

**INFLUENCE OF INSTRUCTIONAL USE OF MOBILE TECHNOLOGIES ON
STUDENTS' ACADEMIC ACHIEVEMENT IN PHYSICS IN SECONDARY
SCHOOLS IN NANDI COUNTY, KENYA.**

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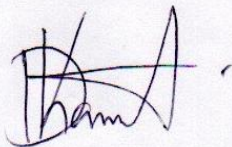
**A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE AWARD OF MASTER OF EDUCATION DEGREE IN INSTRUCTIONAL
TECHNOLOGY OF
MOUNT KENYA UNIVERSITY**

MAY 2025

DECLARATION AND APPROVAL

Declaration

This thesis is my original work and has not been presented for a degree in any other university or for any other award.

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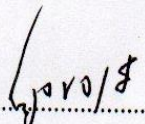
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DEDICATION

Dedicated to my loving family—parents, siblings, spouse, and children—your constant support made this journey possible. Pursue knowledge and truth with relentless passion.



ACKNOWLEDGEMENT

My heartfelt gratitude is extended to my supervisors, Dr. Benson Njoroge as well as Dr. Emily Kirwok, whose invaluable supervision, unwavering commitment of time and energy, and thoughtful guidance greatly enriched this study. I also wish to salute comrades in Mount Kenya University who we have kept inspiring one another with the promise that all will be fine. I sincerely thank the respondents of this study, the Head of Departments (HODs), dedicated teachers, and enthusiastic students whose participation and contributions were invaluable.



ABSTRACT

The instructional use of mobile technologies in education has transformed instructional practices by offering interactive and engaging learning experiences. This study explored the Influence of Instructional Use of Mobile Technologies on Students' Academic Achievement in Physics in Secondary Schools in Nandi County, specifically Nandi East Sub-County. Nandi East was purposively selected due to its history of ICT-focused educational interventions, providing a suitable context for examining the influence of mobile technologies on academic achievement. Specifically, the study examined the effects of mobile-based simulations, ICT-powered lesson presentations, online collaborative learning, and online assessment on students' Physics performance. The study was anchored on the Framework for the Rational Analysis of Mobile Education model and Connectivism theory, which emphasize the role of mobile technologies in facilitating knowledge acquisition, collaboration, and interactive learning. A descriptive-correlational research design was used to investigate the connection between mobile technologies use and academic achievement. The target population, drawn from 31 secondary schools in Nandi East Sub-County, comprised Form Three Physics students, Physics teachers, and Heads of departments. Sample sizes for each category of respondents were determined using Cochran's formula to ensure statistical adequacy. Subsequently, proportionate simple random sampling was employed to select 300 students, while 54 Physics teachers and 29 Heads of Departments were purposively sampled based on their roles in Physics instruction and departmental oversight. Data were collected through questionnaires, observation schedules, and interviews. Piloting was conducted in two additional schools to ensure the validity and reliability of the instruments. Validity was ensured through expert review, and reliability was measured using Cronbach's Alpha, yielding coefficients above 0.7. Descriptive statistics, including means and standard deviations, were used to summarize the data, while inferential statistics, including Pearson correlation and Multiple Regression Analysis, assessed the relationship between mobile technologies instructional use and Physics academic achievement. The study demonstrated that applying mobile technologies instructionally had a notable positive effect on students' performance in Physics. Simulations improved conceptual understanding and problem-solving skills, while ICT-powered lesson presentations enriched lesson delivery and engagement. Online collaborative learning fostered peer interaction, knowledge sharing, and access to diverse Physics resources, while online assessments provided instant feedback, promoting self-regulated learning. However, the effectiveness of these technologies was constrained by inadequate ICT infrastructure and inconsistent implementation across schools. Correlation and regression analyses confirmed a strong positive link, indicating that instructional application of mobile technologies significantly influences students' performance in Physics, with ICT-powered lesson presentations and simulations exhibiting the highest predictive power. The study underscores the need for structured integration of mobile technologies in Physics education, supported by teacher training, institutional policies, and equitable ICT resource distribution. Recommendations for curriculum designers, policymakers, teachers, and school administrators include improving teacher training, expanding access to mobile technologies, and fostering structured digital collaboration and assessments. Further research should explore the long-term impact of mobile technologies adoption on Physics performance.

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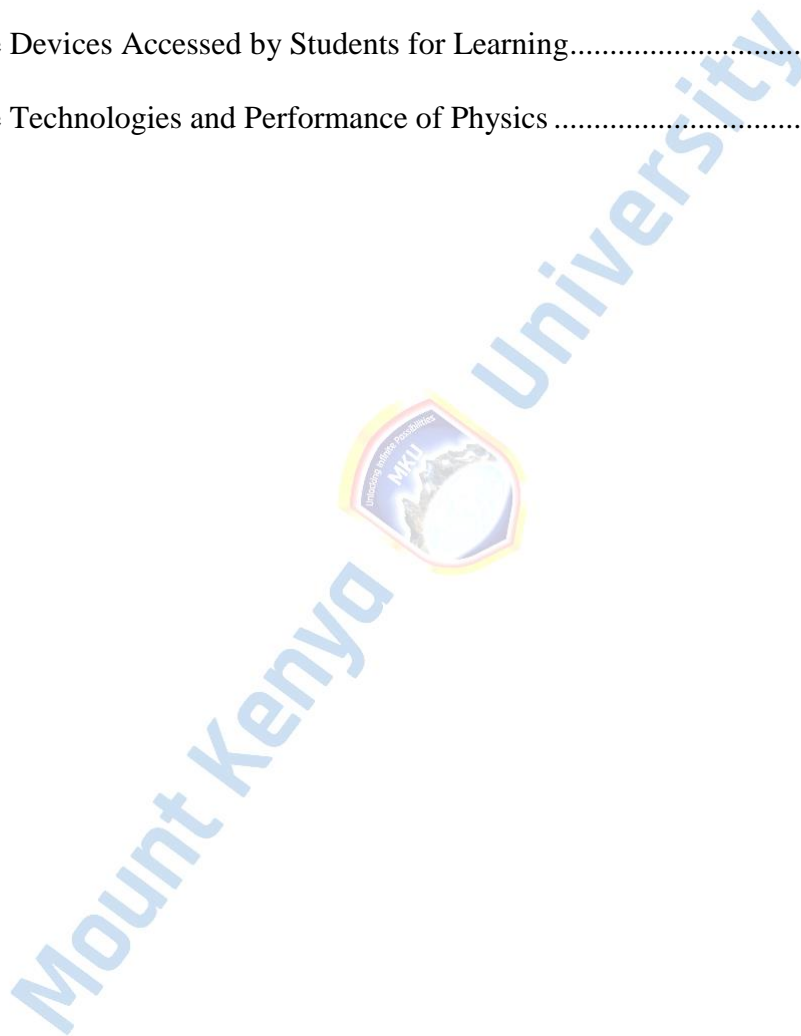
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LIST OF ABBREVIATIONS AND ACRONYMS

CEMASTE	Centre for Mathematics, Science and Technology Education in Africa.
FRAME	Framework for Rational Analysis of Mobile Education
HOD	Head of Department
ICT	Information and Communication Technology
KCSE	Kenya Certificate of Secondary Education
KICD	Kenya Institute of Curriculum Development
KIE	Kenya Institute of Education (<i>now KICD</i>)
KNEC	Kenya National Examinations Council
MKU	Mount Kenya University
MRA	Multiple Regression Analysis
MT	Mobile Technologies
NACOSTI	National Commission for Science, Technology, and Innovation
OCL	Online Collaborative Learning
SCDE	Sub-County Director of Education
SD	Standard Deviation
SPSS	Statistical Package for the Social Sciences
STEM	Science, Technology, Engineering, and Mathematics
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations International Children's Emergency Fund.
Wi-Fi	Wireless Fidelity

CHAPTER ONE

INTRODUCTION

1.1 Introduction

Chapter one of this study entails; the background to the research, the problem being investigated, its scope, the general and, specific aims and guiding questions for this inquiry. Justification and significance of this investigation, limitations, delimitations, assumptions and, operational description of key terms applied throughout the research.

1.2 Background to the Study

Mobile technologies refer to wireless, portable, and internet-enabled tools that facilitate communication, information access, and digital interactions in various sectors, including education. These technologies include smart devices like smartphones, tablets, and laptops, and cloud-based applications, enabling users to interact with digital content anytime and anywhere (Ally & Prieto-Blázquez, 2014). In the field of education, mobile technologies enhance adaptable learning contexts, allowing students to access learning materials, collaborate with peers, and engage in interactive instructional activities beyond the traditional classroom setting.

The application of mobile technologies in education has advanced rapidly due to the increasing accessibility of internet-enabled devices and digital learning platforms. According to Lin et al. (2021), mobile technologies support a learner-centered approach by providing students with real-time access to educational content, enabling personalized learning experiences, and fostering greater interaction between students and teachers. Through digital resources such as educational apps, online videos, and interactive platforms, students can supplement classroom instruction, access additional learning materials, and engage in self-paced learning.

Pechenkina (2017) highlights that in today's digital age, nearly every learner possesses or has access to at least one multifunctional mobile device with diverse applications, making mobile learning increasingly feasible. The expansion of wireless connectivity has further transformed how information is processed and disseminated, offering exceptional opportunities for innovative learning experiences (Berge & Muilenburg, 2013). With the continuous advancement of mobile technologies, education has seen a shift toward self-directed, personalized, and interactive learning approaches, enhancing student engagement and accessibility to academic resources (Brown & Mbatia, 2015).

Physics, as a technical and abstract subject, often requires interactive and practical learning approaches to enhance student comprehension and engagement. However, traditional instructional methods—which rely heavily on theoretical explanations and passive learning—struggle to capture student interest, contributing to low academic performance in the subject. Studies suggest that integrating mobile technologies, such as simulations, ICT-powered lesson presentations, online collaborative learning, and mobile-based assessments, can enhance conceptual understanding and problem-solving skills (Gulek & Demirtas, 2005; Hennessy et al., 2007). However, despite these potential benefits, many rural and semi-urban schools in Kenya still rely on conventional teaching methods, limiting students' exposure to technology-driven learning experiences.

Kenya Institute of Education (KIE), 2006, highlights the importance of science education in fostering critical thinking, problem-solving, and innovation. In particular, Physics plays a vital role in technological and industrial development. However, trends indicate that many students struggle with the subject, leading to low enrollment and high dropout rates. Given these challenges, exploring how mobile technologies can be systematically integrated into Physics instruction is essential.

While prior research acknowledges the potential of mobile technologies in education (UNESCO, 2012; UNICEF & Intermedia, 2013), most studies focus on general adoption trends rather than their direct impact on academic achievement in specific subjects. Moreover, limited research exists on how mobile technologies influence student performance in Physics within rural and semi-urban Kenyan schools, where infrastructural challenges and digital literacy gaps persist. The research aims to fill this gap by investigating how the utilization of mobile technologies influences students' academic achievement in Physics within secondary schools in Nandi East Sub-County.

Despite the increased penetration of mobile devices in Kenya, disparities remain in their adoption for instructional purposes. According to Kemp (2021), Kenya had 59.24 million mobile connections in January 2021, reflecting an 11% increase from the previous year. However, while these statistics suggest widespread mobile accessibility, not all learners benefit equally from mobile-assisted learning due to factors such as teacher preparedness, student digital literacy, and school ICT infrastructure. Therefore, understanding how mobile technologies specifically impact learning processes and academic achievement in Physics is critical for informing policy and practice.

This research investigated the instructional use of mobile technologies in Physics and examined their influence on students' academic achievement in secondary schools within Nandi East Sub-County, Kenya. By focusing on simulations, ICT-powered lesson presentations, online collaborative learning, and online assessments, the study will provide insights into how these tools influence students' engagement, comprehension, and overall achievement in Physics. The findings will contribute to the ongoing discussions on effective use of technology in education, offering practical recommendations for enhancing Physics instruction through mobile learning.

An analysis of national Physics performance trends reveals concerning statistics. Reports from the Kenya National Examination Council (KNEC), (2022) over five consecutive years (2018–2022) indicate that student academic achievement in Physics remains low. Table 1 presents the mean scores for Physics Papers 1 and 2 over this period.

Table 1: Mean KCSE Scores in Physics Papers 1 and 2 for the Years 2018 to 2022

Paper	Maximum Score	2022	2021	2020	2019	2018
P1	80	22.42	21.12	21.58	25.63	22.98
P2	80	21.69	17.59	25.93	20.43	22.13

Source: Kenya National Examination Council 2022 Report

The data highlights a consistent trend of low academic achievement in Physics, with the highest recorded score remaining below 33% over five years. The situation in Nandi, and specifically in Nandi East Sub-County, reflects a similar challenge, necessitating targeted interventions aimed at improving Physics instruction and student outcomes.

This research explored how the instructional use of mobile technologies influenced students' academic achievement in Physics across secondary schools in Nandi County, Kenya, with a specific focus on Nandi East Sub-County. The study assessed how the instructional use of mobile technologies influenced learner engagement, facilitated access to instructional resources, and improved content delivery, evaluating their effectiveness in strengthening Physics education outcomes in this region.

1.3 Statement of the Problem

Despite the proliferation of mobile technologies and their increasing presence in educational settings (Wendeson et al., 2010), their incorporation into Physics instruction remains limited. Many students are not effectively making use of these tools in enhancing conceptual understanding, particularly in Physics—a subject widely considered challenging due to its abstract concepts, intricate theories, and complex models (Mualem & Elyon, 2007).

Persistent low performance in Physics, as reflected in national examination data (Table 1), underscores the need for more effective and interactive instructional strategies.

Although the Ministry of Education, in collaboration with the Centre for Mathematics, Science and Technology Education in Africa (CEMASTE) — an agency under its jurisdiction — has actively promoted the widespread utilization of ICT in pedagogy, schools in Nandi East Sub-County have not fully embraced mobile technologies in Physics instruction. Existing studies on ICT in education have predominantly focused on student engagement rather than their measurable influence on subject-specific academic achievement. Moreover, much of this research has concentrated on well-resourced school environments, creating a gap in understanding how mobile technologies influence academic outcomes in less privileged rural and semi-urban contexts.

In particular, insufficient focus has been placed on the role of mobile-based simulations, ICT-powered lesson presentations, online collaborative learning, and mobile-facilitated assessments in enhancing students' conceptual understanding and problem-solving abilities in Physics. This study addressed this gap by examining how extensively the instructional application of mobile technologies influenced students' academic achievement in Physics within secondary schools in Nandi County, with a specific focus on Nandi East Sub-County. The findings aimed to inform practical decisions regarding the structured utilization of mobile technologies for Physics instruction, particularly in comparable educational setting

1.4 Purpose of the Study

This study aims to investigate the influence of instructional use of mobile technologies on the academic achievement of students in Physics at secondary schools within Nandi County, Kenya, with a specific focus on Nandi East Sub-County, Kenya. Specifically, it investigates how the use of mobile-based simulations, ICT-powered lesson presentations, online

collaborative learning, and online assessments contribute to improving instructional effectiveness and learning outcomes in Physics education.

1.5 Objectives of the Study

- i. To assess the influence of simulations on students' academic achievement in Physics in secondary schools in Nandi East Sub-County, Kenya.
- ii. To examine the influence of ICT-powered lesson presentations on students' academic achievement in Physics in secondary schools in Nandi East Sub-County, Kenya.
- iii. To determine the influence of online collaborative learning on students' academic achievement in Physics in secondary schools in Nandi East Sub-County, Kenya.
- iv. To analyze the influence of online assessment on students' academic achievement in Physics in secondary schools in Nandi East Sub-County, Kenya.

1.6 Research Questions

- i. What is the influence of simulations on students' academic achievement in Physics in secondary schools in Nandi East Sub-County, Kenya?
- ii. What is the influence of ICT-powered lesson presentations on students' academic achievement in Physics in secondary schools in Nandi East Sub-County, Kenya?
- iii. How does online collaborative learning influence students' academic achievement in Physics in secondary schools in Nandi East Sub-County, Kenya?
- iv. How does online assessment influence students' academic achievement in Physics in secondary schools in Nandi East Sub-County, Kenya?

1.7 Justification of the Study

Physics is a foundational component of Science, Technology, Engineering and, Mathematics (STEM) education, which plays a vital role in fostering scientific and technological advancement. STEM education integrates the natural sciences with emerging technologies, emphasizing interactive and experiential learning. Through STEM approaches, students

develop practical skills by visualizing scientific phenomena, interacting with technological tools, and grounding their understanding in real-world processes (Sari et al., 2020). The instructional use of mobile technologies aligns with these principles by offering dynamic, interactive learning experiences that support students' grasp of complex scientific ideas.

Despite the centrality of Physics in STEM education, student performance in the subject remains consistently low in national examinations. In Kenya, Physics continues to attract relatively low enrollment compared to other sciences. For instance, in 2022, only 276,296 candidates undertook the Physics examination in the Kenya Certificate of Secondary Education (KCSE), accounting for just 31.47% of the total 877,972 candidates. This low uptake, combined with persistent underperformance, highlights the need for more effective instructional strategies. The integration of mobile technologies presents a viable approach to addressing these challenges by supporting more engaging, accessible, and effective Physics instruction.

This study is expected to offer practical insights for various education stakeholders. For students, the use of mobile technologies may facilitate improved learning experiences through enhanced access to educational resources and interactive content. Physics educators may benefit from a clearer understanding of how mobile technologies can support instructional delivery and promote student-centered teaching. Parents may gain a deeper understanding of the educational potential of mobile technologies, thereby addressing concerns regarding their use in learning environments. School administrators and policymakers may also draw from the findings to promote the adoption and effective use of mobile technology-based initiatives aimed at improving science education outcomes in Kenyan secondary schools.

1.8 Significance of the Study

The relevance of this research extends to various stakeholders in the education sector, particularly those concerned with teaching and learning Physics at the secondary school level. The findings will inform multiple areas based on the study's specific objectives. By examining the impact of simulations on students' academic achievement, the study offers evidence that can support Physics teachers in adopting simulation tools that enhance conceptual understanding and learner engagement. It will also be useful to content developers in designing interactive and adaptive simulation resources suited for mobile platforms, and to curriculum developers who may consider incorporating simulation-based approaches within the official syllabus to enrich instructional delivery.

With regard to ICT-powered lesson presentations, the study will provide valuable information for teachers and school administrators by showing how digital tools such as multimedia presentations can improve the effectiveness of classroom instruction. This could encourage schools to invest in relevant digital infrastructure and continuous professional development for teachers. Policymakers and teacher training institutions could also utilize the findings to support the development of programmes that promote the efficient instructional application of mobile technologies (MT) within classroom contexts.

In exploring online collaborative learning, the study will benefit teachers by highlighting how structured digital collaboration among students can improve understanding and academic outcomes in Physics. It will also enable students to recognize the importance of peer interaction within a digital learning setting. Moreover, parents may begin to appreciate the academic potential of MT, particularly in supporting students' collaborative learning efforts beyond the physical classroom.

Concerning the utilization of mobile technologies in assessment, the study will be beneficial to teachers and education administrators by demonstrating how mobile-based assessments can enhance the quality of feedback and promote ongoing monitoring of student progress. The findings will also be valuable to education technology developers, who can improve the design and relevance of digital platforms used for assessment in Physics instruction.

Overall, the study is expected to generate empirical evidence regarding the instructional utilization of mobile technologies in Physics education—an area that remains under-researched within the Kenyan context. It will support evidence-based decision-making among curriculum developers, policymakers, and school leaders aiming to enhance the standard of science instruction. The findings are expected to contribute to improved pedagogical practices, enhance learner outcomes, and promote the responsible and productive use of MT in secondary school Physics instruction

1.9 Scope of the Study

This study sought to investigate the effect of the instructional use of mobile technologies on students' academic achievement in Physics in secondary schools located in Nandi East Sub-County, Nandi County, Kenya. The scope was confined to Nandi East Sub-County due to its academic relevance and history of ICT-focused educational interventions, making it an ideal setting for exploring the utilization of mobile technologies in Physics teaching. The study specifically targeted Form Three students taking Physics, Physics instructors, and Heads of Departments (HODs) in secondary schools within the Sub-County.

Form Three students were selected because they had already selected Physics as part of their academic track and had a foundational understanding of the subject, positioning them to evaluate the role of mobile technologies in supporting conceptual understanding, problem-solving, and experimentation in Physics.

The study excluded other groups such as school administrators and parents, as its focus was on the classroom-level utilization of mobile technologies by teachers and learners.

1.10 Limitations of the Study

The study faced limitations that should be considered when interpreting its findings. First, the rapid evolution of mobile technologies poses a challenge to the long-term applicability of the results. As new advancements in mobile technologies continue to emerge, the impact on students' academic achievement in Physics may change, highlighting the need for ongoing research to assess the relevance of these findings over time.

Second, reliance on self-reported data from students and teachers could introduce bias, as respondents may have been hesitant to disclose challenges encountered in using the technologies. To address this limitation, confidentiality was assured to encourage honest responses and minimize social desirability bias.

Additionally, while the study focused specifically on mobile technologies, it remains necessary to acknowledge other elements that may affect students' academic achievement, such as teacher competency, school infrastructure, and government policies. Although efforts were made to account for these variables, their influence could not be entirely controlled for, and their effects on the findings cannot be ruled out.

Despite these limitations, the study provides a critical analysis of mobile technologies utilization in Physics instruction and serves to lay the groundwork for future research.

1.11 Delimitations of the Study

The scope of this study was delimited to the instructional use of mobile technologies in the teaching of Physics in secondary schools within Nandi County, with a specific focus on Nandi East Sub-County. The scope was specifically limited to four key components of

mobile technologies: simulations, ICT-powered lesson presentations, online collaborative learning, and online assessments. These constructs were chosen due to their direct relevance to modern digital pedagogy in science education.

The study participants were restricted to Physics teachers, Heads of Departments (HODs), and Form 3 students. School administrators and policymakers were excluded, as the primary focus was on those directly involved in the instructional process and classroom learning.

To ensure informed consent and willing involvement, all respondents received detailed briefings on the purpose of the study and were assured of confidentiality. These delimitations were intentionally established to maintain a focused, manageable, and relevant scope, in keeping with the research objectives.

1.12 Assumption of the Study

An underlying premise of this research was the expectation that mobile technologies were actively utilized in Physics instruction and learning at secondary schools within Nandi East Sub-County, Kenya. It was further presumed that both students and teachers had adequate access to these technologies, and that their instructional use significantly influenced student engagement and academic achievement in Physics.

1.13 Definition of Key Terms

Academic Achievement The level at which a student excels in physics as measured through assessments, practical applications, and overall mastery of physics concepts and principles.

