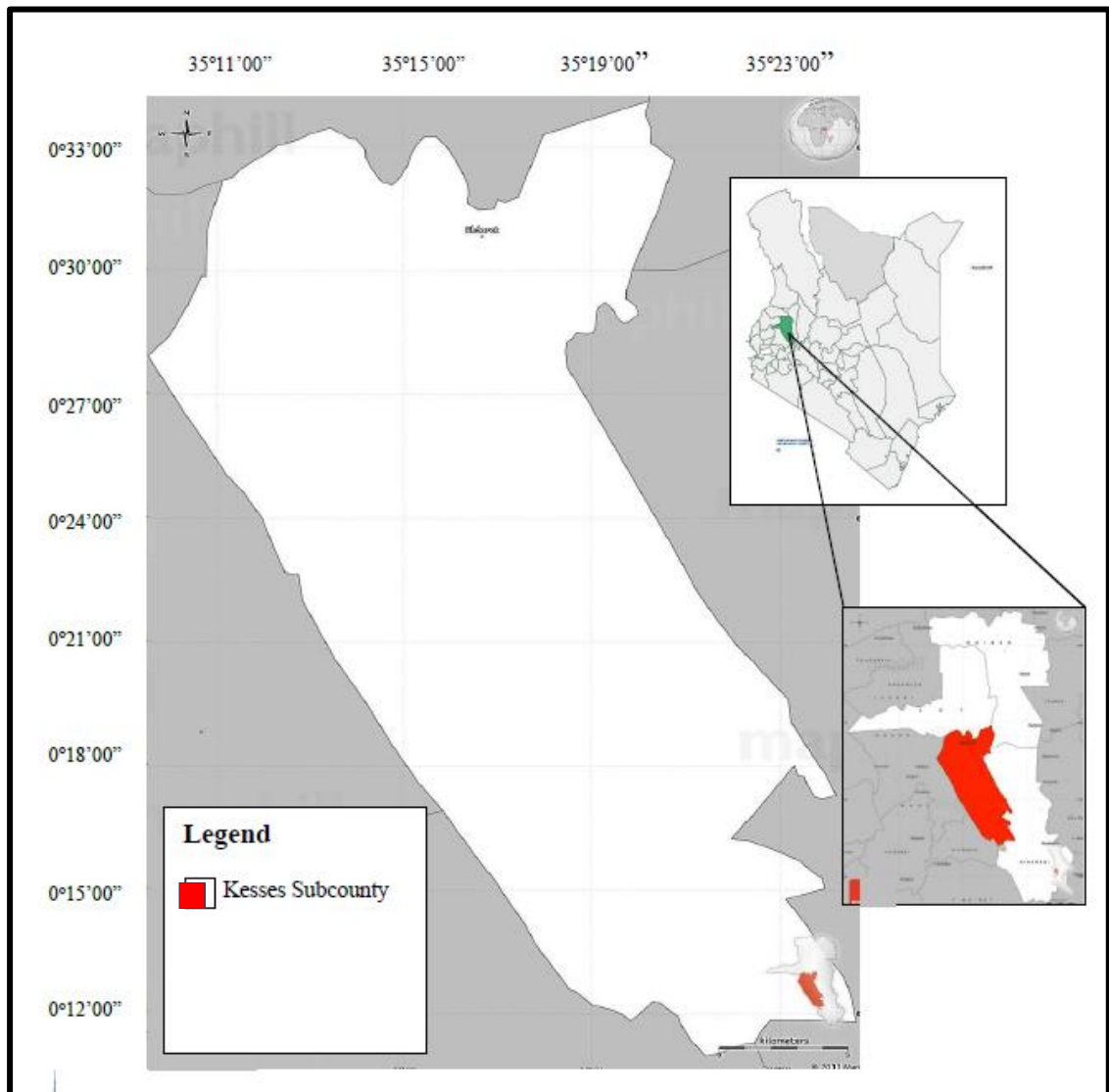
No	Activity	Dates
1	Preparation of Proposal with Supervisors	May 2023-10 th Feb 2025
2	Presentation of Proposal	10 th -13 th February 2025
3	Corrections of Proposal	14 th -21 st February 2025
4	Application of Permit and Authorization letters	22 nd February-10 th March 2025
5	Fieldwork	11 th March-1 st April 2025
6	Data Analysis	15 th April-30 th April 2025
7	Discussion of results	1 st May-15 th May 2025
8	Preparation of summary of finding	16 th May-30 th July 2025
9	Thesis Mock Defence	1 st August-15 th August 2025
10	Corrections of thesis report	15 th August-30 th August 2025
11	Thesis Defence and corrections	1 st September-1 st November 2025

Appendix XVI: Map of Kenya Showing Uasin Gishu County
(Source: Google maps)




Appendix XVIII: Map of the Study Area

Kesses Subcounty Map



(Source: Google maps)


Appendix XIX: Similarity Report



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