Collaborative Learning A learner-focused instructional approach that involves students in physics education through group discussions, peer interactions, shared problem-solving, and digital platforms to enhance conceptual understanding and academic achievement

Instructional Use	The purposeful application of mobile technologies by both educators and learners to enhance the teaching as well as the learning experience in Physics, including content delivery, student engagement, assessment, and problem-solving
Mobile Devices	Portable electronic tools that enable physics teachers and students to interact and access information remotely through networking capabilities. In this study, mobile devices refer to smartphones, tablets, and laptops with input, storage, processing, and output functionalities.
Mobile Technologies (MT)	A combination of mobile hardware (devices) and software (applications, platforms) that facilitates digital access to physics instructional content, enhances interactive learning, and supports communication between students and teachers.
Online Assessment	The administration, evaluation, and feedback process of students' understanding and proficiency in physics using digital platforms and mobile technologies
Simulations	Digital or virtual models that replicate real-world physics concepts, allowing students to interact, observe, and experiment in a controlled learning environment
Traditional Classroom	A conventional face-to-face learning environment where Physics instructors and students meet for instruction, discussions, and assessments without relying on mobile technologies
Wireless Fidelity (Wi-Fi)	Wireless networking technology that enables portable devices to connect to the internet, supporting digital learning, research, and communication in physics education.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter offers an in-depth examination of previous research conducted by scholars in this field. It includes a review of theoretical literature, the guiding theoretical framework, as well as the conceptual framework. Additionally, it examines research gaps and summarizes the key findings of the chapter.

2.2 Mobile Technologies

Mobile technologies (MT) are wireless, portable, and internet-enabled tools that facilitate communication, access to information, and digital interactions. These include smartphones, tablets, and laptops, which support applications such as e-learning, cloud computing, and real-time collaboration. The instructional application of MT in education has reshaped teaching practices, enhancing flexibility, learner engagement, and personalized learning experiences (Crompton et al., 2021).

MT supports digital learning by enabling students to access educational materials anytime, thereby promoting self-paced learning. Cloud-based platforms such as Google Drive allow for collaboration and resource sharing, improving knowledge acquisition (Parmigiani & Hidi, 2019). Interactive simulations and augmented reality further enhance learning, especially in STEM subjects, by providing immersive experiences (AlGerafi et al., 2023). Additionally, mobile-based assessments offer real-time feedback, facilitating continuous student evaluation (Mdlalose, 2022).

The adoption of mobile technologies aligns with Framework for Rational Analysis of Mobile Education (FRAME) Model and Connectivism theory of learning, which emphasize personalized and networked learning. Mobile technologies support individualized learning by adapting content to students' needs while also fostering knowledge-sharing networks beyond

traditional classrooms. Research shows that these technologies improve engagement and academic performance, particularly in science-based subjects (Crompton & Burke, 2020). Moreover, the integration of key components such as simulations, ICT-powered lesson presentations, collaboration tools, and mobile-based assessments is essential in enhancing students' comprehension and problem-solving skills. These elements collectively contribute to a more engaging and learner-focused educational setting, reinforcing the significance of mobile technologies within contemporary education.

While the instructional use of mobile technologies within the learning context offers notable advantages, it faces certain challenges. Inadequate availability of devices and reliable internet connectivity can hinder their effectiveness, especially in resource-constrained settings. Moreover, without proper guidance, mobile devices may contribute to distractions that affect learning outcomes. Teacher preparedness and digital literacy are also critical factors influencing the successful utilization of these technologies (Kearney et al., 2021). Addressing these concerns is necessary to ensure that mobile technologies is effectively leveraged for optimal student learning.

In summary, mobile technologies have revolutionized education by increasing accessibility and engagement. When effectively integrated, they have the potential to enhance students' academic achievement by improving knowledge retention, fostering collaboration, and supporting interactive learning experiences. The incorporation of simulations, ICT-powered lesson presentations, collaboration, and mobile-based assessments is crucial in maximizing the benefits of mobile technologies, particularly in subjects like physics. Ensuring equitable access, structured implementation, and teacher readiness will be key to harnessing their full impact on student performance.

2.3 Empirical Literature Review

Empirical investigations have explored the role of Mobile Technologies (MT) in enhancing physics instruction, highlighting their impact on interactive content delivery, real-time feedback, multimedia resources, personalized learning experiences, and student engagement. Research has demonstrated improvements in conceptual understanding and problem-solving skills through mobile applications, simulations, and virtual labs. Additionally, studies suggest that MT fosters collaborative learning and self-directed study.

However, gaps still exist in the literature. Many studies focus on higher education settings, leaving a need for more research on secondary schools, particularly in the Kenyan context. Additionally, while the benefits of MT are well-documented, there is limited empirical evidence on its long-term effects on academic achievement in physics. The extent to which MT influences different student demographics, such as learners in rural versus urban settings, also remains underexplored. Moreover, most studies emphasize technological availability rather than teachers' and students' competencies in effectively utilizing these tools for learning. Addressing these gaps will deepen comprehension regarding the instructional use of MT and its influence on students' academic achievement in Physics.

2.3.1 Influence of Simulations on Students' Academic Achievement

Simulations are engaging digital tools that replicate real-world processes, enabling students to visualize and manipulate complex scientific concepts in a virtual environment. In Physics, simulations facilitate deeper understanding by enabling learners to conduct virtual experiments, observe real-time outcomes, and engage in problem-solving activities that enhance conceptual mastery. Given their interactive nature, simulations have the potential to address challenges in Physics education, particularly in schools with limited laboratory resources.

Existing research has shown a strong correlation between simulations and academic success in Physics. Almasri (2022) established that students who engaged with simulations exhibited improved problem-solving skills and academic performance. Similarly, De Jong and Joolingen (2018) found that simulations promote inquiry-based learning by allowing learners to manipulate parameters and analyze results. However, these studies primarily focused on general or desktop-based simulations, leaving a gap in understanding how mobile-based simulations, which are increasingly accessible to students, influence Physics learning outcomes in secondary schools.

Further, Sahin and Yilmaz (2020) explored the application of Augmented Reality (AR) simulations and reported that students who utilized AR-enhanced simulations performed significantly better than their peers. The study also highlighted how mobile devices facilitate continuous learning by enabling students to engage with digital experiments beyond the classroom. However, while AR simulations require specialized applications, mobile-based simulations provide a more accessible alternative, particularly in resource-constrained schools. The study did not examine how such readily available mobile simulations influence Physics achievement in secondary schools, an area that this study seeks to address.

Huang et al. (2019) investigated mobile technologies-based simulations in university STEM courses and found that, they improved engagement and conceptual understanding by providing immediate feedback. While this underscores the potential benefits of mobile simulations, the research was carried out in higher education environments. Secondary school learners, especially those in rural areas, encounter different challenges, including limited internet access and inadequate teacher training on mobile simulation use. Thus, the extent to which mobile simulations influence secondary school students' understanding of abstract Physics concepts, such as motion and energy, remains unexplored.

In the Kenyan context, Kairo et al. (2022) found that the instructional use of simulations in secondary school Physics led to higher test scores and increased enthusiasm for the subject. Malack (2020) also emphasized the importance of simulations in strengthening conceptual understanding, while Chumba et al. (2020) highlighted their role as an alternative to traditional laboratory experiments in schools with limited resources. While these studies affirm the positive influence of simulations, they primarily examine the general use of digital simulations rather than those specifically integrated with MT. Given that mobile devices are increasingly available to students; it is crucial to establish how mobile-integrated simulations contribute to academic achievement in Physics at the high school level.

Moreover, a review of existing literature reveals that, most studies have been conducted in urban or well-resourced schools, limiting their applicability to rural and semi-urban schools where mobile devices could serve as an alternative to conventional laboratory experiments. This study bridges this gap by focusing on secondary schools in Nandi East Sub-County, where access to well-equipped Physics labs is often limited. The study will examine how mobile-enhanced simulations influence students' academic performance in Physics, particularly in resource-constrained environments.

By addressing these gaps, this research adds to the growing body of knowledge on MT instructional application in Physics teaching. It provides empirical evidence on whether mobile-based simulations enhance academic achievement and offers practical guidance on how these tools can be effectively implemented in secondary schools.

2.3.2 Influence of ICT-Powered Lesson Presentations on Students' Academic Achievement

Lesson presentation involves leveraging ICT and mobile technologies (MT) to deliver educational content through structured information delivery, interactive teaching methods, and digital resources. In Physics education, ICT-powered lesson presentations incorporate

MT elements like animated content, simulations, multimedia, and interactive tools, which enhance learner engagement and conceptual understanding. The integration of MT further allows for flexible access to instructional content, supporting self-paced learning while reinforcing key scientific concepts. Beyond content delivery, ICT-powered lessons foster 21st-century competencies, including digital literacy, critical reasoning, collaboration, and analytical problem-solving (Lukenge, 2019). Additionally, Lubiano (2018) emphasizes that interactive multimedia fosters active student learning by making lessons more engaging and student-centered. Given the widespread availability of wireless and portable mobile devices and relevant applications, learning environments are rapidly evolving, presenting opportunities for improved academic achievement in Physics.

Empirical research has consistently highlighted the transformative role of ICT in enhancing student performance. Alsawalem (2019) found that ICT-based instructional activities significantly improved academic achievement, affirming the effectiveness of technology in supporting student learning. Similarly, Cheng (2021) reported that ICT integration positively influences both student engagement and performance. These studies reinforce the value of technology-driven pedagogical approaches, yet they do not specifically examine the influence of ICT-powered lesson strategies on deeper learning, problem-solving, and engagement—critical aspects of Physics education. Furthermore, while studies by Ede and Anosike (2023) and Maruping and Velepini (2022) established a correlation between ICT use and student performance in Physics, they did not explore how MT enhance these lesson presentations, particularly in schools with limited teaching resources.

Further, Karanja et al. (2019) used a quasi-experimental design in Nairobi County and found that students taught using ICT-enhanced lesson presentations outperformed their peers taught through traditional methods. Mburu (2021), employing a mixed-methods approach in Nakuru County, reported that ICT integration not only enhanced academic achievement but also

increased student engagement. Additionally, Njoroge (2023), using a descriptive survey in Machakos County, emphasized that MT support interactive learning, yet the study did not measure their direct influence on academic achievement. These findings suggest that while ICT-powered lesson presentations are beneficial, their effectiveness in Physics instruction, particularly when enhanced by MT, remains underexplored.

Despite growing evidence supporting ICT-driven instruction, several critical gaps persist. Most studies have examined ICT integration in general classroom instruction rather than specifically analyzing mobile-enhanced lesson presentations in Physics education. Moreover, research on ICT-powered teaching strategies in secondary schools has predominantly concentrated on well-equipped settings, resulting in a gap in understanding their effectiveness in rural and semi-urban schools with limited technological infrastructure. Additionally, the extent to which mobile-enhanced ICT lesson presentations improve student engagement, problem-solving skills, and, Physics achievement has yet to be extensively examined.

The current investigation addresses these gaps by investigating the influence of MT-enhanced ICT lesson presentations on the achievement of learners in Physics in the Nandi East Sub-County. Utilizing a mixed-methods approach, it aims to provide empirical evidence on how mobile-supported lesson presentations contribute to both engagement and academic performance, particularly in schools with varying levels of technological accessibility. Understanding the effectiveness of mobile-enhanced lesson presentations will inform pedagogical practices and policy decisions, ensuring that MT are optimally utilized to improve Physics learning outcomes in secondary schools

2.3.3 Influence of Online Collaborative Learning on Students' Academic Achievement

Online collaborative learning (OCL) is an instructional approach that leverages digital platforms to facilitate interactive knowledge-building among learners. It fosters teamwork,

discussions, and problem-solving, enabling students to exchange ideas, critically reflect on concepts, and construct knowledge collectively. Through digital collaboration, students engage beyond the physical classroom, improving their communication skills, critical thinking, and active learning. Leveraging mobile technologies further enhances accessibility, enabling learners to engage in real-time, share resources, and take part in academic discussions regardless of location. Given that Physics requires conceptual clarity and problem-solving skills, OCL presents an opportunity to strengthen students' engagement and comprehension of abstract scientific principles.

Empirical studies affirm the positive impact of OCL on academic achievement. Tsai et al. (2023) discovered that, structured online discussions and peer-assisted learning in virtual classrooms positively correlated with student performance. Similarly, Wang and Chen (2019) emphasized that MT facilitates real-time collaboration and immediate feedback, crucial for effective knowledge retention. However, these studies did not specifically examine how MT influence interactive engagement in Physics, a subject that requires hands-on exploration of concepts like motion, electricity, and magnetism.

The impact of digital tools in enhancing STEM education has been widely documented. Salhab and Daher (2023) performed a quasi-experimental investigation on secondary school students and found that OCL significantly improved Physics performance. Their research, which used pre-test and post-test measures, demonstrated that students who engaged in online academic discussions outperformed those who relied on traditional instructional methods. Additionally, MT played a pivotal role in facilitating virtual interactions, bridging learning disparities, and ensuring equal access to academic resources. Malack (2020) further noted that students participating in online collaborative activities exhibited higher academic achievement than those who did not, attributing this to the ability of mobile-supported platforms to enhance engagement and accessibility to Physics learning materials.

Locally, studies have highlighted the transformative impact of online collaboration on student achievement. Kiarie and Muindi (2020) carried out a mixed-methods approach, integrating surveys and classroom observations to explore how digital educational tools can enhance engagement and foster knowledge-sharing. The findings revealed that interactive online discussions created a more engaging learning environment, improving students' conceptual understanding of scientific principles. Furthermore, the study demonstrated that digital platforms facilitate collaborative problem-solving beyond the physical classroom, strengthening students' critical thinking and creativity. However, barriers such as inconsistent digital access and network connectivity challenges continue to hinder the effective adoption of these technologies in Physics instruction. Mburu (2021), explored the role of MT in facilitating interactive learning, noting that while real-time collaboration enhances student participation, its direct influence on subject-specific performance remains largely unexamined.

Despite the growing body of research supporting OCL, significant gaps remain, particularly in subject-specific applications within Physics education. Many studies focus on general academic performance without considering how online collaboration influences Physics achievement. Additionally, while MT are increasingly used to support virtual discussions and group learning, their influence on conceptual understanding, engagement, and problem-solving in Physics has not been extensively studied.

This study seeks to bridge these gaps by investigating how mobile-supported collaborative learning influences students' academic achievement within the sub-county of Nandi East. Unlike previous studies that focus on general ICT integration in education, this research specifically examines how MT fosters engagement, enhances problem-solving skills, and improves academic performance in Physics instruction. Through a structured learning environment, this study will provide empirical evidence on the effectiveness of mobile-

supported OCL, thereby informing instructional strategies that optimize Physics learning outcomes in secondary schools.

2.3.4 Influence of Online Assessment on Students' Academic Achievement

Online assessment involves the use of digital platforms to evaluate students' academic progress, subject knowledge, and skill acquisition. Unlike traditional paper-based assessments, online assessments leverage technology to administer tests, automate grading, and provide immediate feedback, allowing for real-time learning adjustments (Zheng et al, 2023). Various formats, including multiple-choice questions, and peer-reviewed assignments, have been integrated into digital assessment systems to enhance students' conceptual understanding and engagement. The instructional utilization of mobile technologies in assessment practices further enables flexibility, accessibility, and continuous learning, making it a crucial component of Physics instruction in secondary schools.

Existing research has demonstrated the effectiveness of online assessment in improving students' academic achievement. Mukazi (2022) found that real-time feedback mechanisms in online assessment platforms significantly enhance students' comprehension of Physics concepts, as immediate correction of misconceptions reinforces learning. Additionally, gamified online assessments have been shown to improve motivation and engagement, leading to better academic outcomes (Smith et al., 2022). Similarly, Turan (2023) emphasized that standardized online evaluations provide a more reliable measure of students' Physics achievement. However, while these studies highlight the general benefits of online assessment, they do not fully address the challenges associated with its implementation, particularly in the context of MT. Effective integration of mobile-based assessments necessitates that teachers possess adequate digital literacy skills. Barbedo et al. (2023) found that many educators lack the necessary training to effectively utilize mobile tools in

instructional delivery, potentially limiting the efficacy of such assessments in enhancing academic achievement among students.

The role of MT in online assessment has gained attention in recent studies, particularly in improving student engagement and performance. Salhab and Daher (2023) conducted a quasi-experimental study at the university level, comparing students' performance before and after the implementation of mobile-based assessments. Their findings revealed, mobile-supported assessments increased student participation and provided greater flexibility, ultimately enhancing learning outcomes. Similarly, Evariste et al. (2022) noted that secondary school learners who engaged in mobile-integrated online assessments achieved higher scores in Physics. These studies suggest that mobile platforms improve accessibility and feedback mechanisms, ensuring students can review their performance instantly and make necessary improvements. However, their focus on higher education and well-resourced secondary schools leaves a gap in understanding how mobile-enhanced assessments influence Physics achievement in rural, resource-constrained schools.

Further, studies examining mobile-supported formative assessments indicate positive impacts on students' academic performance. Kiarie and Muindi (2020) found that interactive digital quizzes and adaptive online testing improved Physics students' engagement and conceptual understanding. Their research highlighted that mobile assessment tools encourage interactive learning by providing students with real-time analytics on their performance. However, challenges such as limited internet connectivity, device accessibility, and teacher preparedness hinder full-scale adoption in secondary schools. Similarly, Mburu (2021) examined mobile-based formative assessments and found that while instant feedback mechanisms motivated students to actively participate in learning, the direct influence on Physics problem-solving skills remained underexplored.

While existing studies affirm that online assessment enhances student engagement and academic achievement, there remains still a notable lack of clarity in comprehending the ways in which mobile-based online assessments distinctly influence Physics achievement at the secondary school level, particularly in rural areas. Most studies examine general digital assessment trends, but few explore subject-specific applications, especially in Physics, where conceptual learning and problem-solving require specialized assessment strategies. Moreover, the extent to which mobile-supported assessments facilitate real-time feedback, improve conceptual retention, and enhance Physics performance in resource-limited settings remains unclear.

This study addresses these gaps by focusing on mobile-enhanced online assessment in secondary school Physics within Nandi East Sub-County. By investigating how MT influence assessment effectiveness, engagement, and performance, this research contributes to evidence-based instructional strategies for integrating digital assessment in Physics education. Unlike previous studies that focus on urban or university settings, this study provides understanding into how mobile-supported assessments can bridge accessibility gaps and optimize learning outcomes in rural and semi-urban secondary schools.

2.4 Theoretical Literature Review

This study is anchored on Marguerite Koole's (2009) Framework for the Rational Analysis of Mobile Education (FRAME), which examines how the learner interacts with, technology, and the surrounding social environment in mobile learning. FRAME model emphasizes how mobile devices support cognitive engagement, enhance usability, and foster social connections to improve learning outcomes. By framing mobile technologies (MT) within an appropriate theoretical model, researchers can better understand their role in shaping students' academic achievement.

Additionally, Siemens' (2005) Connectivism Theory underscores the importance of networks, digital interactions, and real-time collaboration in modern learning environments. It posits that, knowledge is spread over various online platforms, while learning occurs through active participation in digital communities. Mobile technologies facilitate personalized learning experiences, enable instant access to information, and enhance student engagement, making them vital tools in contemporary education.

2.4.1 Framework for Rational Analysis of Mobile Education (FRAME)

The goal of this framework is for researchers to understand and gain a deeper insight into the complexities of mobile learning beyond its apparent practicality (Koole et al., 2010). The model defines mobile learning as the process that emerges from the confluence of mobile technology, social interaction, and human learning capacity. The FRAME model tackles concerns ranging from information overload and knowledge mapping to collaborative learning that are prevalent in today's classrooms. It provides a framework for addressing these challenges and enhances the learning experience. The FRAME model is a learning approach within which learners may connect and communicate with each other while both are geographically and chronologically far apart. It emphasizes the dynamic interaction between learners, technology, and context, making learning more flexible, personalized, and accessible across diverse educational settings. This adaptability fosters a deeper understanding and engagement with content. The context of the FRAME model pertains to information. Information might come from the learner's internal or external sources, such as personal, social, technical, or environmental stimuli. The learning environment is made up of all of these stimuli (Koole, 2009).

The FRAME model is depicted through a Venn diagram as shown in Figure 1 below.

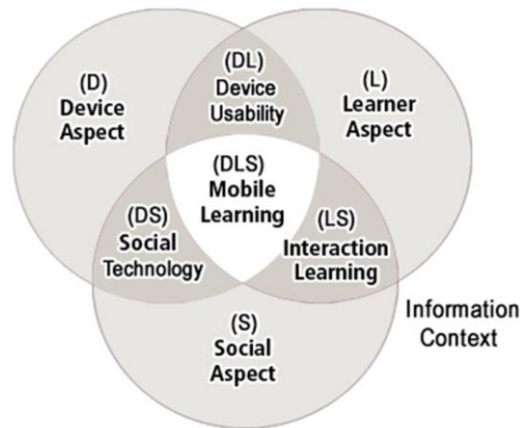


Figure 1: Venn Diagram Representing Aspects of the FRAME Model

The three interconnected domains within the FRAME Model represent its core components: Device Usability, the Learner Aspect, and the Social Aspect. These three elements come together to provide a definition of mobile learning. The secondary intersections, or areas where two circles meet, include qualities that relate to both aspects. Learner aspect covers features of individual learners, whereas the social elements explain processes of interaction among individuals. The functionalities of mobile devices are described through the qualities found within the secondary junction of context learning (DL) and social technology (DS). Instructional and learning ideas are found in the secondary intersection named interaction Learning (LS). The main intersection (DLS), which reflects and characterizes the mobile learning (ML) process in theory, is a culmination of all three elements. FRAME model outlines a style for erudition whereby scholars could perhaps transition between real and, virtual places and engage or connect with; other students, information, as well as systems at any time and from any location.

Table 2 Summarizes the characteristics of the FRAME Model as depicted in the Venn diagram (Figure 1).

Table 2: Summary of Characteristics of the FRAME Model

Set and Intersection	Characteristics (Where learning occurs)
Device Aspect (D)	Material elements Processor speed, Storage and retrieval Input/output capabilities-mobile apps
Learner Aspect (L)	Requisite knowledge Memory transfer Proclivities of learning Rewards or motivation,
Social Aspect (S)	Conversation Collaboration Connection
Device Usability (DL)	Transportability Accessibility to Information Satisfaction, Psychological comfort
Social Technology (DS)	Connectivity Networking. Interaction tools
Interaction Learning (LS)	Curriculum Cognition Communities of learning, Practices of Pedagogy Interaction-Learners, Instructors, Content (Mobile Technologies)
Mobile Learning (DLS)	Mediation-mediators and translators Access and selection of information. Navigation of Knowledge

Source: Marguerite Koole's Framing of Mobile Learning (2009)

The FRAME Model provides a structured approach to understanding how MT contribute to learning, particularly in enhancing students' academic achievement in physics. This model defines mobile learning as the result of an interaction between three key elements: Device Usability (D), Learner Aspect (L), and, Social Aspect (S). These components collectively shape the effectiveness of mobile learning and establish the foundation for utilizing MT in education.

The FRAME model aligns with the focus of this study on utilizing MT in physics education. The model highlights device usability, which includes key features such as processor speed, storage capacity, retrieval capabilities, and mobile applications that support learning. These technological aspects ensure that mobile devices can facilitate simulations, animations, online collaboration, and interactive assessments, all of which play an essential part in enhancing learners' grasp of physics concepts and improving academic performance.

The social aspect of the FRAME model underscores the significance of collaboration, communication, as well as connectivity within mobile learning. Through mobile platforms such as WhatsApp, YouTube, Kahoot, TikTok (Educational Accounts), Microsoft Teams, Edmodo, PhET Simulations and other online forums, students can engage in discussions, access educational content, and participate in group activities beyond the traditional classroom setting. This enhances peer learning, knowledge-sharing, and academic support, ultimately improving students' engagement and achievement in physics.

The learner aspect in the FRAME model focuses on individual students' knowledge, learning preferences, memory transfer, and motivation. By incorporating MT, students can access physics content at their own pace, replay instructional videos, and interact with digital learning resources tailored to their needs. This personalized approach supports deeper comprehension, active learning, and improved retention of physics concepts, ultimately leading to better academic outcomes.

The interaction learning (LS) component of the FRAME model addresses curriculum, pedagogy, and cognitive engagement in mobile learning. By utilizing mobile learning tools such as simulations, animations, and virtual laboratories, students can visualize complex physics theories and apply them in practical scenarios. This approach enhances students'

ability to bridge the gap between abstract theories and real-world applications, thereby promoting deeper comprehension of physics principles.

The framework highlights Device Usability (DL), which ensures accessibility, portability, and psychological comfort in mobile learning. With mobile technologies, students can retrieve educational materials at their convenience, enabling self-paced learning and effective revision. This is particularly beneficial for students who may require additional time to grasp challenging physics concepts outside the classroom environment.

Government policy serves as an intervening variable in the instructional utilization of mobile technologies in education. The FRAME model's emphasis on knowledge navigation, information access, and mediation suggests that policy interventions should focus on improving infrastructure, teacher training, and digital content development to enhance mobile learning in physics education. Ensuring that schools possess the required technological resources and teacher support systems will maximize the benefits of mobile learning.

The FRAME model provides a theoretical foundation for this research by demonstrating how mobile devices, learner engagement, and social interactions contribute to effective mobile learning. It provides a structured framework for analyzing the influence of mobile technologies on students' academic performance in physics and emphasizes the importance of accessibility, collaboration, and instructional design in mobile-based education. By leveraging the principles of the FRAME model, this study seeks to offer empirical evidence on effective strategies for utilizing mobile technologies to enhance physics learning outcomes for secondary school students in Nandi East Sub-County, Nandi County.

2.4.2 Connectivism Theory of Learning

A theory of learning provides a structured framework explaining how individuals acquire, process, and retain knowledge (Mezirow, 2018). Learning theories offer valuable perspectives on cognition, motivation, and engagement, guiding effective instructional strategies. In digital education, Connectivism has emerged as a relevant theory, particularly suited for the 21st-century technological landscape.

Siemens (2020) defines Connectivism as a theory that recognizes knowledge as distributed across networks, rather than being confined to an individual. It emphasizes digital connectivity, where learning occurs through interactions with peers, digital resources, and online communities. A core principle of Connectivism is that meaningful learning is facilitated through collaboration and information-sharing in technology-enhanced environments. Downes (2023) further characterizes Connectivism through three key dimensions: knowledge, learning, and community—where knowledge informs learning, learning shapes communities, and communities contribute to knowledge construction.

Connectivism is relevant to this study due to its alignment with MT utilization in Physics education. This research examines how mobile-based tools, such as simulations, collaborative learning, and online assessments, influence students' academic achievement. Connectivism provides a strong theoretical foundation by underscoring the importance of digital interactivity, real-time knowledge access, and peer collaboration—factors that enhance engagement and comprehension in Physics. Through MT, learners can retrieve diverse learning materials, engage in interactive evaluations, and participate in collaborative conversations, reinforcing their understanding of concepts and ability to solve problems.

Moreover, Connectivism highlights the shift from traditional teacher-centered instruction to student-centered learning, where learners take an active role in knowledge construction. This

aspect is particularly relevant as mobile technologies facilitate self-directed learning, enabling students to investigate Physics concepts outside the classroom environment. The theory also supports the use of digital simulations and multimedia, which have been shown to enhance the comprehension of abstract concepts—a key challenge in physics learning.

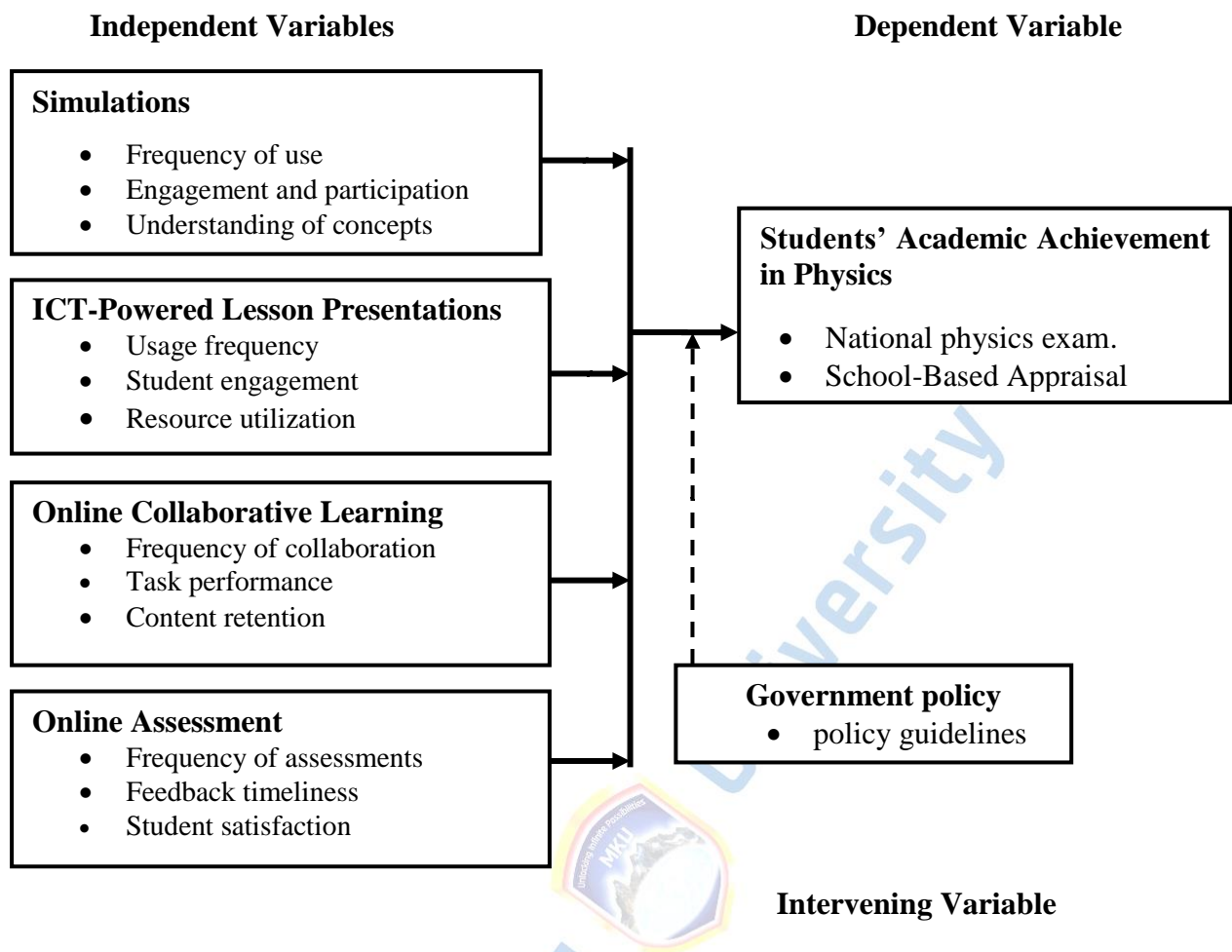
Despite its strengths, Connectivism has faced criticism, particularly regarding its applicability in structured learning environments and its reliance on digital access (Kasmia, 2023). Some scholars argue that it lacks empirical validation in formal education settings and may not adequately address learners' cognitive development (Stefanou, 2021). However, as MT become more integrated into classrooms, Connectivism offers a relevant lens for analyzing how digital tools enhance student learning outcomes.

By framing this study within the Connectivist perspective, the research seeks to explore how MT facilitates knowledge acquisition, fosters peer collaboration, and ultimately influences students' academic achievement in Physics. This theoretical foundation offers a critical perspective on the significance of digital technologies in modern education, reinforcing the central argument of this study that effective utilization of technology can enhance instructional delivery and increase student engagement in Physics classrooms.

2.5 Conceptual Framework

The conceptual framework serves as an organized representation of the primary elements of a study and the manner in which they relate to each other (Mutai, 2018). In this study, the instructional use of mobile technologies (MT) is examined as the Independent Variable, while students' academic achievement in Physics is treated as the Dependent Variable. Government policy acts as an Intervening Variable that could shape the relationship between MT instructional use and academic outcomes.

. These variables are conceptually linked as illustrated in Figure 2.



Source: The Researcher (2023)

Figure 2: Conceptual Framework on Instructional Use of Mobile Technologies

This study is anchored on two key theoretical foundations: The FRAME model and the Connectivism Learning Theory. FRAME model (Koole, 2009) highlights the dynamic interaction between mobile devices, learners, and social contexts in enabling effective mobile learning. It supports the study's focus on how mobile technologies such as simulations, ICT-powered lesson presentations, online collaboration, and digital assessments enhance Physics instruction and learning outcomes.

Likewise, Connectivism (Siemens, 2005) underscores the importance of digital connectivity, networked learning, and access to diverse knowledge sources. This theory aligns with the study's objective of investigating how MT promote learner engagement, conceptual understanding, and, foster students' ability to apply problem-solving strategies in Physics.

For conceptual clarity, a brief overview of how the variables are assessed is provided (Figure 2). Simulations are evaluated based on their contribution to learners' conceptual understanding and problem-solving in Physics. ICT-powered lesson presentations are assessed by their effectiveness in improving lesson engagement, delivery of content, and student attentiveness. Online collaborative learning is examined through student self-reports on the use of digital tools, level of peer engagement, and frequency of interaction in Physics-related tasks. Online assessments are measured by the immediacy and quality of feedback they provide and their impact on learners' self-regulated learning and academic confidence.

The study also introduces government policy as an intervening variable, given its foundational role in shaping the educational environment in which MT are adopted. Unlike moderating variables that simply affect the strength of a relationship, an intervening variable like policy actively shapes the conditions—such as infrastructure availability, institutional support, and teacher training—that determine the effectiveness of MT utilization in improving academic outcomes.

By conceptualizing the relationships among these key constructs, the framework offers a structured approach to understanding how MT influence students' academic achievement in Physics. It supports the study's overarching goal of evaluating mobile technologies-driven instructional strategies and their practical application in secondary school settings.

2.6 Research Gaps

A research gap is an unexplored or insufficiently studied area within a field of study that requires further investigation. It represents a missing piece of knowledge, an unresolved question, or a limitation in existing research that a new study seeks to address. Identifying and addressing these gaps ensures that new research enhances scholarly understanding and provides practical solutions to existing challenges.

One significant research gap in physics education lies in examining the impact of MT-enhanced simulations on students' academic achievement. Simulations have long been acknowledged for their capacity to enhance conceptual understanding, bolster problem-solving abilities, and promote student engagement in physics education (Almasri, 2022; De Jong & Joolingen, 2018; Sahin & Yilmaz, 2020). Despite these benefits, there is a limited number of empirical studies that directly link simulations to measurable academic performance, especially within the secondary school setting. Most existing research (Kairo et al., 2022; Malack, 2020) tends to focus on qualitative factors, such as student motivation and engagement, rather than quantitative assessments of academic achievement.

Furthermore, the role of mobile-supported simulations in improving conceptual understanding in physics within under-resourced environments remains insufficiently investigated. While simulations have proven useful in enhancing learning outcomes, the potential of mobile technologies in resource-constrained settings, such as secondary schools in Nandi East Sub-County, remains largely unexplored. To fill this gap, this study uses standardized assessments to provide objective evidence of how MT-enhanced simulations influence academic achievement in physics. This research aims to enhance physics education by evaluating the effectiveness of simulations while addressing region-specific challenges.

Closely related to mobile-based simulations is the use of ICT-powered lesson presentations in physics instruction. ICT-driven presentations have been associated with improved student engagement and knowledge retention (Lukenge, 2019; Lubiano, 2018; Cheng, 2021). Studies by Alsawalem (2019) and Maruping and Velepini (2022) indicate a positive correlation between ICT-enhanced lesson delivery and students' academic performance. However, the existing literature lacks consistency in methodological approaches, with many studies relying on self-reported data rather than standardized academic performance metrics (Ede & Anosike, 2023). Furthermore, while ICT-powered lessons have been extensively examined in

developed regions, there is a scarcity of research on their effectiveness in rural and resource-constrained environments. The extent to which ICT-powered lesson presentations influence students' achievement in physics, particularly in under-resourced secondary schools, remains an area requiring empirical investigation. This study will address this gap by examining both qualitative and quantitative outcomes, providing a holistic understanding of the role of ICT-powered lesson presentations in improving physics achievement in Nandi East Sub-County.

Beyond lesson delivery, Online Collaborative Learning (OCL) has emerged as an essential component of effective education. OCL promotes critical thinking, problem-solving, and active engagement in students (Tsai et al, 2023; Wang & Chen, 2019). Research by Salhab and Daher (2023) suggests that students involved in OCL demonstrate improved academic performance due to enhanced peer interactions and knowledge-sharing. However, studies specifically linking OCL to students' achievement in physics remain scarce. Most research has examined general academic performance rather than subject-specific outcomes (Malack, 2020; Kiarie & Muindi, 2020). Additionally, while MT has been recognized as a tool for enabling online collaboration, limited studies have explored its role in facilitating peer learning in physics education, particularly in secondary school settings. This study seeks to investigate how MT-enabled collaborative learning influences students' achievement in physics in Nandi East Sub-County, analyzing both cognitive and interactive learning outcomes to provide a comprehensive perspective on its effectiveness.

Another critical gap in physics education research relates to how effective online assessments are in enhancing students' academic achievement. Online assessments offer immediate feedback, personalized learning experiences, and greater accessibility (Mukazi, 2022; Smith et al., 2022; Turan, 2023). Existing studies point to a positive correlation between online assessments and, students' achievement in physics (Salhab & Daher, 2023; Evariste et al., 2022). However, research specifically examining how MT-facilitated online assessments

influence students' performance in physics in secondary schools remains limited. Many studies fail to evaluate the effectiveness of different online assessment formats in measuring conceptual understanding, problem-solving abilities, and the development of analytical reasoning and higher-order thinking skills across diverse learning contexts. Additionally, challenges such as internet connectivity, student adaptability, and assessment credibility remain underexplored, particularly in rural contexts. This study will bridge this gap by analyzing the role of MT-enhanced online assessments in improving students' physics achievement, thereby offering a critical analysis for educators and policymakers to optimize digital assessment strategies.

While various studies have explored the impact of MT on education, there remains a significant contextual gap in understanding its influence on students' achievement in physics within Nandi East Sub-County. Many existing studies do not account for region-specific challenges, such as inadequate infrastructure, limited digital literacy, and poor internet access, factors that may hinder the successful adoption of MT-enhanced learning (Kiarie & Muindi, 2020). Furthermore, although previous research has investigated how mobile technologies impact learners' participation and motivation in physics, limited studies have examined its direct effect on academic achievement, particularly in rural and semi-rural secondary schools.

To address these gaps, this study will investigate how the instructional use of MT influences Physics learning in Nandi East Sub-County, taking into account the unique infrastructural and socio-economic factors affecting secondary schools in the region. The findings will offer localized evidence to inform targeted interventions and policy recommendations for the effective adoption of MT in Physics instruction. Through this research, educators and policymakers will gain a deeper understanding of how mobile-based innovations can be strategically implemented to enhance learning outcomes in Physics, particularly in contexts where mobile technologies offer new opportunities for educational advancement.

2.7 Chapter Summary

This chapter offered a detailed review of scholarly works related to the instructional use of MT in Physics learning, focusing on their influence on students' academic achievement. The empirical review examined studies on mobile-based simulations, ICT-powered lessons, online assessments, and collaborative learning. Existing literature indicates that MT tools support concept comprehension, learner engagement, and mastery of Physics content. However, prior studies often relied on qualitative data, lacked standardized achievement metrics, or were conducted in technology-rich contexts.

The theoretical review was anchored on the FRAME Model, which explains the interaction between mobile devices, learners, and social environments in facilitating mobile learning. Additionally, the study adopted the Connectivism Theory of Learning, which emphasizes knowledge acquisition through digital networks, peer collaboration, and real-time resource access. These theories support the role of MT in promoting student-centered learning, interactivity, and engagement. The conceptual framework illustrated the relationship between the independent variable (instructional use of MT), the dependent variable (students' academic achievement in Physics), and the intervening variable (government policy).

Research gaps identified include the limited empirical evidence on the influence of the instructional use of MT on students' academic achievement in Physics, particularly within the context of secondary schools in Nandi East Sub-County, Kenya. Moreover, existing studies often overlook region-specific challenges such as limitations in infrastructure, gaps in digital literacy, and contextual barriers. This study addresses these gaps by investigating the influence of MT on students' academic achievement in Physics, contributing to development of evidence-based strategies and policy recommendations for improving Physics education.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This section presents the methodology that guided this study. It outlines key components, including research design, target population, sample size, and sampling methods. The chapter also elaborates on the instruments and procedures used for data collection. To ensure the credibility of the findings, it addresses validity and, reliability of the research instruments. Lastly, the chapter outlines the data analysis techniques and highlights the ethical considerations observed to maintain research integrity and uphold ethical standards.

3.2 Research Methodology

Research methodology refers to the systematic approach used to collect, analyze, and interpret data in addressing a research problem (Kothari, 2017). It provides the overarching approach guiding the research, including the selection of data collection methods, analysis techniques, and validation strategies. This research adopted a mixed-methods design, integrating both quantitative and qualitative methods to explore the influence of mobile technologies on students' academic achievement in Physics.

The quantitative approach employed structured surveys administered to both students and teachers. Pearson's Correlation Coefficient was used to assess the strength and direction of the relationships between the instructional use of MT and academic achievement in Physics. Multiple Regression Analysis (MRA) was employed to evaluate the predictive influence of specific MT instructional utilization elements, such as simulations, ICT-powered lesson presentations, online collaborative learning, and online assessments.

The qualitative approach complemented the numerical findings by exploring lived experiences of both teachers and students with MT. Semi-structured interviews and observations were used to gather in-depth data on instructional practices. Thematic analysis

was conducted to categorize and interpret recurring patterns and meaningful interpretations from the qualitative data (Opiyo et al., 2017). The integration of both methods allowed for triangulation, enhancing the depth, credibility, and comprehensiveness of these findings.

3.3 Research Design

Research design is a structured framework that directs data collection, measurement, and analysis, ensuring the study effectively addresses its research questions (Kothari, 2017). Unlike research methodology, which defines the overall approach to the study, research design specifies how data will be gathered and analyzed within that methodological framework.

The study utilized a descriptive-correlational design to explore the association between the instructional use of mobile technologies and students' academic achievement in Physics, without manipulating any variables. The descriptive aspect documented the extent and nature of MT use in physics instruction, while the correlational component established whether a relationship existed between the instructional use of MT and academic achievement. Descriptive-correlational designs are suitable for studies that explore naturally occurring relationships between variables (Creswell & Creswell, 2017).

The independent variable was the Instructional Use of Mobile Technologies, which encompassed simulations, ICT-powered lessons, online collaborative learning, and online assessments. The dependent variable was students' academic achievement in physics.

Data Information gathering involved structured Likert-scale surveys, guided interviews, and structured observation checklists. These tools captured the frequency, intensity, and nature of MT use in instructional settings. Interviews with Heads of Departments (HODs) captured administrative understanding and implementation experiences.

Quantitative data analysis was carried out with the help of SPSS software. The Pearson correlation coefficient was applied to assess the associations among the study variables, while MRA determined the extent to which specific MT components predicted Physics academic achievement. Qualitative data were analyzed thematically using manual coding and categorization techniques to identify recurring ideas and meaningful interpretations. This design enabled the study to systematically analyze both descriptive and relational aspects of MT use in Physics instruction, offering both breadth and depth in addressing research questions.

3.4 Location of the Study

The study was carried out in Nandi East Sub-County, one of the five administrative divisions of Nandi County, Kenya, which also includes Nandi South, Nandi North, Nandi Central, and Tinderet. Nandi East was purposively selected due to its relevance to the study's focus.

Nandi East was selected based on academic considerations, including the presence of both rural and semi-urban secondary schools offering Physics, ongoing ICT instructional interventions, and consistently low academic performance in Physics—mirroring national trends. Preliminary observations and educational reports indicated a relatively low level of instructional use of MT in Physics teaching within the sub-county. This trend has coincided with a decline in student enrollment in Physics, suggesting possible connections between pedagogical practices and learner engagement or achievement.

Given these contextual factors, Nandi East was deemed a suitable microcosm for examining the instructional use of MT and its influence on academic achievement in Physics. Findings from this focused investigation are expected to inform county-level policy formulation and guide the improvement of instructional strategies across the County.

3.5 Target Population

A population refers to a complete group of individuals, events, or entities that exhibit similar observable characteristics (Mugenda & Mugenda, 2003). For the purpose of this study, the target group included Physics teachers, Heads of Departments (HODs), and Form Three students drawn from 31 secondary schools situated in Nandi East Sub-County, a division of Nandi County, Kenya. This diverse group allows for a comprehensive examination of the use of MT in Physics instruction.

The study population consisted of all schools offering Physics in the Sub-County, including all students, teachers, and Heads of Department involved in Physics instruction. However, the target population was specifically drawn from Form Three Physics students, Physics instructors, and HODs overseeing Physics instruction within these schools. Table 3 presents a comparative overview of the study population and the target population, highlighting the specific groups under investigation.

Table 3: Comparative Overview of Study and Target Populations

Category	Study Population	Target Population	Total
Schools	Secondary schools in Nandi East Sub-County	(Not individually targeted)	-
Physics Students	All Physics students in the study schools	Form Three Physics students	896
Physics Teachers	All Physics teachers in the study schools	Physics teachers in the study area	63
HODs	All Heads of Science/Physics in the study schools	HODs overseeing Physics instruction	31

Source: SCDE Nandi East (2023)

Form Three Physics students, who have voluntarily chosen the subject, are central to this study. Their motivation and interest in the field and careers are crucial for understanding real-world implications and the impact of technology on students' academic achievement.

Students have chosen the subject as one of their KCSE examinable subjects, signaling its importance as a discipline relevant to their future careers. Their engagement with MT in Physics education provides essential data on its effectiveness in enhancing learning experiences.

Physics teachers were selected as they play a pivotal role in delivering Physics instruction and integrating MT in their lessons. Most of these teachers are regular educators, not on contractual terms, and possess the, necessary pedagogical skills as well as subject knowledge to successfully implement MT in Physics teaching. Their perspectives are crucial in identifying successes, challenges, and strategies for optimizing technology use in Physics education.

Heads of Departments (HODs) for Physics or Science play a pivotal role in overseeing the use of MT, evaluating their effectiveness, and providing guidance to teachers. They ensure that such utilization aligns with educational policies and curriculum standards while contributing strategic perspectives on implementation and sustainability. Table 4 presents a detailed breakdown of the target population by respondent category.

Table 4: Distribution and Composition of the Target Population

Respondents	Target Population (N)
Physics Students	896
Physics Teachers	63
Heads of Department (HODs)	31

Source: SCDE Nandi East (2023)

The structured selection of this population ensures that the study captures multiple perspectives on the use of MT in Physics education, from students who experience the learning process, to teachers responsible for lesson delivery, and HODs overseeing the implementation of technology in schools.

3.6 Sampling Technique and Sample Size

Determining a sample entails choosing a subset of participants drawn from a larger population such that the sampled individuals exhibit characteristics representative of the overall group (Maina, 2012). To achieve a representative sample, the study employed appropriate sampling techniques based on the nature of the target population.

3.6.1 Sampling Techniques

A combination of sampling strategies was used to obtain a sample that accurately reflected the participant population, comprising Form Three Physics students, their instructors, and departmental heads, (HODs), and secondary schools in the Sub-County of Nandi East. The approach minimized selection bias while enhancing generalizability.

Simple random sampling was applied in choosing 29 secondary schools out of a total of 31, ensuring proportional representation. These schools formed the basis for student, teacher and HOD selection. Proportionate simple random sampling was applied to select 300 Form Three Physics students from a total of 896, as determined using Cochran's formula. Selection was proportional to each school's student population, followed by simple random sampling. This approach enhances representativeness by ensuring fair subgroup inclusion (Etikan & Bala, 2017; Makwana et al., 2023). Gender balance was also considered, with 176 boys and 124 girls included.

Physics teachers were selected using critical case sampling, ensuring inclusion of educators experienced in MT incorporation in Physics instruction. One teacher per school was purposively selected, with random sampling applied in schools with multiple Form Three Physics teachers. This method ensured the participation of teachers directly engaged in instructional practices (Patton, 2015). For HODs total enumeration sampling was applied due to the small population size, ensuring near-complete representation of those overseeing Physics instruction.

By integrating proportionate, purposive, and simple random sampling, this study minimized selection bias, improved reliability, and strengthened the validity of research findings.

3.6.2 Sample Size

Given the finite nature of the population, the total number of potential respondents was considered in determining the sample size, which was calculated using Cochran's formula:

$$n_0 = \frac{Z^2 p(1-p)}{e^2}$$

Where;

n_0 = Initial sample size for an infinite population

Z = Z-score (1.96 for 95% confidence level)

p = Estimated proportion of the population (0.5 for maximum variability)

e = Margin of error (4.62% or 0.0462)

For finite populations, the adjusted sample size (n) is calculated as:

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$$

Schools; $n = \frac{451}{1 + (451-1)/(31)}$ **n=29**

HODs; $n = \frac{451}{1 + (451-1)/(31)}$ **n=29**

Physics Teachers; $n = \frac{451}{1 + (451-1)/(63)}$ **n=54**

Physics students; $n = \frac{451}{1 + (451-1)/(896)}$ **n=300**

Table 5: Distribution of Sample Size and Sampling Techniques

Category	Population	Sample Size	Sampling Technique
Schools	31	29	Simple Random Sampling
Physics Students	896	300	Proportionate Simple Random Sampling
Physics Teachers	63	54	Purposive Sampling & Random Sampling
HODs	31	29	Total Enumeration Sampling

Source: Researcher (2023)

Cochran's formula of 1977 was selected for its effectiveness in determining sample sizes for finite populations while incorporating the desired confidence level and margin of error

(Kanaki & Kalogiannakis, 2023). This approach minimizes sampling bias, enhances statistical reliability, and ensures the selection of a representative sample. Moreover, it is widely recognized in educational research for its precision in handling diverse population sizes.

3.7 Research Instruments

Collection of data was carried out through questionnaires, observation and interview schedule. Operationalizing the three methods together enables triangulation, where data from multiple sources can be compared and contrasted to enhance accuracy, consistency, and comprehensiveness in the research findings.

3.7.1 Questionnaire

Structured questionnaires were administered to both Physics instructors and students to gather their perspectives regarding the influence of utilizing MT on students' academic achievement in Physics. According to Iwaniec (2019), a questionnaire—also referred to as a feedback form—is a data collection tool made up of systematically arranged questions intended to gather information from participants. Iwaniec further highlights that questionnaires are cost-effective and, can reach a large number of respondents simultaneously. However, demographic challenges may hinder their successful implementation in research. To enhance reliability, respondents were guaranteed strict confidentiality, and the questionnaires were distributed and retrieved immediately to minimize potential bias and maximize response rates.

Questionnaire for Students

The questionnaires administered to students sought to collect detailed feedback on their learning experiences, academic performance, and perceptions of the role of MT in Physics education. As the primary unit of analysis, students provided data covering all study objectives, ensuring a thorough examination of the influence of MT on learning. As some

student participants were minors, consent forms were issued and signed on their behalf by principals of the respective schools prior to their participation in the study.

Questionnaire for Teachers

Teachers were provided with structured questionnaires to capture their perspectives on the influence of utilizing MT on students' academic achievement in Physics. The questionnaire included a section on demographic information to contextualize their responses. Since students were the main unit of analysis, teachers' responses served to supplement the findings. To ensure a sequential and unbiased data collection process, teachers completed the questionnaire after students had submitted theirs.

3.7.2 Observation

Observation was employed as a data collection method to gather information that participants might be unwilling or unable to disclose through self-reported methods. The observer focused on assessing the availability and utilization of MT, examining how these tools were integrated into instructional activities. This approach enabled the validation and contextualization of self-reported data, offering a comprehensive perspective on the actual implementation and effectiveness of MT in physics education

The observation systematically assessed the availability and utilization of key MT enablers in schools, focusing on infrastructure that supports digital learning. The study specifically examined the presence and use of mobile devices, which facilitate student engagement with digital learning resources. Additionally, smartboards and projectors were observed to determine their role in enhancing interactive learning through visual and multimedia instructional approaches.

Given that effective adoption of MT depends on reliable internet access, the observation also covered network infrastructure, specifically routers and Wi-Fi availability. These elements

are crucial for accessing online simulations, educational applications, and digital content. By evaluating both the presence and actual use of these technologies, the observation process provided empirical validation of self-reported data from teachers, ensuring a more accurate understanding of MT usage.

3.7.3 Interviews for the Heads of Department

Heads of Department (HODs) were interviewed to explore their perspectives and experiences regarding utilization of mobile technologies (MT) in physics instruction. These one-on-one interviews provided an opportunity for in-depth discussions, enabling a detailed understanding of the successes and challenges associated with MT implementation.

The qualitative interviews focused on HODs' views on the impact of MT in areas such as simulations, ICT-powered lessons, online collaborative learning, and online assessments, specifically in relation to students' academic achievement in physics within the Kenyan educational context. These interviews complemented the quantitative data collected through questionnaires from students and teachers, offering a more holistic view of MT's influence. The interviews were conducted immediately after collecting the questionnaires, ensuring a seamless transition between data collection methods.

3.8 Validity and Reliability of Research Instruments

The strength of any research lies in the rigorous assurance of both validity and reliability of its outcomes. Maintaining these standards strengthens the trustworthiness and precision of the study's findings.

3.8.1 Validity

Validity denotes the degree to which a research instrument accurately captures the concept it is designed to assess (Robson et al., 2016), determining the accuracy of the test results. To ensure validity, the research instruments, including questionnaires and interview schedules, were critically reviewed with input from supervisors and subject matter experts, and any

remaining limitations were addressed through further refinement and pilot testing to enhance accuracy and reliability.

3.8.2 Reliability

According to Mugenda and Mugenda (2003), reliability refers to the consistency with which a research instrument yields similar outcomes when applied repeatedly under comparable conditions. In research, reliability ensures that, the measurement tools yield stable and consistent results over time, thus enhancing the trustworthiness of the findings and minimizing potential errors or biases that could undermine the study’s conclusions.

To ensure reliability, the researcher conducted a pilot study in two schools that were excluded from the main study. A total of 34 students and 6 teachers participated, offering a suitable sample for assessing the consistency of the research instruments. Internal consistency of the questionnaire items for both students and teachers was assessed using the Cronbach’s Alpha test. Recognized as the most effective test for multi-item scales at the interval level of measurement, Cronbach’s Alpha provides a quantifiable estimate of internal consistency (Opiyo et al., 2017).

The reliability test results for students are presented in Table 6 below, which provides a detailed overview of the internal consistency of the variables tested

Table 6: Reliability Test Results for Students

Variable	Cronbach's Alpha (α)	Number of Items	Conclusion
Simulations	.717	8	Reliable
ICT-Powered Lesson Presentations	.796	6	Reliable
Online Collaborative Learning	.813	8	Reliable
Online Assessment	.916	8	Reliable

The reliability coefficient (α) of each variable are as follows; Simulations $\alpha=0.717$, ICT-Powered Lesson Presentations $\alpha=0.796$, Online Collaborative Learning $\alpha=0.813$ and Online

Assessment $\alpha=0.916$. With a ten item instrument for each of the two variables meant for teachers, the Cronbach's Alpha showed coefficients for ICT-Powered lesson presentations and Online Assessment as $\alpha=0.811$ and $\alpha=0.876$ respectively (Table 7).

Table 7: Reliability Test Results for Teachers

Variable	Cronbach's Alpha	Number of Items	Conclusion
ICT-Powered Lesson Presentations	.811	10	Reliable
Online Assessment	.876	10	Reliable

According to the report, a Cronbach's alpha, $\alpha=0.70$ is deemed within acceptability for reliability. Since the reliability coefficients of all variables exceeded 0.70, it can be concluded that the research instruments demonstrate reliability.

3.9 Data Collection Procedure

The researcher was issued with ERC certificate by Mount Kenya university which enabled collection of authorization documents from the National Council for Science, Technology & Innovation (NACOSTI) that permitted him to gather relevant data. These documents were accompanied by a self-introduction letter and an authorization letter from the SCDE–Nandi East, intended to facilitate the researcher's introduction to the participating institutions. Distribution of questionnaires to the respondents in the schools was done by the investigator with the assistance of the physics instructors. Respondents were kindly requested to complete the questionnaire and return it to the researcher immediately. Consent for minors was obtained through the school principals, who signed on their behalf. The researcher during the filling of questionnaires observed MT infrastructure in the schools visited. Interviewing of HODs was done after filling of the questionnaires.

3.10 Data Analysis Procedure

This research utilized descriptive as well as inferential statistics to process the gathered data. Numerical data drawn from questionnaires issued to physics students and teachers were entered into a computer and analyzed using the SPSS software. Summary statistics, including frequencies, percentages, average values, and Standard Deviation (SD), were used to organize and explain the data. A five-point Likert-type scale was adopted to assess respondents' opinions regarding the use of MT in the instruction of physics. The interpretation of response weightings is presented in Table 8.

Table 8: Likert Scale Response Categories and Interpretation

Response	Weighting	Cut Point Range	Interpretation
Strongly Agree	5	=>4.21 - 5.0	Strongly Agree
Agree	4	=>3.41 - 4.20	Agree
Uncertain	3	=>2.61 - 3.40	Uncertain
Disagree	2	=>1.81 - 2.60	Disagree
Strongly Disagree	1	=>1.0 - 1.80	Strongly Disagree

To examine relationships between variables, Inferential statistics were applied. Pearson Correlation Coefficients were employed to assess strength as well as direction of relationship between instructional use of mobile technology (MT) and, students' academic achievement in physics. Pearson correlation is a statistical measure which determines the strength and direction of a linear relationship among two continuous variables, the correlation coefficient, represented by r , can range from -1 to 1. An r value of 1 signifies a complete positive relationship, meaning when one variable rises, the other rises proportionally. Alternatively, an r value of -1 signifies a perfectly inverse relationship, such that an increase in one variable is consistently associated with a corresponding decrease in the other. A correlation coefficient of 0 suggests no linear relationship between the variables. While Pearson correlation helps identify associations, it does not establish causation or explain the nature of the relationship (Field, 2022).

Additionally, Multiple Regression Analysis (MRA) was utilized to determine the predictive influence of instructional use of mobile technologies on students' academic performance. MRA helped control for potential confounding variables such as school infrastructure, teacher preparedness, and government policies, ensuring precise interpretation of results.

The study utilized the subsequent Multiple Regression model:

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \alpha$$

Y =dependent variable (Students' achievement in physics)

β_0 =Regression intercept

$\beta_1, \beta_2, \beta_3$ & β_4 represent the gradient values in the regression equation

Independent variables are;

X_1 is Simulations

X_2 is ICT–Powered Lesson Presentations

X_3 is Online Collaborative Learning

X_4 is Online Assessment

α is Error term

The statistical techniques used for each research objective are detailed in Table 9.

Table 9: Summary of Statistical Analysis Techniques for Research Objectives

Research Objectives	Statistical Techniques of Analysis
To Assess the influence of simulations on students' academic achievement in Physics	Descriptive Statistics Multiple Regression Analysis
To Examine the influence of ICT-powered lesson presentations on students' academic achievement in physics	Descriptive Statistics Multiple Regression Analysis
To Determine the influence of online collaborative learning on students' academic achievement in physics	Descriptive Statistics Multiple Regression Analysis
To Analyze the influence of online assessment on students' academic achievement in physics	Descriptive Statistics Multiple Regression Analysis

The study examined the independent variable—Instructional use of Mobile Technologies—through four key constructs: simulations, ICT-powered lesson presentations, online collaborative learning, and online assessment. These constructs represent different ways in which mobile technology can enhance physics education.

The dependent variable, students' academic achievement in physics, was evaluated through various indicators, including improved performance, formative and summative assessments, classroom tests, teacher evaluations, and student portfolios. Additionally, government policy was considered an Intervening Variable, potentially influencing the connection between instructional use of mobile technologies and, students' academic achievement (Leedy & Ormrod, 2015; Creswell & Creswell, 2017).

By applying MRA, the study quantified the degree of influence each component of mobile technologies had on the students' academic achievement. This approach strengthened the dependability of the conclusions drawn by ensuring that the observed relationships were not incidental but reflective of real-world educational outcomes.

3.11 Ethical Considerations

Ethical considerations involve the moral responsibilities of a researcher in protecting participants' rights, dignity, and overall well-being. While research is essential in generating new knowledge, it must uphold human dignity at all times (Ambang et al., 2021). This study maintained high ethical standards by ensuring participant confidentiality and safeguarding their privacy. Consistent with Creswell and Creswell (2017), the research purpose, data usage, and potential benefits were clearly communicated through verbal and written means to promote informed participation.

Before the study commenced, approvals were obtained from relevant institutional authorities. Permission to participate was granted by the school principals, who acted as responsible

adults on behalf of the students. This approach ensured that the rights of all students were respected according to their age and status.

All data collection instruments were securely stored, and personal identities were kept anonymous. Academic integrity was also observed through proper citation of all sources and acknowledgment of all referenced authors. The data gathered will not be used to harm any individual or institution, nor for financial gain. These ethical measures reinforced the credibility of the research while upholding the welfare and dignity of all participants.



CHAPTER FOUR

RESEARCH FINDINGS AND DISCUSSIONS

4.1 Introduction

This chapter presents the research results, interpretations, and discussions, aligned with the study's objectives and research questions, based on the reviewed literature. The study aimed to assess the influence of simulations, explore the role of ICT-powered lesson presentations, evaluate the effect of online collaborative learning, and examine how online assessment impacts students' academic achievement in Physics in secondary schools within Nandi East Sub-County, Nandi County. Data analysis was conducted using SPSS, with results presented through descriptive and inferential statistics.

4.2 Response Rate

Questionnaires were distributed to Physics teachers and students. Of the expected 54 Physics teachers, 51 participated, while all 300 Physics students successfully completed and returned their questionnaires. Additionally, 28 Heads of Department (HODs) were interviewed, with one HOD not participating. This resulted in a high response rate, with 100% participation from students and an almost complete response from teachers and HODs, ensuring a reliable data collection process.

4.3 Demographic Information

The study assessed the data on demographics for physics instructors and the students.

4.3.1 Students' Demographic Information

The research assessed the following demographic information for students: gender, age, access to unlimited Wi-Fi services, the mobile device most commonly used for learning and the perceived influence of mobile technologies (MT) on the performance in Physics, and the students' performance marks in Physics.

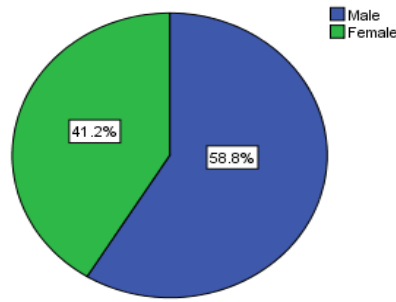


Figure 3: Gender of Students

The study assessed gender distribution of the respondents, revealing that, 58.8% of the students were male, while 41.2% were female. The findings indicate a higher proclivity of male students toward Physics, a trend commonly observed in STEM-related subjects. This gender disparity suggests the need for targeted interventions to encourage more female students to engage in Physics and related fields.

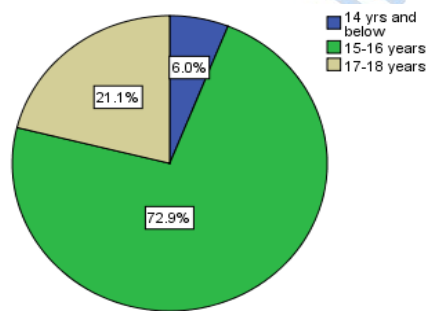


Figure 4: Student Age Profile

The study aimed to explore the age range of the participants. The results indicated that 6% of the respondents were aged below 14 years, while 72.9% were between 15 and 16 years, and 21.1% were aged 17 to 18 years (Figure 4). This indicates that the majority of Form Three students taking Physics were aged between 15 and 16 years. Since a significant portion of the respondents were minors, the researcher issued consent forms, which were signed by the principal on behalf of the students, as the school authority and a significant adult in their academic and personal development.

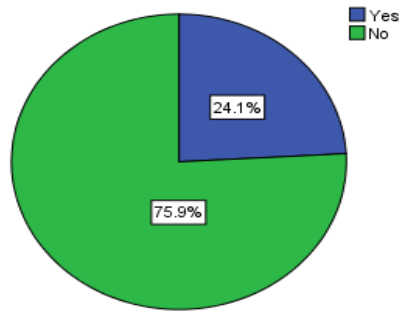


Figure 5: Access to Unlimited Wi-Fi Services by Students

The study sought to determine whether students had access to unlimited Wi-Fi services. The findings indicated that 24.1% of the respondents reported having access, while 75.9% stated they did not. These results highlight that the majority of students lacked access to unlimited Wi-Fi services.

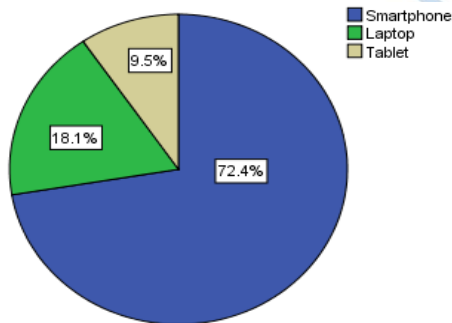


Figure 6: Mobile Devices Accessed by Students for Learning

Figure 6 summarizes the mobile devices most frequently accessed by respondents for educational purposes. The results showed that, 72.4% of the students reported using smartphones, 18.1% accessed laptops, and 9.5% used tablets. These findings suggest that, smartphones were the most widely utilized devices for learning, whereas laptops and, tablets were less frequently accessed. Although these devices were available to students, their distribution was not equitable among learners.

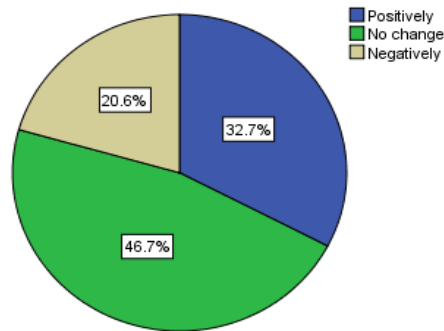


Figure 7: Mobile Technologies and Performance of Physics

The research examined the influence of MT on students' Physics achievement. As shown in Figure 7, 32.7% of respondents reported a positive influence, 46.7% saw no effect, and 20.6% felt MT had a negative impact. These findings suggest that, overall, MT do not significantly affect Physics performance, though a minority of students perceived them negatively.

Table 10: Distribution of Students' Average Physics Exam Scores (Last Three Terms)

Score Range %	f	Percentage (%)
Below 30	85	28.3
30 - 49	90	30.0
50 - 64	70	23.3
65 - 79	40	13.3
80 and Above	15	5.0
Total	300	100

The findings reveal that 58.3% of students achieved below 50% in Physics over the past three terms, with 28.3% in the "Below 30%" category. Only 18.3% scored 65% and above, indicating generally low performance. These results highlight the need for enhanced instructional strategies, such as MT integration, to improve engagement, comprehension, and academic achievement in Physics. Leveraging digital tools like simulations, ICT-powered lesson presentations, and online assessments could provide interactive learning experiences, fostering deeper conceptual understanding and better performance outcomes in the subject.

Table 11: Students' Self-Rated Performance in Physics

Performance	Category %	f	%
Very Poor	Below 30	80	26.7
Poor	30 - 49	95	31.7
Average	50 - 64	75	25.0
Good	65 - 79	35	11.7
Excellent	80 and above	15	5.0
Total		300	100

The students' self-rating of their Physics performance closely mirrors their actual exam scores, with 58.4% of respondents rating themselves as either poor or very poor in the subject (Table 11). Only 16.7% rated themselves as "Good" or "Excellent." These findings highlight a significant gap in student confidence and achievement, reinforcing the need for innovative teaching methods, such as mobile technologies, to improve engagement, motivation, and academic success in Physics. Implementing mobile-based learning tools could support students in overcoming challenges and enhance their understanding of complex Physics concepts.

4.3.2 Teachers' Demographic Information

The research assessed how long the teachers had been teaching Physics, their highest level of qualification, and type of mobile devices they frequently access.

Table 12: Length of Teaching Physics

Years	f	%
1-4	12	23.5
5-9	20	39.2
10-14	15	29.4
15 and above	4	7.9
Total	51	100.0

The study examined the teaching experience of Physics teachers, as shown in Table 12. Results indicated 23.5% had been teaching Physics for between 1 and, 4 years, 39.2% for 5 to 9 years, 29.4% for 10 to 14 years, and 7.9% for 15 years or longer. These findings suggest that, majority of teachers had a teaching experience range of 5 to 9 years, implying that they had likely acquired relevant skills, competencies, and pedagogical strategies to teach the subject effectively. The comparatively smaller proportion of those with more than 15 years of experience may be attributed to their transition into administrative roles.

Table 13: Education Level of Teachers

Education Level	f	%
Masters	15	29.4
Degree	32	62.7
Diploma	4	7.9
Total	51	100.0

A summary of Physics teachers' academic credentials, as presented in Table 13, indicates that 29.4% had attained a Master's degree, 62.7% held a Bachelor's degree, while 7.9% were qualified at the Diploma level. The study established that most of the teachers possessed Bachelor's degrees, with fewer possessing either a Diploma, or a Master's qualification. However, based on their academic credentials, all respondents met the minimum requirement to teach in secondary schools in Kenya, where a Diploma is the lowest acceptable qualification.

Table 14: Mobile Devices Accessed by Teachers for Learning

Mobile Device	f	%
Smartphone	12	23.5
Laptop	31	60.8
Tablet	8	15.7
Total	51	100.0

The study's analysis of mobile devices frequently accessed by instructors for learning revealed that 23.5% used smartphones, 60.8% accessed laptops, and 15.7% utilized tablets (Table 14). These findings suggest that the majority of teachers primarily relied on laptops for teaching Physics, compared to smartphones and tablets. Additionally, the results indicate that all instructors accessed at least one form of mobile device for instructional purposes.

Table 15: Teachers' Responses on the Influence of Mobile Technologies

Influence of MT on Performance	f	%
Positively	32	62.7
No Influence	9	17.6
Negatively	10	19.7
Total	51	100.0

The study's analysis of teachers' responses regarding the influence of mobile technologies on Physics academic achievement revealed that 62.7% of teachers perceived mobile technologies as having a positive Influence on students' performance. 17.6% indicated that mobile technologies had no significant impact, while 19.7% believed they negatively influenced achievement (Table 15).

These findings suggest that most teachers acknowledge the benefits of MT in Physics education, particularly in enhancing student engagement, interactive simulations, and collaborative learning. This aligns with Kairo et al. (2022), who discovered that the use of simulations in Kenyan secondary schools led to higher test scores and increased enthusiasm for Physics. Since simulations are a fundamental aspect of mobile technology integration, these results further support the claim that mobile technologies enhance academic achievement by providing interactive, engaging, and accessible learning experiences.

Table 16: Teachers' Reported Mean Class Scores for Physics

Mean Score (%)	f	%
Below 30	5	9.8
30 - 49	15	29.4
50 - 64	18	35.3
65 - 79	10	19.6
80 and Above	3	5.9
Total	51	100.0

Most teachers reported class mean scores between 30% and 64%, with 35.3% in the 50–64% range and 29.4% in the 30–49% bracket—reflecting generally low Physics performance. Only 5.9% indicated scores of 80% and above. These findings highlight the need for improved instructional strategies, such as integrating MT to foster engagement, boost motivation, enhance conceptual understanding, and ultimately raise academic achievement in Physics.

Table 17: Teachers' Rating of Students' Average Physics Achievement

Performance	Category %	f	%
Very Poor	Below 30	4	7.8
Poor	30 – 49	14	27.5
Average	50 – 64	19	37.3
Good	65 – 79	10	19.6
Excellent	80 and above	4	7.8
Total		51	100.0

Teachers' performance ratings show that most students fall within the "Poor" (27.5%) or "Average" (37.3%) categories (Table 17), with few achieving "Good" (19.6%) or "Excellent" (7.8%) levels. This trend underscores the need for targeted interventions such as MT integration to help address learning gaps in Physics. By offering interactive, engaging, and student-centered tools, MT can enhance comprehension, boost motivation, and support better academic performance in the subject.

4.4 Influence of Simulations on Students' Academic Achievement in Physics

This objective aimed to assess the degree to which simulations influence students' academic achievement in Physics. The study aimed to explore whether students perceive simulations as enhancing their conceptual understanding of Physics, improving their problem-solving skills, and increasing engagement with the subject. In particular, it investigated the role of various digital resources, including tutorials, animated demonstrations, and virtual experiments, in strengthening students' grasp of theoretical concepts while improving their practical abilities.

The research further examined how digital platforms contribute to providing access to simulations, which in turn foster collaboration and discussions among students. These platforms encourage group problem-solving and peer learning, enhancing students' interactions with Physics content and promoting a deeper comprehension of the subject.

Information was gathered using questionnaires administered to 300 students, which focused on their perceptions of the influence of simulations regarding their impact on students' achievement in Physics. Alongside the student questionnaires, interviews with Heads of Departments (HODs) were conducted to gain detailed analysis into how simulations were integrated into Physics instruction. Observations were made during school visits to assess how simulations were being used in the classroom and their effectiveness in supporting student learning.

The data gathered from students, HODs, and observations underwent analysis through both summary and inferential methods. Descriptive methods offered insights into students' perceptions, while advanced statistical tools such as Pearson correlation and MRA were utilized to assess the relationship between the instructional use of simulations and students' academic achievement in Physics.

A summary of students' responses regarding these aspects is presented in Table 18.

Table 18: Students' Opinion on Influence of Simulations on Students' Academic Achievement in Physics

Statement	N	Mean	SD
Simulations help me understand complex Physics concepts and improve problem-solving.	300	2.92	0.91
Animated Physics tutorials reinforce my classroom learning	300	2.94	1.02
Interactive simulation apps enhance my understanding of Physics problems and solutions.	300	2.12	0.95
Virtual Physics experiments using online simulations improve my practical skills.	300	2.14	0.96
Creating animated simulations helps me grasp Physics topics better.	300	2.16	0.94
Accessing educational Physics simulations from online platforms enhances my learning.	300	3.20	0.98
Participating in online discussions about Physics simulations deepens my understanding.	300	2.14	0.91
Collaborating with classmates through shared Physics simulations improves my grasp of concepts.	300	2.07	0.90

The findings indicate that while simulations play a role in enhancing students' understanding of complex Physics concepts, their usage varies significantly. Item 1 sought to determine whether students use simulations for conceptual understanding and problem-solving, yielding a mean score of 2.92 (SD = 0.91). This suggests that while some students actively use simulations, they are not yet fully integrated into learning practices.

Similarly, item 2, which assessed students' engagement with animated Physics tutorials to reinforce classroom learning, recorded a mean of 2.94 (SD = 1.02). suggesting that, animations are recognized as valuable for comprehension and retention, though their adoption remains moderate.

However, item 3, which explored the use of interactive simulation applications in studying Physics problems, recorded a lower mean of 2.12 (SD = 0.95). This suggests that despite the

potential of interactive simulations to enhance problem-solving through hands-on engagement and feedback, their usage is limited. A similar trend was observed in item 4, which examined the use of virtual Physics experiments ($M = 2.14$, $SD = 0.96$), indicating that students may still prefer traditional lab experiences over digital alternatives.

Item 5 assessed students' involvement in creating animated simulations to explain Physics topics, revealing a mean of 2.16 ($SD = 0.94$). While creating animations can enhance both conceptual mastery and collaboration, the findings suggest that students rarely engage in this practice, possibly due to a lack of technical skills or resources.

Conversely, item 6, which examined students' access to educational Physics simulations from online platforms, recorded a relatively higher mean of 3.20 ($SD = 0.98$). This suggests that students frequently use existing digital simulations to supplement their learning, indicating a preference for ready-made resources over self-created content.

In contrast, item 7, which evaluated participation in online discussions about Physics simulations, showed a mean of 2.14 ($SD = 0.91$), while item 8, which assessed collaboration in sharing and discussing simulations, recorded the lowest mean of 2.07 ($SD = 0.90$). These findings indicate that while simulations have potential for peer learning and collaboration, students do not widely engage in interactive discussions or teamwork related to simulation-based learning.

4.4.1 Descriptive Analysis of Influence of Simulations on Students' Academic Achievement in Physics

The study examined the influence of simulations on students' academic achievement in Physics, focusing on their role in conceptual understanding, problem-solving, and engagement with digital learning tools. Table 18 presents the descriptive statistics summarizing students' perceptions of simulation use in Physics learning.

Findings indicate that students moderately utilize simulations to improve their grasp of intricate Physics principles and engage with animated tutorials to reinforce classroom learning. This suggests that while simulations are recognized as valuable tools for visualization and comprehension, their actual usage in Physics lessons remains limited. These results align with prior research (Kairo et al., 2022; Almasri, 2022), which underscores the effectiveness of digital simulations in making abstract scientific concepts more tangible and accessible to learners.

However, the study also reveals that engagement with interactive simulation applications and virtual experiments is relatively low. This indicates that while students acknowledge the potential benefits of simulations, barriers such as limited resources, digital literacy, or motivation may hinder their full integration into learning processes. Furthermore, students reported limited participation in creating their own animated simulations or collaborating on simulation-based activities through digital platforms. This suggests that while students may passively consume digital simulations, the interactive and collaborative aspects of simulation-based learning are underutilized.

Students reported higher engagement with online Physics simulations on educational platforms, indicating a preference for ready-made tools over creating personalized simulations. This suggests that while digital resources are accessible, developing hands-on simulation activities remains an area for improvement. The low engagement in collaborative simulation activities highlights a gap in integrating peer-driven digital learning, especially in rural areas with limited technological infrastructure (Chumba et al., 2020; Malack, 2020)

Overall, the results suggest that while simulations are acknowledged as valuable learning tools, their full potential in fostering interactive and hands-on learning experiences remains

underutilized. Greater integration of simulations into Physics instruction, along with structured support for their effective use, could enhance students' academic achievement.

4.4.2 Inferential Analysis on Influence of Simulations on Students' Academic Achievement in Physics

To examine the influence of simulations on students' academic achievement in Physics, Pearson Correlation and Multiple Regression Analyses (MRA) were performed. The outcomes are summarized in Tables 19, 20, and 21.

Pearson Correlation Analysis

Pearson Correlation analysis was conducted to evaluate the nature and magnitude of the relationship between simulations and students' academic achievement.

Table 19 presents the findings.

Table 19: Correlation Between Simulations with Students' Academic Achievement

Variable	Academic Achievement in Physics
Simulations	$r = 0.289, p = 0.002$ (Significant)

The findings revealed a statistically significant positive correlation ($r = 0.289, p < 0.01$) between the use of simulations and, students' academic achievement in Physics. This suggests that students who actively interact with simulations are likely to achieve better outcomes in the subject. The moderate strength of the correlation indicates that while simulations contribute to improved academic performance, other factors may also play a role. These findings are consistent with earlier research (Huang et al., 2019; Sahin & Yilmaz, 2020), which highlight that when simulations are effectively integrated into learning, they enhance student engagement and conceptual understanding. By providing interactive and visual representations of abstract Physics concepts, simulations facilitate deeper comprehension and support problem-solving skills, making them a valuable tool for modern Physics instruction.

4.4.3 Model Fitness and Regression Summary: Students

To explore the predictive strength of simulations in influencing students' academic achievement, a regression analysis was conducted.

Table 20 presents the model summary.

Table 20: Model Summary (Students)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.652	0.426	0.398	1.321

The regression analysis further examined the extent to which simulations, along with other digital learning strategies, influenced students' academic achievement in Physics. The R-Square value (0.426) indicates that 42.6% of the variance in students' academic achievement can be explained by simulations, ICT-powered lesson presentations, online collaborative learning, and online assessment. This finding suggests that digital learning strategies significantly contribute to students' achievement in Physics.

Moreover, the Adjusted R-Square (0.398) confirms that nearly 40% of students' academic achievement is influenced by these digital learning strategies, while 57.4% of the variation is explained by external factors such as teaching methodologies, student motivation, and school infrastructure. The correlation coefficient ($R = 0.652$) further suggests a strong positive correlation between, instructional use of MT and students' academic achievement in Physics, reinforcing the significance of utilizing digital tools to improve learning outcomes.

4.4.4 Multiple Regression Analysis

A MRA was conducted to ascertain the extent to which simulations predict students' academic achievement.

The findings are presented in Table 21.

Table 21: Multiple Regression Analysis for Influence of Simulations on Students' Academic Achievement

Predictor Variable	Unstandardized Coefficient (B)	Standardized Coefficient (β)	t	p-value
Simulations	0.158	0.134	3.245	0.002**

The MRA revealed that simulations had, notable positive influence on students' academic achievement in Physics ($\beta = 0.134$, $p = 0.002$). This indicates that an increase in the use of simulations is associated with improved student performance in Physics. The positive Beta coefficient further supports the idea that integrating simulations into Physics instruction can enhance conceptual understanding and problem-solving skills.

However, the relatively small effect size suggests that the impact of simulation-based learning may depend on other factors, such as the quality of implementation, student engagement, and accessibility of digital resources. This aligns with previous research highlighting that while simulations are beneficial, their impact is maximized when they are properly structured and actively used in learning activities.

Additionally, the Adjusted R^2 value (0.398) reinforces that simulations, along with other MT-based instructional strategies, explain approximately 40% of the variation in students' academic achievement. This underscores the importance of digital learning tools in enhancing Physics education while also indicating that other external factors contribute significantly to students' performance.

4.4.5 Discussion of Findings on Influence of Simulations on Students' Academic Achievement in Physics

The findings highlighted the influence of simulations on students' academic achievement in Physics, considering both descriptive and inferential analyses. While students acknowledged

the benefits of simulations in enhancing conceptual understanding, problem-solving skills, and engagement, their actual utilization remained moderate to low. The descriptive analysis revealed that students frequently accessed Physics simulations from online platforms but engaged less in interactive simulation applications, virtual experiments, and collaborative simulation-based learning. Suggesting that while students recognize the potential of simulations, they may lack the necessary resources, digital literacy skills, or instructional support to fully integrate them into their learning processes. These results are consistent with prior studies highlighting the need for structured instructional integration to maximize the effectiveness of simulations in learning (Almasri, 2022; Sahin & Yilmaz, 2020).

The correlation analysis indicated a moderate, a statistically significant positive correlation between the use of simulations and students' academic achievement in Physics, with Pearson Coefficient of 0.289 and, a significance value of 0.002. This suggests that, students engaging more frequently with simulations tended to perform better academically. The regression analysis further confirmed that simulations had a statistically meaningful, though modest, positive effect on academic achievement, as evidenced by a standardized coefficient of 0.134 and, a p-value of 0.002. The model summary indicated that simulations, along with other mobile technologies-based instructional strategies, explained approximately 40% of the variation in students' academic achievement in Physics, as indicated by an adjusted R^2 value of 0.398 (Table 20). While these findings confirm that simulations contribute to student performance, their effect is not dominant, implying that other pedagogical and contextual factors significantly shape academic outcomes.

A key observation from the findings was that while students used simulations primarily to reinforce teacher-led instruction, their engagement remained largely passive. Many relied on ready-made simulations rather than actively manipulating them to explore Physics concepts independently. The low engagement in interactive and collaborative simulation-based

activities suggests that students may not have been sufficiently trained on how to utilize these tools effectively for problem-solving and conceptual exploration. These results are consistent with previous studies by Chumba et al. (2020) and Malack (2020), which highlight the importance of teacher facilitation in guiding students toward active learning through simulations.

Additionally, the study found that the positive influence of simulations was relatively small compared to studies conducted in well-resourced environments where simulations significantly enhance academic achievement in Physics (Huang et al., 2019; Sahin & Yilmaz, 2020). This discrepancy could be attributed to variations in access to high-quality digital tools and the quality of implementation. The findings suggest that in the study context, which focused on secondary schools in Nandi East Sub-County, limited technological infrastructure, inconsistent use of simulations in classroom instruction, and varying levels of teacher expertise in digital pedagogy may have moderated the effectiveness of simulations in enhancing educational outcomes.

The findings also align with Frame Theory, which emphasizes that the availability, usability, and structured utilization of digital tools shape their effectiveness in educational settings. Schools with inadequate access to technology or insufficient teacher preparedness struggle to maximize the benefits of simulations, leading to suboptimal learning outcomes. Additionally, Connectivism Theory suggests that learning in the digital age is most effective when students actively engage with technology, collaborate, and participate in knowledge networks. The findings indicated that students' engagement with simulations was isolated and passive rather than interactive and collaborative, limiting the full potential of these tools in enhancing learning outcomes.

Interviews with Heads of Department reinforced these findings, highlighting that mobile-powered simulations helped students visualize abstract Physics concepts, making them more comprehensible. They noted that students who actively engaged with interactive simulations demonstrated better problem-solving skills and, higher critical thinking abilities. However, the Heads of Department also pointed out key barriers to effective implementation, such as limited access to digital devices, unreliable internet connectivity, and inadequate teacher training on simulation-based instruction.

Observations made during school visits further supported these findings, as schools with adequate MT infrastructure and active use of simulations was associated with increased student engagement and better academic performance. In classrooms where digital devices such as tablets, projectors, and interactive simulation tools were effectively integrated into lesson delivery, students demonstrated stronger conceptual understanding and higher internal examination scores. Conversely, schools with limited access to technological resources exhibited lower performance trends, suggesting that the meaningful integration of simulations into classroom instruction plays a role in enhancing students' academic achievement.

The findings suggest that the potential of simulations to improve academic achievement in Physics can only be fully realized if systematically integrated into classroom instruction. Merely providing access to simulations is insufficient; deliberate efforts are needed to ensure meaningful student engagement. Teachers must undergo professional development on effective simulation-based strategies to guide interactive and exploratory learning. Additionally, there is a need for well-designed, curriculum-aligned digital simulations to ensure relevance. Lesson plans should incorporate simulations into regular activities, rather than treating them as optional. The learning environment should promote active and collaborative engagement, encouraging students not only to consume but also to create, manipulate, and analyze simulations together.

To enhance engagement, project-based learning approaches could be introduced, where students design and test their own simulations, fostering a deeper understanding of Physics concepts. Additionally, teachers should encourage group-based simulation activities where students collaborate, discuss findings, and solve problems collectively.

Overall, while simulations offer significant potential as a teaching tool in Physics, their current implementation in the study context appears suboptimal. The small but significant regression findings suggest that simulations have a measurable, though limited, influence on academic achievement. Addressing issues related to accessibility, engagement, and structured instructional use through improved teaching strategies, increased teacher support, and enhanced student participation will be crucial in maximizing the benefits of simulation-based learning in Physics education.

4.5 Influence of ICT-Powered Lesson Presentations on Students' Academic Achievement

This objective aimed to examine how ICT-powered lesson presentations influence students' academic achievement in Physics. The study focused on integrating mobile technologies into Physics education, exploring how these methods enhanced student engagement, comprehension, and academic performance. The research sought to understand the effectiveness of ICT in improving learning outcomes and, overall student success in Physics.

To collect data for this objective, questionnaires were distributed to 300 students and, 51 teachers to obtain their perceptions on the use of ICT-powered lesson presentations. In addition, 28 Heads of Departments (HODs) were interviewed to assess the influence of using ICT tools in teaching Physics. Observations were also made during school visits to assess the application of ICT in enhancing student learning.

The data collected from students, teachers, HODs, and observations were analyzed using both descriptive and inferential statistics. Descriptive statistics were employed to summarize the responses, while inferential statistics, including Pearson correlation and multiple regression analysis, were used to examine the relationship between ICT-powered lesson presentations and students' academic achievement in Physics.

The findings from the student and teacher questionnaires are presented in Tables 18 and 19 below.

Students' Opinion on the Influence of ICT-Powered Lesson Presentations on students' Academic Achievement in Physics

The study aimed to gather detailed students' perspectives on the influence of ICT-powered lesson presentations on their academic achievement in Physics. It examined whether digital tools and multimedia resources enhance their comprehension and overall performance in the subject. Specifically, the study explored whether ICT-powered lessons improve students' understanding and knowledge of Physics, the effectiveness of available digital tools and applications, and the role of internet reliability and speed in supporting ICT-based learning.

Additionally, the study assessed whether ICT-powered lesson presentations enhance access to up-to-date and curriculum-aligned Physics content, foster meaningful interaction and communication between teachers and students, and promote the integration of high-quality educational videos as instructional aids to facilitate deeper understanding of complex Physics phenomena.

Table 22 shows a summary of students' views on the influence of ICT-powered lesson presentations on academic achievement.

Table 22: Students' Opinion on the Influence of ICT-Powered Lesson Presentations on Students' Academic Achievement in Physics

Statement	N	Mean	SD
ICT-powered lesson presentations enhance my understanding and knowledge of Physics.	300	2.94	1.00
The available digital tools and applications used in ICT-powered lessons are effective for learning Physics.	300	2.91	0.96
The reliability and speed of internet connectivity support the effectiveness of ICT-powered Physics lessons.	300	2.02	0.86
I find that ICT-powered lessons significantly increase access to current and important information in Physics.	300	2.95	0.94
The level of interaction facilitated by ICT-powered lessons between physics teachers and students is satisfactory.	300	3.28	0.89
I frequently use educational videos in ICT-powered lessons for understanding complex Physics phenomena	300	3.87	1.02
Valid N (Listwise)	300		

Item 1 in Table 20 assessed whether ICT-powered lesson presentations enhance students' understanding and knowledge of Physics. The recorded mean was 2.94, with a SD of 1.00. This suggests that while some students recognize the value of ICT-powered lesson presentations in improving their understanding, a significant number may not actively benefit from them.

Similarly, item 2 examined the effectiveness of digital tools and applications used in ICT-powered lessons. The results yielded a mean of 2.91 and an SD of 0.96, indicating that some students find these tools useful in facilitating learning. However, the mean suggests that the effectiveness of these digital tools is not universally experienced by all students, possibly due to variations in accessibility, familiarity, or instructional approaches.

Item 3 focused on the reliability and speed of internet connectivity as a factor influencing the effectiveness of ICT-powered Physics lessons. The findings revealed a mean score of 2.02 and an SD of 0.86, indicating that many students do not find internet connectivity sufficiently

reliable to support effective ICT-integrated learning. The low mean suggests that unstable or slow internet access could be a restricting element in the effective execution of ICT-powered Physics lessons.

The study further examined whether ICT-powered lessons significantly increase access to current and important information in Physics (item 4). The mean recorded was 2.95, with an SD of 0.94, implying that some students acknowledge the role of ICT-powered lessons in enhancing their access to updated Physics knowledge. However, the variation in responses indicates that not all students experience this benefit equally.

Satisfaction with the level of interaction facilitated by ICT-powered lessons between Physics teachers and students was assessed in item 5. The findings revealed a mean mark of 3.28 and, an SD of 0.89, suggesting that, majority of students are satisfied with, the degree of interaction that ICT-powered lessons provide. This highlights the potential of ICT in fostering communication, engagement, and feedback between students and teachers.

Lastly, item 6 explored the use of educational videos in ICT-powered lessons for understanding complex Physics phenomena. This item recorded the highest mean of 3.87 and an SD of 1.02, indicating that most students find educational videos particularly helpful in grasping complex Physics concepts. The high mean suggests that students actively utilize multimedia resources as a supplement to traditional learning methods, benefiting from the visual and interactive nature of educational videos.

Teachers' Opinion on ICT-Powered Lesson Presentations on Students' Academic Achievement in Physics

The study sought to assess teachers' opinions on the influence of ICT-powered lesson presentations on students' academic achievement in Physics. The research aimed to understand how integrating ICT tools in lesson delivery influences students' comprehension,

engagement, and overall learning experiences. Various aspects of ICT-powered lesson presentations were evaluated, focusing on their effectiveness in teaching Physics concepts, enhancing student participation, and improving instructional strategies.

Specifically, the study examined whether ICT-powered lesson presentations help students understand complex Physics concepts by offering visual and interactive content. It also explored how frequently teachers use digital simulations to enhance student engagement in Physics learning. Additionally, the study evaluated the degree to which ICT tools support differentiated instruction, enabling teachers to cater to diverse student needs.

Furthermore, the study examined the role of ICT-powered lesson presentations in lesson planning, particularly in the use of online Physics resources and tools to improve the quality of instruction. It also examined whether ICT integration facilitates formative assessments, allowing teachers to track student progress effectively.

Another key area of focus was the influence of ICT-powered lesson presentations on student participation, particularly through utilization of interactive whiteboards. The study also sought to determine whether these lesson presentations aid in connecting the theoretical and practical aspects of Physics by incorporating real-world applications and virtual labs.

Moreover, the study explored whether ICT tools encourage collaborative learning among students by enabling group discussions and shared learning experiences. The extent to which ICT-powered lessons incorporate real-time data and virtual labs to enrich the learning process was also assessed. Finally, the study examined the overall impact of ICT-powered lesson presentations on teachers' instructional methods, particularly in fostering dynamic and interactive teaching approaches.

The results of this investigation are shown in Table 23.

Table 23: Teachers' Opinion on the Influence of ICT-Powered Lesson Presentations on Students' Achievement in Physics

Statement	N	Mean	SD
ICT-powered lesson presentations enhance my students' understanding of complex Physics concepts.	51	2.84	1.06
I frequently use digital simulations in ICT-powered lessons to improve student engagement in Physics.	51	2.38	0.86
ICT-powered lesson presentations help in differentiating instruction to meet diverse student needs in Physics.	51	3.00	1.00
The availability of online Physics resources and tools enhances the quality of my lesson planning.	51	2.84	0.80
ICT-powered lessons facilitate more effective formative assessments in Physics.	51	3.30	0.94
The integration of interactive whiteboards in ICT-powered lessons improves student participation.	51	3.46	0.96
ICT-powered lesson presentations help bridge gap between theoretical & practical aspects of Physics.	51	3.53	0.87
The use of ICT in lessons encourages collaborative learning among students in Physics.	51	2.76	1.16
The incorporation of real-time data and virtual labs in ICT-powered lessons enriches the learning experience.	51	3.04	0.68
ICT-powered lesson presentations positively impact my teaching methods and strategies in Physics.	51	3.00	0.91
Valid N (Listwise)	51		

Item 1 in Table 23 assessed whether ICT-powered lesson presentations enhance students' understanding of complex Physics concepts. The recorded mean mark was 2.84, with a SD of 1.06, suggesting that while some teachers perceive ICT-powered lessons as beneficial in improving students' comprehension, this view is not universally held.

Item 2 investigated the frequency of use of digital simulations and animations in ICT-powered lessons to improve student engagement. The results showed a mean of 2.38 and an SD of 0.86, indicating that most teachers do not frequently incorporate digital simulations

and animations to enhance student engagement in Physics. The relatively low mean suggests potential barriers such as lack of access to digital resources, inadequate training, or time constraints.

Item 3 examined whether ICT-powered lesson presentations help in differentiating instruction to meet diverse student needs in Physics. The recorded mean was 3.00, with an SD of 1.00, indicating that most teachers believe ICT-powered lessons support differentiated instruction, allowing them to cater to students with varying learning abilities.

The availability of online Physics resources and tools enhancing the quality of lesson planning was assessed in item 4. The mean score was 2.84, with an SD of 0.80, suggesting that teachers generally acknowledge the role of online resources in lesson planning. However, the mean value indicates that while online resources are available, their utilization may not be optimal.

Item 5 explored whether ICT-powered lessons facilitate more effective formative assessments in Physics. The findings recorded a mean of 3.30 and an SD of 0.94, implying that most teachers perceive ICT-powered lessons as beneficial in conducting formative assessments, allowing them to track students' progress and, alter their instructional strategies appropriately.

The integration of interactive whiteboards in ICT-powered lessons improving student participation was examined in item 6. Findings revealed a mean of 3.46, with an SD of 0.96, suggesting, majority of teachers believe interactive whiteboards enhance student participation by making lessons more engaging and interactive.

Item 7 assessed whether ICT-powered lesson presentations helped in bridging the gap between theoretical and practical aspects of Physics. The recorded mean was 3.53, with an SD of 0.87, indicating that most teachers acknowledge the role of ICT-powered lessons in

connecting theoretical Physics concepts with practical applications. This suggests that digital tools, virtual simulations, and interactive media enhance students' ability to relate classroom learning, to real-world contexts.

The influence of ICT in encouraging collaborative learning among students in Physics was explored in item 8. The mean recorded was 2.76, with an SD of 1.16, suggesting that while some teachers perceive ICT as a tool for fostering collaboration, this is not a universally shared perspective. The relatively lower mean could be attributed to limited implementation of collaborative ICT resources like virtual discussion spaces and collaborative online platforms.

Item 9 examined the extent to which the incorporation of real-time data and virtual labs in ICT-powered lessons enriches the learning experience. The findings recorded a mean of 3.04 and an SD of 0.68, suggesting that most teachers believe integrating real-time data and virtual experiments enhances students' learning experiences, providing opportunities for hands-on exploration and inquiry-based learning.

Finally, item 10 assessed whether ICT-powered lesson presentations positively impact teaching methods and strategies in Physics. The results revealed a mean of 3.00 and an SD of 0.91, indicating that the majority of teachers believe that ICT-powered lessons influence their teaching strategies, allowing them to adopt more dynamic, interactive, and student-centered instructional approaches.

4.5.1 Descriptive Analysis on the Influence of ICT-Powered Lesson Presentations on Students' Academic Achievement

The study examined the influence of ICT-powered lesson presentations on students' academic achievement in Physics, focusing on mobile technologies-based instructional delivery, interactive digital tools, and mobile-supported lesson presentations. These factors were

analyzed in terms of their ability to improve student engagement, deepen conceptual understanding, and strengthen problem-solving skills.

The findings indicate that a majority of students frequently encountered ICT-powered lesson presentations in their Physics lessons. They reported that integrating animations, videos, and simulations into instruction significantly improved their ability to visualize abstract concepts, making learning more engaging and interactive. The availability of digital lesson presentations also facilitated self-paced learning, as students could review instructional materials on mobile devices at their convenience. These findings align with prior research indicating that ICT-powered lesson presentations promote deeper conceptual understanding and positively influence academic achievement (Lukenge, 2019; Lubiano, 2018).

However, there were variations in students' engagement levels with ICT-enhanced lesson presentations. While many students accessed digital instructional content through classroom projectors and mobile devices, fewer actively participated in interactive activities such as virtual simulations and online discussions. This suggests that while ICT integration is relatively common, disparities exist in student engagement, possibly due to differences in accessibility, technological proficiency, or teacher expertise in ICT integration.

Teachers also acknowledged the effectiveness of ICT-powered lesson presentations in improving Physics instruction. They highlighted that using digital media enabled them to illustrate complex concepts more effectively, leading to improved student comprehension and retention. Additionally, mobile-supported lesson delivery provided flexibility in instructional pacing, allowing students to revisit content beyond the classroom. These perspectives align with prior research which emphasize the role of ICT in promoting active learning and improving academic outcomes (Alsawalem, 2019; Cheng, 2021).

4.5.2 Inferential Analysis on the Influence of ICT-Powered Lesson Presentations on Students' Academic Achievement

To determine the relationship between ICT-powered lesson presentations and students' academic achievement in Physics, Pearson correlation and multiple regression analysis (MRA) were conducted for both students (N = 300) and teachers (N = 51).

Pearson Correlation Analysis

Correlation analysis revealed a moderate, positive correlation between ICT-powered lesson presentations and, students' academic achievement for both students and teachers.

Table 24: Correlation Between ICT-Powered Lesson Presentations and Students' Academic Achievement

Respondents	Academic Achievement in Physics
Students	$r = 0.421, p = 0.002$ (Significant)
Teachers	$r = 0.437, p = 0.001$ (Significant)

The results indicate that both students and teachers perceive ICT-powered lesson presentations as positively associated with improved academic performance in Physics. The students' correlation ($r = 0.421, p = 0.002$) suggests a moderate positive connection, while the teachers' correlation ($r = 0.437, p = 0.001$) slightly strengthens this relationship, reinforcing the importance of ICT-enhanced instructional delivery. These findings align with previous studies demonstrating that ICT integration enhances student engagement and comprehension, ultimately leading to better academic outcomes (Ede & Anosike, 2023; Maruping & Velepini, 2022).

4.5.3 Model Fitness and Regression Summary: Teachers

The regression analysis for teachers aimed to examine the predictive influence of mobile technologies, ICT-powered lesson presentations, and online assessments on the students' academic achievement in Physics.

The results, summarized in Table 25

Table 25: Model Summary (Teachers)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.641	0.411	0.401	1.349

The results, summarized in Table 25, indicate that MT and digital learning strategies account for 41.1% of the variance in student performance in Physics. This highlights the significant role of digital tools in shaping academic outcomes. An Adjusted R-Square value of 0.401 further confirms that about 40% of student achievement is linked to these strategies, with the other 58.9% potentially shaped by variables teacher effectiveness, classroom environment, and student engagement.

The coefficient ($R = 0.641$) shows a moderate to strong positive correlation between MT and student performance, from the teachers' perspective. This suggests that digital tools, including ICT-powered lessons, have a meaningful influence on student achievement in Physics. However, other contextual and school-based factors also contribute to academic performance.

Multiple Regression Analysis

A MRA was conducted to assess the predictive strength of ICT-powered lesson presentations on students' academic achievement in Physics, incorporating data from both students and teachers. The results are presented in Table 26.

Table 26: Multiple Regression Analysis for the Influence of ICT-Powered Lesson Presentations on Students' Academic Achievement

Respondents	Predictor Variable	Unstandardized Coefficient (B)	Standardized Coefficient (β)	t	p-value
Students	ICT-Powered Lesson Presentations	0.265	0.368	4.312	0.001 (Significant)
Teachers	ICT-Powered Lesson Presentations	0.291	0.384	4.527	0.001 (Significant)

The findings indicate that ICT-powered lesson presentations significantly predict students' academic achievement in Physics for both students and teachers. For students, the Standardized Coefficient ($\beta = 0.368$, $p = 0.001$) suggests that greater exposure to ICT-powered instruction enhances their academic achievement. This implies that students who frequently interact with digital instructional materials, such as MT presentations and interactive content, tend to develop a stronger grasp of Physics concepts.

Similarly, for teachers, the Standardized Coefficient ($\beta = 0.384$, $p = 0.001$) reinforces the crucial role of ICT lessons in improving instructional delivery and student learning outcomes. This highlights that teachers who effectively incorporate ICT-powered lessons into their teaching methods contribute to better student engagement and comprehension. These results align with prior studies emphasizing that, digital devices not only support student learning but also enhance teaching effectiveness by providing diverse instructional strategies.

Additionally, the Adjusted R^2 value was 0.3989 (Table 20), indicating that ICT-powered lesson presentations explain approximately 39.8% of the variation in students' academic achievement across both datasets. This underscores the significant contribution of ICT-enhanced instruction while acknowledging that other pedagogical and contextual factors account for the remaining 60.2% of the variation.

These findings emphasize the need for structured ICT integration in Physics instruction. While ICT-powered lesson presentations have a positive influence on student learning, their effectiveness depends on factors such as accessibility to digital resources, teacher proficiency in ICT use, and students' engagement in interactive digital learning. Schools should increase ICT training for teachers, enhance access to MT instructional tools, and encourage more interactive student engagement with digital content to maximize the benefits of ICT-powered lesson presentations.

4.5.4 Discussion of Findings on the Influence of ICT-Powered Lesson Presentations on Students' Academic Achievement in Physics

The findings of this study indicate that ICT-powered lesson presentations significantly contribute to students' academic achievement in Physics. Both students and teachers acknowledged that instructional use of mobile technologies (MT) enhanced students' understanding of complex concepts while improving their engagement with instructional content. The availability of online resources and mobile-supported learning further enabled students to revisit lesson materials at their convenience, reinforcing classroom instruction and supporting self-paced learning. These results generally align with Lukenge (2019), who convincingly argued that, ICT-powered lesson presentations equip students with, critical 21st-century skills, comprising digital literacy, teamwork, problem-solving, and, critical thinking. Similarly, Lubiano (2018) emphasized that interactive MT enhances student learning by making lessons more engaging and interactive.

However, disparities in students' experiences with ICT-powered lesson presentations were observed. While many students recognized the benefits of digital instructional tools, some encountered barriers including inconsistent internet access, insufficient availability of digital tools, and variations in instructional approaches. The effectiveness of ICT-powered lesson presentations largely depended on resource availability and the extent to which teachers integrated interactive and student-centered digital strategies into their lessons. These findings align with Mburu (2021), who found that using ICT lessons during instruction not only improved students' academic achievement but also increased engagement. Similarly, Cheng (2021) demonstrated that ICT lessons positively influenced students' engagement and achievement, reinforcing the contribution of technology toward facilitating effective learning.

Teachers also acknowledged the benefits of ICT-powered lesson presentations in improving lesson delivery, supporting differentiated instruction, and facilitating formative assessments.

The use of interactive MT tools, including virtual experiments, helped in bridging the gap between, theoretical and, practical applications of Physics, making lessons more relevant to real-world contexts. These observations align with Njoroge (2022), who emphasized that MT supports interactive learning, although their direct influence on academic achievement remained largely unexplored.

Despite the positive impact, several challenges were identified. One major issue was the infrequent use of digital simulations and limited collaborative learning opportunities. Additionally, the adoption of ICT tools across schools was inconsistent. While some teachers actively incorporated MT into lesson planning and assessment, others faced constraints such as inadequate training and insufficient institutional support for ICT integration. These findings align with those of Ede and Anosike (2023) and Maruping and Velempini (2022), who found a correlation between ICT use and student performance in Physics but did not examine the specific impact of ICT-powered lesson strategies on student understanding, engagement, and problem-solving.

Statistical analysis further reinforced these findings. The correlation analysis demonstrated a moderate, positive association between ICT-powered lesson presentations and students' academic achievement for both students and teachers. The correlation coefficient for students ($r = 0.421$, $p = 0.002$) and teachers ($r = 0.437$, $p = 0.001$) indicates that increased exposure to ICT-powered instruction is associated with improved academic achievement in Physics. Additionally, the R-Squared value of 0.411 for teachers suggests that 41.1% of the variance in students' academic achievement may be attributed to, integration of MT, ICT-powered lesson presentations, and online assessments, highlighting the significance of these digital strategies. Furthermore, MRA confirmed that ICT-powered lesson presentations significantly predict students' academic achievement, as reflected by a standardized coefficient of $\beta = 0.368$ ($p = 0.001$) for students and $\beta = 0.384$ ($p = 0.001$) for teachers. The adjusted R^2 value

of 0.398 suggests that ICT-powered lesson presentations explain approximately 39.8% of the variation in students' academic achievement. The results align with Karanja et al. (2019), who established that students taught with ICT-enhanced presentations outperformed those taught using traditional methods.

Interviews with Heads of Department provided further understanding of the influence of ICT-powered lesson presentations. Respondents noted that schools with well-integrated ICT tools reported higher student engagement, increased motivation, and better comprehension of Physics concepts. They highlighted that ICT-enhanced lesson delivery, particularly the use of digital experiments, contributed to a more interactive learning experience. However, disparities in infrastructure and inconsistent adoption of technology among teachers affected its overall effectiveness. Some Heads of Department observed that, teachers who had undergone ICT training were more adept at utilizing digital tools into their lessons, whereas those without such training struggled to use them effectively.

Observations made during school visits further corroborated these findings. It was noted that while most schools had limited ICT infrastructure, a few had advanced digital tools such as smartboards, projectors, and interactive learning applications. In schools where these resources were actively utilized, students exhibited better conceptual understanding, and their internal assessment scores reflected improved academic performance. However, the use of smartboards was extremely rare, with only a few schools having access to them, and even in those cases, their integration into daily lesson delivery was inconsistent. In most schools, ICT-powered lessons were conducted using projectors and teachers' personal laptops, while mobile devices were primarily used for accessing online materials rather than for interactive engagement. The lack of uniform ICT adoption across schools meant that students in better-equipped institutions benefited more from technology-enhanced learning, while those in under-resourced schools lagged behind.

These findings suggest that optimizing ICT integration in lesson delivery, addressing infrastructure challenges, and promoting interactive learning approaches can further enhance the effectiveness of ICT-powered instruction in Physics education. Expanding access to ICT tools, ensuring structured teacher training, and fostering a culture of digital innovation in the classroom will be essential in bridging the digital divide and maximizing the potential of ICT-powered lesson presentations to improve student learning outcomes.

4.6 Influence of Online Collaborative Learning on Students' Academic Achievement

This objective determined the influence of online collaborative learning (OCL) on students' academic achievement in Physics. Specifically, it examined whether students perceive online collaborative platforms as tools that enhance interaction with peers and instructors, facilitating deeper comprehension of Physics concepts. The study also explored whether online collaboration improves engagement with learning materials, supports assignment completion, and supplements traditional textbook-based learning.

The study also examined how students perceive the effectiveness of OCL in promoting critical thinking, enhancing problem-solving abilities, and encouraging creativity in tackling Physics problems. It further examined whether participation in online collaborative environments contributes to improved academic performance in Physics.

To gather data, questionnaires were issued to 300 students to capture their perspectives on OCL. Observations were also conducted to examine how online collaboration was integrated into students' learning experiences. The gathered data were analyzed through both descriptive and inferential statistics. Descriptive statistics summarized students' responses, while inferential analysis, including Pearson correlation and multiple regression, was used to determine the relationship between online collaborative learning and students' academic achievement in Physics. The findings are summarized in Table 27.

Table 27: Students' Opinion on Influence of Online Collaborative Learning on Students' Academic Achievement in Physics

Statement	N	Mean	SD
Using online collaborative platforms enhances my interaction with classmates, improving my understanding of Physics.	300	2.97	1.23
Online collaborative tools strengthen my engagement with my Physics teacher, improving my grasp of concepts.	300	2.88	1.23
Online collaborative learning increases my access to diverse Physics learning materials, improving comprehension..	300	3.30	1.28
Online collaborative tools make it easier for me to complete and understand Physics assignments.	300	3.07	1.20
Participating in online collaborative learning complements and deepens my understanding of Physics concepts beyond textbooks.	300	2.92	1.15
Using interactive online collaborative platforms strengthens my problem-solving and critical thinking skills in Physics	300	2.74	1.19
Online collaborative learning encourages creative approaches to solving Physics problems.	300	2.88	1.15
Regular participation in online collaborative learning improves my overall performance in Physics	300	2.91	1.14

Item 1 in Table 27 assessed whether using online collaborative platforms enhances students' interaction with classmates, improving their understanding of Physics. The recorded mean being 2.97, with a SD of 1.23, suggesting that while some students find online collaboration beneficial for peer interaction, engagement levels vary.

Item 2 examined whether online collaborative tools strengthen engagement with Physics teachers, improving concept comprehension. The findings showed a mean of 2.88 and an SD of 1.23, indicating that some students perceive online collaboration as useful for teacher-student interaction, although this may not be a universally held view.

Item 3 explored whether online collaborative learning increases students' access to diverse Physics learning materials, enhancing comprehension. The results recorded a mean of 3.30 with an SD of 1.28, suggesting that the majority of students find online platforms effective in

broadening their access to learning resources, thus improving their understanding of Physics concepts.

The influence of online collaborative tools in completing and understanding Physics assignments was examined in item 4. The findings recorded a mean of 3.07 with an SD of 1.20, indicating that many students consider these tools beneficial in facilitating and clarifying their academic tasks.

Item 5 assessed whether participation in online collaborative learning complements and deepens students' understanding of Physics concepts beyond textbooks. The results revealed a mean score of 2.92 and a standard deviation (SD) of 1.15, suggesting that some students recognize the value of online collaboration in supplementing traditional learning materials, although its adoption is not widespread.

Item 6 examined the extent to which interactive online collaborative platforms strengthen Students' problem-solving abilities and critical thinking skills in Physics. The findings recorded a mean of 2.74 with an SD of 1.19, indicating that while some students actively use these platforms for cognitive development, the overall engagement level remains moderate.

Item 7 explored whether online collaborative learning encourages creative approaches to solving Physics problems. The mean recorded was 2.88, with an SD of 1.15, suggesting that some students perceive online collaboration as a means to develop innovative problem-solving strategies.

Finally, item 8 assessed the overall impact of regular participation in online collaborative learning on students' Physics performance. The results showed a mean of 2.91 with an SD of 1.14, indicating that some students believe that these platforms contribute positively to their academic achievement in Physics.

4.6.1 Descriptive Analysis of the Influence of Online Collaborative Learning on Students' Academic Achievement

The research assessed students' views on OCL and its influence on their academic achievement in Physics. Findings indicate that a considerable number of students believe that online collaborative platforms enhance peer interaction, thereby improving their comprehension of Physics concepts. These results are consistent with Tsai et al. (2023), who observed that, structured online group discussions positively correlated with academic achievement. Similarly, students reported that online collaborative tools facilitated engagement with teachers, although the frequency and quality of interaction varied among respondents.

Many students acknowledged that online collaboration increased their access to diverse Physics learning materials, which contributed to a deeper understanding of concepts. Wang and Chen (2019) emphasized that MT facilitates real-time collaboration and immediate feedback, which are crucial for effective learning. Additionally, students found online collaborative tools beneficial for completing and understanding assignments, supporting findings by Salhab and Daher (2023), who reported that digital learning tools improve comprehension and accessibility.

The study also explored whether OCL extends beyond textbook-based knowledge to promote deeper conceptual understanding. While some students recognized the potential benefits, overall engagement in online collaborative activities for conceptual enrichment remained moderate.

Regarding cognitive development, a number of students reported that interactive online platforms strengthened their problem-solving as well as critical-thinking skills. However, participation in such activities was not as widespread compared to other aspects like resource access and assignment completion. Similarly, while some students noted that online

collaboration encouraged creative approaches to solving Physics problems, engagement in such activities remained relatively low.

Lastly, the study examined whether regular participation in OCL leads to better academic performance in Physics. While some students believed that online collaboration positively influenced their performance, the overall adoption and effectiveness varied across different learning environments.

4.6.2 Inferential Analysis of the Influence of Online Collaborative Learning on Students' Academic Achievement

To determine the statistical association between Online Collaborative Learning (OCL) and students' academic achievement in Physics, Pearson correlation and MRA were performed.

Pearson Correlation Analysis

Pearson correlation analysis was performed to evaluate the strength and direction of the association between OCL and students' academic achievement. The results are presented in Table 28.

Table 28: Correlation Between Online Collaborative Learning and Students' Academic Achievement

Variables	Academic Achievement in Physics
Online Collaborative Learning	$r = 0.521, p < 0.001$

The results indicate a moderate positive correlation ($r = 0.521, p < 0.001$), suggesting that greater engagement in OCL is linked to enhanced academic achievement in Physics.

Multiple Regression Analysis

MRA was conducted to assess how well OCL predicts students' academic achievement.

The findings are summarized in Table 29.

Table 29: Multiple Regression Analysis of Online Collaborative Learning and Students' Academic Achievement

Model	Unstandardized Coefficients (B)	Standardized Coefficients (β)	t	p-value
(Constant)	32.102	-	5.762	<0.001
Online Collaborative Learning	0.462	0.518	6.934	<0.001

The results indicate that OCL significantly predicts students' academic achievement in Physics ($\beta = 0.518$, $p < 0.001$). The unstandardized coefficient ($B = 0.462$) implies that a one-unit increase in engagement with OCL consistently corresponds to a 0.462-unit rise in students' academic achievement. An adjusted R^2 value of 0.398 (Table 20) suggests that, OCL accounts for nearly 39.8% of the variation in students' academic achievement, emphasizing the importance of integrating collaborative online platforms to enhance learning outcomes in Physics.

4.6.3 Discussion of Findings on the Influence of Online Collaborative Learning on Students' Academic Achievement

The findings indicate that online collaborative learning (OCL) is essential in enhancing students' academic achievement in Physics. Students reported that engaging in collaborative activities such as peer discussions, group problem-solving, and teamwork in digital learning environments enhanced their conceptual understanding and overall performance. The use of mobile-supported platforms facilitated seamless knowledge-sharing, enabling students to revisit learning materials, seek clarifications from peers, and actively participate in discussions beyond the classroom.

These results align with Tsai et al. (2023), who established that structured online group discussions and peer-assisted learning positively correlate with academic achievement.

Similarly, Wang and Chen (2019) emphasized that MT facilitates real-time collaboration and immediate feedback, both essential for effective learning.

The study further revealed that OCL increased students' access to diverse Physics learning materials, which improved their comprehension of concepts. Students found online platforms beneficial for completing assignments, engaging in problem-solving discussions, and deepening their understanding beyond textbooks. These findings support Salhab and Daher (2023), who reported that digital learning tools enhance comprehension and accessibility, ultimately improving students' academic achievement.

However, the effectiveness of online collaboration varied among students. HODs noted that structured facilitation was crucial for engagement, emphasizing the role of proper guidance and teacher involvement in fostering academic achievement. These findings align with Kiarie and Muindi (2020), who found that interactive online discussions enhance learning by improving conceptual understanding and critical thinking, though digital access and connectivity issues remain significant challenges.

Despite the benefits of OCL, the study identified several challenges affecting its effectiveness. Some students struggled with availability of digital devices and stable internet connectivity, restricting their capacity to fully engage in online discussions. Additionally, variations in school infrastructure affected the extent to which MT was integrated into collaborative learning. In some cases, students relied on traditional face-to-face interactions due to a lack of ICT resources, reducing the effectiveness of digital collaboration. These findings support Mburu (2021), who noted that while MT enable real-time collaboration, their impact on subject-specific learning remains underexplored.

Statistical analysis further reinforced these findings, demonstrating a moderate, positive relationship between OCL and students' academic achievement. Correlation analysis

indicated that increased engagement in online collaboration was associated with higher performance in Physics ($r = 0.521$, $p < 0.001$). MRA confirmed that online collaboration significantly predicts students' academic achievement ($\beta = 0.518$, $p < 0.001$), reinforcing its role as a key instructional strategy. The adjusted R^2 value of 0.398 suggests that OCL explains approximately 39.8% of the variation in students' academic achievement. These results align with Malack (2020), who established, students participating in online collaborative activities demonstrated better performance in Physics compared to those who did not, with mobile-supported learning environments enhancing accessibility to digital resources and active participation in discussions.

Observations made during school visits further supported these findings. In schools where OCL was effectively implemented, students were actively engaged in Physics discussions, and their participation in lessons was notably high. Digital platforms were utilized for group assignments, peer discussions, and sharing of resources, contributing to a more interactive learning environment. However, in some schools, online collaboration was minimally incorporated, and students relied predominantly on teacher-centered instruction, limiting opportunities for peer interaction and collective problem-solving.

These findings suggest that fostering OCL, addressing barriers to participation, and integrating mobile-supported platforms to enhance teamwork can significantly improve students' academic achievement. Strengthening teacher training on collaborative instructional strategies, ensuring equitable access to ICT resources, and promoting structured peer learning opportunities will be essential in maximizing the benefits of collaboration for student success in Physics.

4.7 The Influence of Online Assessment on Students' Academic Achievement

This objective analyzed the influence of online assessments on students' academic achievement in Physics. The research examined various aspects of online assessment, including frequency, quality of feedback, and accessibility, to determine their impact on student performance. By evaluating both student and teacher perspectives, the study sought to establish how online assessments contribute to learning outcomes and overall academic achievement.

A sample of 300 students and 51 teachers were given structured questionnaires to facilitate the systematic collection of relevant study data. Additionally, interviews were conducted with 28 Heads of Departments (HODs) to gather further perspectives on the instructional use of online assessments in Physics instruction. Observations were also carried out to assess how online assessments were implemented across different learning environments.

The data were examined through a combination of descriptive and inferential methods. Descriptive analysis offered a summary of students' and teachers' perspectives on the application, frequency, and perceived effectiveness of online assessments. Inferential analysis was conducted to explore significant relationships and determine, predictive influence of online assessments on students' academic achievement in Physics across various instructional contexts.

The findings are comprehensively presented in Tables 30 and 31 to support the interpretation of the results.

Students' Opinion on the Influence of Online Assessment on Students' Academic Achievement in Physics

The study aimed to analyze students' perspectives on the influence of online assessments on their academic achievement in Physics. It examined various aspects of online assessments,

including their effectiveness in providing feedback, enhancing engagement, and promoting self-paced learning. The study explored how online assessments contribute to students' comprehension, time management skills, and overall comfort with Physics evaluations.

Specifically, the study investigated if online assessments offer prompt responses that aid learners in identifying errors and enhancing their grasp of Physics concepts. Additionally, it assessed whether students find online quizzes and tests more engaging and motivating compared to traditional paper-based exams.

Another key area of focus was whether students frequently use online assessments to track their progress and improvement in Physics over time. The research further examined whether the flexibility of online assessments, which permits students to take tests at their own pace and, convenience, greatly enhances their learning experience, helping them better understand complex topics and improve performance.

Furthermore, the research examined the role of interactive elements in online assessments in improving students' comprehension of Physics concepts. It also assessed whether online assessments help students enhance their ability to manage time effectively, enabling more efficient allocation of effort and focus during evaluations, especially under self-paced digital testing environments.

The study explored the impact of having a variety of question formats in online assessments, such as multiple-choice questions and simulations, in aiding students' learning and conceptual understanding. Lastly, it examined whether students feel more comfortable and less anxious taking Physics assessments online compared to traditional paper-based methods. Table 30 comprehensively displays the outcomes derived from this investigation.

Table 30: Students' Opinion on the Influence of Online Assessment on Students' Academic Achievement in Physics

Statement	N	Mean	SD
Online assessments provide immediate feedback that helps me understand my mistakes in Physics.	300	3.20	1.20
I find online quizzes and tests more engaging and motivating than traditional paper-based exams.	300	3.18	1.19
I frequently use online assessments to track my progress and improvement in Physics over time.	300	3.09	1.19
The flexibility of online assessments enables me to take tests at my own pace and convenience.	300	2.88	1.15
Online assessments often include interactive elements that enhance my comprehension of Physics concepts.	300	3.17	1.24
Online assessments in Physics regularly helps me develop better time management skills	300	3.16	1.23
The variety of question formats in online assessments (e.g., multiple choice, simulations) aids my learning.	300	3.15	1.21
I feel more comfortable and less anxious taking Physics assessments online compared to traditional methods	300	2.63	1.16

Item 1 in Table 30 examined whether online assessments provide immediate feedback that helps students understand their mistakes in Physics. The recorded mean was 3.20, with a SD of 1.20, suggesting that most students acknowledge the value of instant feedback in improving their comprehension and correcting errors.

Item 2 assessed whether students find online quizzes and tests more engaging and motivating than traditional paper-based exams. The results showed an average score of 3.18 and a SD of 1.19, suggesting that most students perceive online assessments as a more engaging and stimulating method of evaluation compared to traditional exams.

Item 3 investigated the extent to which students frequently use online assessments to track their progress and improvement in Physics over time. The recorded mean was 3.09, with an

SD of 1.19, suggesting that many students use online assessment tools for self-monitoring and tracking their academic growth in Physics.

The flexibility of online assessments, enabling learners to complete evaluations at a pace that suits them, and convenience, was assessed in Item 4. The findings showed a mean of 2.88 and an SD of 1.15, indicating that while some students appreciate the flexibility, the extent to which they fully utilize this advantage may vary.

Item 5 examined whether online assessments often include interactive elements that enhance students' comprehension of Physics concepts. The results recorded a mean of 3.17 and an SD of 1.24, suggesting that majority of students recognize the interactive nature of online assessments as beneficial in reinforcing Physics concepts.

The role of online assessments in helping students develop better time management skills was explored in Item 6. The findings showed a mean of 3.16 and an SD of 1.23, indicating that most students believe online assessments contribute to their ability to manage time more effectively when completing Physics tasks.

Item 7 investigated whether the variety of question formats in online assessments (e.g., multiple choice, simulations) aids students' learning. The recorded mean was 3.15, with an SD of 1.21, suggesting that students find diverse question formats useful in enhancing their understanding of Physics concepts.

Finally, Item 8 assessed whether students feel more comfortable and less anxious taking Physics assessments online compared to traditional methods. The findings recorded a mean of 2.63 with an SD of 1.16, indicating that while some students prefer online assessments, others may still experience anxiety or discomfort when taking Physics tests digitally.

Teachers' Opinion on Influence of Online Assessment on Students' Academic Achievement in Physics

The study investigated teachers' perspectives on the influence of online assessments in shaping students' academic achievement in Physics. It aimed to understand how online assessments impact students' learning experiences, engagement, and comprehension of Physics concepts.

The study examined whether online assessments provide immediate feedback, helping teachers identify students' misconceptions and adjust their instructional approaches accordingly. Additionally, it explored teachers' opinions on whether online quizzes and tests are more engaging and motivating for students compared to traditional paper-based exams.

Another key focus was whether teachers found online assessments effective in monitoring students' progress and improvement in Physics over time. The study also assessed whether the flexibility of online assessments, permitting learners to complete tests according to their individual pace, enhances academic progress.

The research further explored the effectiveness of interactive elements in online assessments in improving students' understanding of Physics concepts. It also examined whether online assessments help students develop better time management skills, enabling them to manage test durations more efficiently.

Additionally, the study investigated whether teachers believe that the variety of question formats in online assessments, such as multiple-choice and simulations, aids students' comprehension of Physics. Teachers' frequency of analyzing and reporting students' performance using online assessment tools was also assessed.

Another aspect explored was whether online assessments provide a platform for incorporating multimedia elements, such as videos and animations, to help clarify Physics

concepts. Lastly, the study examined teachers' views on whether the use of online assessments has reduced their workload, particularly in grading and providing feedback.

Table 31 presents the outcomes of this analysis.

Table 31: Teachers' Opinion on the Influence of Online Assessment on Students' Achievement in Physics

Statement	N	Mean	SD
Online assessments provide immediate feedback that helps me identify students' misconceptions in Physics.	51	3.23	1.09
I find online quizzes and tests more engaging and motivating for students compared to traditional paper-based exams.	51	2.53	0.87
Online assessments allow me to monitor students' progress and improvement in Physics over time effectively.	51	1.92	1.11
The flexibility of online assessments enables students to complete tests at their own pace, which enhances their learning.	51	2.92	1.25
Online assessments often include interactive elements that enhance students' understanding of Physics concepts.	51	2.69	0.94
Online assessments in Physics help students develop better time management skills.	51	1.92	1.38
The variety of question formats in online assessments (e.g., multiple choice, simulations) aids students' comprehension.	51	3.15	0.98
I frequently analyze and report on students' performance using online assessment tools	51	3.08	1.26
Online assessments provide a platform for incorporating multimedia elements, such as videos and animations, to clarify Physics concepts.	51	3.46	1.16
The use of online assessments in Physics has reduced my workload related to grading and providing feedback.	51	2.56	0.87
Valid N (Listwise)	51		

Item 1 in Table 31 examined whether online assessments provide immediate feedback that helps teachers identify students' misconceptions in Physics. The recorded mean was 3.23,

with a SD of 1.09, suggesting that most teachers acknowledge the value of instant feedback in diagnosing students' misunderstandings and guiding instructional adjustments.

Item 2 assessed whether teachers find online quizzes and tests more engaging and motivating for students compared to traditional paper-based exams. The findings revealed a mean of 2.53 and an SD of 0.87, indicating that while some teachers recognize the engaging nature of online quizzes, the level of enthusiasm for these assessments remains moderate.

Item 3 investigated the extent to which online assessments allow teachers to monitor students' progress and improvement in Physics over time effectively. The recorded mean was 1.92, with an SD of 1.11, suggesting that only a minority of teachers find online assessments useful for tracking student progress, potentially due to challenges in data interpretation or limitations in assessment tools.

The flexibility of online assessments giving learners the opportunity to complete tests according to their individual schedules, thereby enhancing learning, was assessed in Item 4. The findings showed a mean of 2.92 and an SD of 1.25, suggesting that some teachers recognize the benefits of flexibility in online assessments, though this perspective is not universally held.

Item 5 examined whether online assessments often include interactive elements that enhance students' understanding of Physics concepts. The results recorded a mean of 2.69 and an SD of 0.94, indicating that while some teachers acknowledge the interactive potential of online assessments, their effectiveness in enhancing comprehension may depend on implementation.

The role of online assessments in helping students develop better time management skills was explored in Item 6. The findings showed a mean of 1.92 and an SD of 1.38, suggesting that

most teachers do not perceive online assessments as significantly contributing to students' time management abilities.

Item 7 investigated whether the variety of question formats in online assessments (e.g., multiple choice, simulations) aids students' comprehension. The recorded mean was 3.15, with an SD of 0.98, suggesting that a majority of teachers believe diverse question formats contribute positively to students' grasp of Physics concepts.

The ease of analyzing and reporting on students' performance using online assessment tools was assessed in Item 8. The findings recorded a mean of 3.08, with an SD of 1.26, indicating that most teachers find online assessment tools beneficial in tracking and reporting students' academic progress.

Item 9 examined whether online assessments provide a platform for incorporating multimedia elements, such as videos and animations, to clarify Physics concepts. The findings recorded a mean of 3.46, with an SD of 1.16, suggesting that a majority of teachers recognize the potential of multimedia-enhanced online assessments in improving concept clarity.

Finally, Item 10 assessed whether the use of online assessments in Physics has reduced teachers' workload related to grading and providing feedback. The recorded mean was 2.56, with an SD of 0.87, indicating that while some teachers believe online assessments alleviate grading workload, this perspective is not strongly shared by all.

4.7.1 Descriptive Analysis of the Influence of Online Assessment on Students' Academic Achievement

The study aimed to analyze students' and teachers' perceptions of influence of online assessment on students' academic achievement in Physics. Findings indicate that a significant number of students and teachers believe online assessments enhance comprehension of Physics concepts. Students reported that frequent engagement with digital tests allowed them

to track their learning progress, reinforcing key concepts. Teachers similarly observed that online assessments helped identify students' strengths and areas needing improvement. These results align with (Mukazi, 2022), who found that students engaging in regular online formative assessments demonstrated higher retention rates in STEM subjects.

Both students and teachers highlighted the benefits of real-time feedback in online assessments, emphasizing its role in reinforcing learning. Teachers noted that immediate feedback allowed for timely intervention, supporting findings by Mukazi, who found that real-time feedback mechanisms in online assessment platforms significantly enhance students' comprehension of Physics concepts by immediately correcting misconceptions.

Many students acknowledged online assessment platforms enable self-paced learning, helping them manage their study time more effectively. Teachers supported this view, indicating that digital tests facilitated differentiated instruction by allowing students to focus on their weaker areas. Kiarie and Muindi (2020) similarly reported that interactive digital quizzes and adaptive online testing improved Physics students' engagement and conceptual understanding, enabling learners to evaluate their progress effectively

The study further examined whether online assessments reduce exam anxiety and enhance test performance. While some students felt more comfortable with digital tests due to their flexibility, others expressed concerns over technical difficulties and time constraints. Teachers noted that while online assessments promoted test-taking confidence for some students, accessibility challenges hindered effective implementation.

Finally, the study explored whether frequent use of online assessments improves students' academic performance in Physics. While the majority of students and teachers recognized its positive impact, effectiveness varied based on school infrastructure and students' access to digital tools.

4.7.2 Inferential Analysis of the Influence of Online Assessment on Students' Academic Achievement

To examine the association between online assessment and students' academic achievement levels in Physics, Pearson correlation and MRA were conducted.

Pearson Correlation Analysis

Pearson correlation analysis was carried out separately for students' and teachers' responses to evaluate the strength and direction of the relationship between online assessment and students' academic achievement. The results are summarized in Table 32.

Table 32: Correlation Matrix for Online Assessment and Students' Academic Achievement

Variable	Students' Academic Achievement	Online Assessment t (Students)	Students' Academic Achievement t (Teachers)	Online Assessment t (Teachers)
Students' Academic Achievement (Students)	1	.318*	-	-
Online Assessment (Students)	.318*	1	-	-
Students' Academic Achievement (Teachers)	-	-	1	.620**
Online Assessment (Teachers)	-	-	.620**	1

Note: *Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

Findings from the correlation analysis (Table 32) revealed a moderate positive correlation ($r = 0.318$, $p < 0.05$) between students' engagement in online assessments and their academic achievement. This suggests that as students participate more in digital assessments, their academic performance in Physics improves. The moderate correlation indicates that online assessment plays a role in reinforcing students' understanding of Physics concepts, allowing them to track their progress more effectively.

Teachers' responses, on the other hand, revealed a stronger positive correlation ($r = 0.620$, $p < 0.01$) between online assessment and students' academic achievement. This implies that

teachers perceive online assessments as significantly contributing to students' performance. The stronger correlation from teachers' responses suggests that digital assessments provide valuable insights into students' learning progress, enabling educators to offer timely interventions and personalized feedback. These findings align with Evariste et al. (2022), who reported that secondary school students who engaged in mobile-integrated online assessments achieved higher scores in Physics. Similarly, Zheng et al, (2023) found that immediate feedback from online assessments contribute significantly to enhancing problem-solving skills and knowledge application.

Multiple Regression Analysis

To evaluate the predictive influence of online assessment on students' academic achievement while accounting for other digital learning factors, a MRA was performed. The regression coefficients, presented in Table 33, provide the extent to which online assessment contributes to students' academic achievement.

Table 33: Multiple Regression Analysis for Online Assessment and Students' Academic Achievement

Model	Unstandardized Coefficients (B)	Standardized Coefficients (Beta)	t	Sig. (p-value)
(Constant)	2.515	-	2.675	.011
Online Assessment (Students)	.328	.296	3.019	.005**
Online Assessment (Teachers)	.620	.512	9.410	.000**

Note: **Significant at the 0.01 level.

The regression coefficients reveal that online assessment significantly predicts students' academic achievement. The standardized coefficient for students' responses ($\beta = 0.296$, $p = 0.005$) suggests that students who frequently engage in online assessments tend to perform better in Physics. On the other hand, teachers' responses showed a stronger predictive value

($\beta = 0.512$, $p < 0.001$), reinforcing that teachers consider digital assessments as a crucial tool for improving student performance.

The unstandardized coefficients reveal that a one-unit increase in online assessment engagement leads to a 0.328-unit increase in students' academic achievement based on student responses and a 0.620-unit increase based on teacher responses. This indicates that while both students and teachers recognize the value of online assessment, teachers perceive its impact as even more substantial.

These findings emphasize the critical role of structured digital assessment tools in enhancing Physics learning outcomes. Students acknowledged that online assessments provided real-time feedback, opportunities for self-paced learning, and reinforcement of key concepts. However, some students also reported experiencing issues like system malfunctions and limited time availability. Teachers, on the other hand, highlighted that digital assessments facilitated timely interventions and differentiated instruction, allowing students to focus on areas that required improvement.

In conclusion, both students and teachers recognized that frequent engagement with online assessment positively influences students' academic achievement. However, the degree of effectiveness depends on various factors, including availability of technological resources, students' proficiency in using digital tools, and the availability of well-structured digital assessment tools. These findings support the need for increased investment in digital assessment platforms, teacher training on online evaluation strategies, and improved technological infrastructure in schools to maximize the benefits of online assessments in Physics education.

4.7.3 Discussion of Findings on the Influence of Online Assessment on Students' Academic Achievement

The findings indicate that online assessments significantly contribute to enhancing students' academic achievement in Physics. Students reported that digital quizzes, interactive assessments, and instant feedback mechanisms improved their understanding of Physics concepts and facilitated better engagement with learning materials. The flexibility of online assessments allowed learners to complete evaluations at their own pace, promoting self-regulated learning. These findings align with Mukazi (2022), who suggests that frequent online assessments enhance retention rates in STEM subjects by allowing students to track their learning progress more effectively. Similarly, Mukazi found that real-time feedback mechanisms in online assessment platforms significantly enhance students' comprehension of Physics concepts, as immediate correction of misconceptions reinforces learning.

Despite these benefits, the study revealed variations in students' experiences with online assessments. While many students acknowledged the advantages of digital evaluation, some expressed concerns about test anxiety, technical difficulties, and inconsistent access to digital tools. The effectiveness of online assessments depended on students' digital literacy levels, the quality of test design, and school infrastructure. Observations indicated that although some schools had access to digital assessment tools such as Google Forms and Kahoot, their use was inconsistent. Many teachers relied on traditional paper-based assessments, with mobile-based quizzes being used occasionally rather than as a structured evaluation strategy. Additionally, the availability of ICT infrastructure, including projectors, computers, and stable internet connectivity, varied across schools, influencing the extent to which online assessments were implemented. These findings align with Ede and Anosike (2023), who reported that schools with structured digital assessment programs achieved better learning outcomes in Physics due to increased student engagement and real-time feedback.

Teachers recognized the value of online assessments in tracking student progress, identifying learning gaps, and reinforcing conceptual understanding. Interviews with HODs revealed that while some teachers actively used digital assessment platforms, others faced challenges such as inadequate training (Barbedo et al., 2023) and lack of institutional support. In schools where teachers received structured ICT training, the integration of mobile-based quizzes and interactive tests into lesson plans was more effective, leading to better formative evaluation practices. However, in other schools, digital assessment tools were underutilized, and teachers primarily depended on traditional evaluation methods. The findings align with Smith et al. (2022), who observed that, although digital assessments enhance student engagement, their effectiveness depends on factors such as teacher preparedness and institutional support.

The correlation analysis showed a moderate, positive association ($r = 0.318$, $p < 0.05$) between students' participation in online assessments and their academic achievement, indicating, students who frequently engage in digital assessments achieve better in Physics. Teachers' responses revealed a stronger correlation ($r = 0.620$, $p < 0.01$), implying that educators perceive online assessments as highly beneficial in reinforcing student learning. These outcomes align with the conclusions drawn by Evariste et al. (2022), who observed that, students who consistently engaged in mobile-integrated assessments demonstrated improved Physics performance due to greater accessibility and real-time feedback.

Furthermore, Multiple Regression Analysis confirmed that online assessments significantly predict students' academic achievement in Physics. The R-value of 0.652 reflects a strong positive association, whereas the R-Square value of 0.426 implies that 42.6% of the differences in students' academic performance are attributable to the influence of online assessments and, other technology-based instructional approaches. The standardized regression coefficients revealed that both students ($\beta = 0.296$, $p = 0.005$) and teachers ($\beta = 0.512$, $p < 0.001$) viewed online assessments as critical in shaping Physics achievement.

These findings align with Salhab and Daher (2023), who reported that structured mobile-supported assessments enhance flexibility, student engagement, and learning outcomes in Physics education.

Observations further revealed that although smartphones and tablets were available in some schools, their integration into online assessments was not fully optimized. In many cases, students used their devices mainly for accessing online study materials rather than engaging in structured digital evaluations. Additionally, the absence of clear policies on ICT integration in assessment resulted in varied implementation across schools. In well-resourced institutions, students benefited from frequent online assessments, while those in under-resourced schools continued relying on conventional testing methods. These findings highlight the need for structured policies that promote equitable access to digital assessments across diverse learning environments.

These results suggest that optimizing the design of online assessment tools, addressing technological barriers, and promoting interactive digital evaluation strategies can further enhance their influence on academic achievement in Physics. Expanding access to ICT resources, ensuring structured teacher training, and fostering a culture of digital innovation in assessment practices will be essential in bridging the digital divide and maximizing the effectiveness of online assessments in Physics education.

4.8 Summary

The study comprehensively examined how the instructional utilization of mobile technologies (MT) influences students' academic achievement in Physics, focusing on secondary schools in Nandi East Sub-County, Nandi County, Kenya. Demographic analysis revealed that 59.2% of Physics students were male, and 73.6% were aged between 15–17 years. All students owned mobile devices, primarily smartphones (74.1%), but only 26.3% had access to

unlimited internet, limiting the full utilization of MT for learning. Teachers were professionally trained, mostly Degree holders, with laptops (60.8%) preferred for instructional use. Although 62.7% of teachers recognized the benefits of MT in Physics education, their actual classroom integration was limited.

The study examined MT use across four instructional constructs: simulations, ICT-powered lesson presentations, online collaborative learning, and online assessment. Simulations were available but inconsistently used, often depending on teacher initiative. ICT-powered presentations were partially integrated but not routine. Online collaboration and assessment were hindered by poor infrastructure, low digital literacy among teachers, and limited institutional support. These constraints made it difficult to fully embed MT into daily instruction.

Performance data revealed persistent underachievement in Physics. A total of 58.3% of students scored below 50% in Physics over the past three terms, while 28.3% scored below 30%. Student self-assessments echoed this trend, with 58.4% rating their performance as "Poor" or "Very Poor," and only 16.7% as "Good" or "Excellent." Teachers reported similar findings, noting that most class mean scores fell between 30% and 64%, and the majority of students were rated as "Poor" or "Average." These statistics emphasized the need for improved instructional strategies.

Inferential analysis confirmed that mobile technologies significantly influenced student outcomes. Pearson correlation revealed a positive association between MT instructional use and academic performance. Multiple regression analysis results showed that simulations ($\beta = 0.134$), ICT-powered lessons ($\beta = 0.368$), online collaborative learning ($\beta = 0.518$), and online assessments ($\beta = 0.296$) were all significant predictors ($p < 0.01$), with the model

accounting for 42.6% of the variance in performance (Adjusted $R^2 = 0.426$). Online collaboration had the greatest influence.

Teacher data showed ICT-powered lessons ($\beta = 0.384$) and online assessment ($\beta = 0.512$) significantly predicted student achievement. Simulations and collaboration were not assessed among teachers. Qualitative findings supported the quantitative results and stressed the importance of resolving challenges to optimize mobile technologies utilization in Physics instruction.



CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction.

This chapter offers a concise synthesis of the study's principal findings, emphasizing the influence of instructional use of MT in Physics education on students' academic achievement. It presents conclusions drawn based on the specific aims and guiding questions of the research, followed by practical recommendations aimed at informing policy, enhancing pedagogy, and fostering effective integration of technology in secondary school Physics instruction. Furthermore, the chapter outlines potential areas for further research to address identified gaps and to enrich the growing body of knowledge on mobile technology utilization in science education.

5.2 Summary of Findings

The research examined the influence of the instructional use of mobile technologies on students' academic achievement in Physics in secondary schools within Nandi County, with a specific focus on Nandi East Sub-County. The investigation focused on four specific dimensions: Simulations, ICT-powered lesson presentations, Online collaborative learning (OCL), and Online assessments.

Findings on simulations indicated that mobile-based simulation tools contributed positively to students' conceptual understanding, critical thinking, and problem-solving in Physics. An analysis of the correlation indicated a moderate positive relationship between the use of simulations and, academic achievement. Furthermore, multiple regression analysis (MRA) confirmed that simulations significantly predicted student performance, suggesting that increased use of simulation tools may improve learning outcomes in Physics.

Regarding ICT-powered lesson presentations, the study found that while digital tools were generally available, their instructional use was inconsistent across schools. When effectively

integrated, MT improved student engagement, enhanced visualization of abstract concepts, and promoted deeper comprehension. Correlation and regression results demonstrated a significant positive relationship between ICT-enhanced teaching and, student academic achievement, with structured implementation contributing to notably higher Physics scores.

The study also examined OCL and, its role in promoting academic success. Findings showed that peer interaction through digital platforms encouraged knowledge sharing, teamwork, and reflective learning. Pearson correlation indicated a moderate positive relationship between OCL participation and academic achievement, while MRA confirmed its predictive value. Nonetheless, disparities in digital access, varying levels of student participation, and lack of structured frameworks limited the full potential of collaborative strategies in some schools.

In terms of online assessments, the study found tools such as mobile quizzes, interactive tests, and real-time feedback mechanisms enhanced students' understanding and retention of Physics concepts. Statistical analyses indicated a moderate positive correlation between online assessments and student academic achievement. Both student and teacher participation in digital assessments emerged as significant predictors of academic performance. Schools that regularly implemented structured online assessments reported better outcomes compared to those that relied exclusively on traditional paper-based evaluations.

Overall, the findings suggest that mobile-supported instructional strategies—particularly simulations and ICT-powered lesson presentations—contribute significantly to enhancing students' academic performance in Physics. Although OCL and digital assessments also contributed positively, their impact was somewhat constrained by infrastructural limitations, inconsistent implementation, and varying levels of preparedness among educators and learners.

5.3 Conclusions

This study concludes that, MT usage have a significant and multifaceted influence on academic achievement in secondary school Physics. Simulations emerged as effective tool, enhancing students' conceptual grasp and problem-solving capacity. However, the full potential of these technologies remains underutilized due to infrastructural constraints and limited teacher training.

ICT-powered lesson delivery was found to significantly improve student comprehension and engagement, though inconsistencies in implementation across schools hindered broader impact. Similarly, OCL enriched the academic experience by fostering peer support and interaction, but its effectiveness was undermined by the absence of structured digital engagement frameworks and unequal access to devices.

Online assessments positively influenced learning by promoting frequent practice and timely feedback. Nevertheless, their success was tempered by challenges such as inadequate connectivity, low digital literacy among some users, and a lack of standardized evaluation systems.

In sum, while MT hold substantial promise in strengthening Physics education, their integration remains uneven and suboptimal. Overcoming persistent barriers—such as limited digital infrastructure, inadequate teacher preparation, and insufficient institutional support—is key to unlocking their full educational potential.

5.4 Recommendations

Drawing from the study's outcomes, a number of suggestions are put forward to strengthen the instructional use of MT in Physics instruction within secondary school education. These recommendations focus on policy, teacher development, infrastructure, and stakeholder engagement to ensure more effective implementation of MT.

First, it is essential for the Ministry of Education to establish clear policies that outline the integration of MT in science instruction. These policies should provide a structured basis to guide the consistent and effective use of digital tools across secondary schools. In addition to policy development, it is important to invest in digital infrastructure, such as reliable internet connectivity, mobile devices, and subject-specific instructional software. These investments are critical to facilitating the seamless adoption of MT in Physics instruction.

Second, teacher training should be prioritized so that educators possess the required competencies to successfully use MT in classroom instruction. Professional development initiatives should focus on enhancing digital literacy, pedagogical strategies, and proficiency with instructional tools like simulations and online assessments. Furthermore, schools should offer ongoing technical support and mentorship to assist teachers in integrating these technologies into their teaching practices.

Third, schools should develop structured frameworks for OCL to foster student engagement and digital inclusivity. It is important to promote mobile-assisted learning strategies that encourage peer interactions, group problem-solving, and knowledge-sharing. To address digital inequality, schools should ensure equitable access to mobile learning tools, particularly in under-resourced areas.

Additionally, efforts should be made to involve parents in supporting mobile learning initiatives. Schools should implement programs to inform parents of the educational benefits of MT and encourage responsible usage. Parental involvement is critical for reinforcing the use of mobile tools both in school and at home.

Finally, the poor perception of MT in schools is primarily a management issue rather than a technological limitation. Resistance to digital learning often arises from weak institutional policies, inadequate leadership, and insufficient teacher preparedness rather than inherent

flaws in the technology itself. School administrators should take proactive measures to create a structured digital learning environment, establish clear guidelines on MT utilization, and provide continuous professional development for educators. Addressing these management challenges is critical in transforming MT from perceived distractions into powerful instructional tools that enhance academic achievement in Physics.

5.5 Suggestions for Further Research

The inquiry provides valuable information on the instructional utilization of mobile technologies (MT) in Physics education, but several areas warrant further investigation. Longitudinal studies are needed to assess the sustained impact of MT on academic achievement over time, offering a clearer understanding of their long-term effects on learning outcomes in Physics and other STEM subjects.

Comparative research could explore the influence of socio-economic factors on mobile learning adoption, particularly in rural and urban schools, to understand how resource availability affects engagement with MT. Experimental studies that examine the causal association between MT integration and academic performance would also be valuable.

Additionally, future research should focus on teachers' attitudes and their ability to adapt to MT integration. Understanding the challenges faced by educators can inform targeted professional development strategies. Finally, research into optimizing mobile-assisted assessment models is needed to identify the most effective digital tools for improving conceptual mastery and academic performance in Physics.

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PART B: Influence of Simulations on Students' Academic Achievement in Physics

Opinions of respondents, concerning influence of simulations on physics achievement. Please tick [] where applicable.

5=Strongly agree 4=Agree 3=Uncertain 2=Disagree 1=Strongly disagree)

	Statement	5	4	3	2	1
1	Simulations help me understand complex Physics concepts and improve problem-solving.					
2	Animated Physics tutorials reinforce my classroom learning.					
3	Interactive simulation apps enhance my understanding of Physics problems and solutions.					
4	Virtual Physics experiments using online simulations improve my practical skills.					
5	Creating animated simulations helps me grasp Physics topics better.					
6	Accessing educational Physics simulations from online platforms enhances my learning.					
7	Participating in online discussions about Physics simulations deepens my understanding.					
8	Collaborating with classmates through shared Physics simulations improves my grasp of concepts.					

PART C: Influence of ICT-Powered Lesson Presentations on Students' Academic Achievement in Physics

Opinions of respondents regarding influence of ICT-powered lesson presentations on physics academic achievement

(5=Strongly agree 4=Agree 3=Uncertain 2=Disagree 1=Strongly disagree)

	Statement	5	4	3	2	1
1	ICT-powered lesson presentations enhance my understanding and knowledge of Physics.					
2	The available digital tools and applications used in ICT-powered lessons are effective for learning Physics.					
3	The reliability and speed of internet connectivity support the effectiveness of ICT-powered Physics lessons.					
4	I find that ICT-powered lessons significantly increase access to current and important information in Physics.					
5	I am satisfied with the level of interaction facilitated by ICT-powered lessons between Physics teachers and students.					
6	I frequently use educational videos in ICT-powered lessons for understanding complex Physics phenomena					

PART D: Online Collaborative Learning on Students' Achievement in Physics

Opinions of the respondents regarding, influence of online collaborative learning on students' academic achievement in physics

(5=Strongly agree 4=Agree 3=Uncertain 2=Disagree 1=Strongly disagree)

	Statement	5	4	3	2	1
1	Using online collaborative platforms enhances my interaction with classmates, improving my understanding of Physics.					
2	Online collaborative tools strengthen my engagement with my Physics teacher, improving my grasp of concepts.					
3	Online collaborative learning increases my access to diverse Physics learning materials, improving comprehension..					
4	Online collaborative tools make it easier for me to complete and understand Physics assignments.					
5	Participating in online collaborative learning complements and deepens my understanding of Physics concepts beyond textbooks.					
6	Using interactive online collaborative platforms strengthens my problem-solving and critical thinking skills in Physics					
7	Online collaborative learning encourages creative approaches to solving Physics problems.					
8	Regular participation in online collaborative learning improves my overall performance in Physics					

PART E: Influence of Online Assessment on Students' Academic Achievement in Physics

Opinions of respondents regarding, influence of online assessment on students' academic achievement in physics (5=Strongly agree 4=Agree 3=Uncertain 2=Disagree 1=Strongly disagree)

	Statement	5	4	3	2	1
1	Online assessments provide immediate feedback that helps me understand my mistakes in Physics.					
2	I find online quizzes and tests more engaging and motivating than traditional paper-based exams.					
3	I frequently use online assessments to track my progress and improvement in Physics over time.					
4	The flexibility of online assessments enables me to take tests at my own pace and convenience.					
5	Online assessments often include interactive elements that enhance my comprehension of Physics concepts.					
6	Online assessments in Physics regularly helps me develop better time management skills					
7	The variety of question formats in online assessments (e.g., multiple choice, simulations) aids my learning.					
8	I feel more comfortable and less anxious taking Physics assessments online compared to traditional methods					

Much Appreciated for Your Time

APPENDIX B: QUESTIONNAIRE FOR TEACHERS

The researcher is carrying out research on the influence of instructional use of Mobile Technologies on students' academic achievement in Physics. Kindly, reply to this questionnaire. The information provided, shall be accorded utmost confidentiality.

Instructions: Kindly tick [] or provide answers as applicable

PART A: Demographic Information

1. What is the duration of your experience teaching Physics?

- a) 1-4 years []
- b) 5-9 years. []
- c) 10-14 years. []
- d) 15 years & above []

2. Please indicate your highest level of academic qualification

- a) PhD [] b) Masters [] c) Degree []
- d) Diploma [] e) Others (Specify)_____.

3. Which type(s) of mobile device do you frequently use for learning purposes?

- a) Smartphone [] b) Laptop [] c) Tablet []

4. In your opinion, how do mobile technologies influence students' performance in Physics?

- a) Positively [] b) No influence [] c) Negatively []

5. What is the most recent class mean score for Physics in percentage (e.g., 65%)?

Mean Score: _____ %

6. Based on your experience, how would you rate the average Physics performance of your student's exam results?

- [] 1 – Below 30% (Very Poor)
- [] 2 – 30% to 49% (Poor)
- [] 3 – 50% to 64% (Average)
- [] 4 – 65% to 79% (Good)
- [] 5 – 80% and above (Excellent)

PART B: Influence of ICT-Powered Lesson Presentations on Students' Academic Achievement in Physics

Opinions of the respondents-teachers regarding, influence of ICT-powered lesson presentations on students' academic achievement in physics. Kindly tick as appropriate.

(5=Strongly agree 4=Agree 3=Uncertain 2=Disagree 1=Strongly disagree)

	Statement	5	4	3	2	1
1	ICT-powered lesson presentations enhance my students' understanding of complex Physics concepts.					
2.	I frequently use digital simulations and animations in ICT-powered lessons to improve student physics engagement .					
3.	ICT-powered lesson presentations help in differentiating instruction to meet diverse student needs in Physics.					
4.	The availability of online Physics resources and tools enhances the quality of my lesson planning.					
5.	ICT-powered lessons facilitate more effective formative assessments in Physics.					
6	The integration of interactive whiteboards in ICT-powered lessons improves student participation.					
7	ICT-powered lesson presentations help bridge gap between theoretical & practical aspects of Physics.					
8	Use of ICT in lessons encourages collaborative learning among students in Physics.					
9	The incorporation of real-time data and virtual labs in ICT-powered lessons enriches the learning experience.					
10	ICT-powered lesson presentations positively impact my teaching methods and strategies in Physics.					

PART C: Influence of Online Assessment on Students' Academic Achievement in Physics

Opinions of the respondents regarding influence of online assessment on students' academic achievement in physics. Kindly tick where applicable

(5=Strongly agree 4=Agree 3=Uncertain 2=Disagree 1=Strongly disagree)

	Statement	5	4	3	2	1
1	Online assessments provide immediate feedback that helps me identify students' misconceptions in Physics.					
2.	I find online quizzes and tests more engaging and motivating for students compared to traditional paper-based exams.					
3.	Online assessments allow me to monitor students' progress and improvement in Physics over time effectively.					
4	The flexibility of online assessments enables students to complete tests at their own pace, which enhances their learning.					
5	Online assessments often include interactive elements that enhance students' understanding of Physics concepts.					
6	Online assessments in Physics help students develop better time management skills.					
7	The variety of question formats in online assessments (e.g., multiple choice, simulations) aids students' comprehension.					
8	I frequently analyze and report on students' performance using online assessment tools					
9	Online assessments provide a platform for incorporating multimedia elements, such as videos and animations, to clarify Physics concepts.					
10	The use of online assessments in Physics has reduced my workload related to grading and providing feedback.					

APPENDIX C: OBSERVATION SCHEDULE FOR MT INFRASTRUCTURE

School Name: _____ Date of Observation: _____

Observer's Name: _____

Observation Criteria

Item to be Observed	Availability	Utilization Observed
Smartphones, Tablets, Laptops	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
Smartboards	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
Projectors	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
Routers	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No
Wi-Fi Availability	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No

APPENDIX D: INTERVIEW SCHEDULE FOR HEADS OF DEPARTMENT

The researcher is carrying out research on the influence of the instructional use of mobile technologies on students' academic achievement in Physics. Any information provided, shall be accorded utmost confidentiality.

1. What are the educational implications of MT-enabled simulations on students' academic achievement in physics?
2. How do ICT-powered lesson deliveries influence students' academic achievement in Physics?
3. What are the educational implications of integrating mobile technologies on students' academic achievement in physics?
4. How does instructional use of Mobile Technologies influence online collaborative learning in Physics?
5. What are your views on the influence of mobile learning on academic achievement of students in physics in Kenya?

Thank You for Your Time

APPENDIX E: INTRODUCTION LETTER TO RESPONDENTS

Dear Respondent,

RE: QUESTIONNAIRE ON THE INFLUENCE OF INSTRUCTIONAL USE OF MOBILE TECHNOLOGIES ON STUDENTS' ACADEMIC ACHIEVEMENT IN PHYSICS IN SECONDARY SCHOOLS IN NANDI COUNTY, KENYA.

I am Daniel Kibiwott, a postgraduate student at Mount Kenya University (MKU), pursuing a Master of Education degree in Instructional Technology. As part of my academic requirements, I am conducting research on the influence of instructional use of mobile technologies on students' academic achievement in physics. The findings of this study will be submitted to Mount Kenya University.

You have been selected to participate in this study because you are well-positioned to provide insights into the extent of mobile technology integration in teaching Physics in your school. I kindly request your cooperation in completing this questionnaire. Please be assured that all information provided will be treated with the highest level of confidentiality and used solely for academic purposes.

Your participation is highly valued, and I sincerely appreciate your time and support.

Thank you in advance.

Sincerely,



Daniel K. Kibiwott.

Postgraduate Student

Mount Kenya University

APPENDIX F: CONSENT FORM FOR MINORS

I, give consent for the minors to participate in the research project entitled, “**Influence of Instructional Use of Mobile Technologies on Students' Academic Achievement in Physics in Secondary Schools in Nandi County, Kenya**” The study has been elucidated to me and my questions answered to my satisfaction. I understand that the minor’s right to withdraw from participating or refuse to participate will be respected and that his/her responses and identity will be kept confidential. I give this consent voluntarily.

School Principal’s Signature: **Date:**

I agree to participate in the research study titled ‘**Influence of Instructional Use of Mobile Technologies on Students' Academic Achievement in Physics in Secondary Schools in Nandi County, Kenya**’ carried out by Daniel Kibiwott, (MED/2019/55219) with whom I have discussed the research with.

I have read a copy of this form written in plain language. I had the opportunity to ask questions concerning this research and I have received satisfactory answers. I know the purpose, threats as well as approaches of this study.

I consent to participate in this study and that the following have been adequately clarified to me:

My participation in the study is absolutely voluntary.

My right to, pull out of the study at any time without any repercussions to me.

The threats due to my participation in the study

The measures that have been taken to address any possible threats

The study might not be directly beneficial to me.

What is expected of me in the study

The persons I should contact in case of any concerns related to the study.

The security and privacy of my personal info

I also consent to the publication of results from this study on the understanding that my identity will not be disclosed.

Minors Signature: **Date:**

Researcher’s Signature: **Date:**

APPENDIX G: MOUNT KENYA UNIVERSITY INTRODUCTION LETTER

Mount Kenya  University
ELDORET CAMPUS

Building: Mount Kenya University Plaza

Telephone: +254 20 2641361

Street: Ronald Ngala Street

Fax: +254 64 51 437

Postal Address: P.o. Box 2591 30100 Eldoret

Cell: +254 724205425, +254 724205432

Email: eldoretcenter@mku.ac.ke

**OFFICE OF THE DEPUTY DIRECTOR, ACADEMIC AND RESEARCH
AFFAIRS**

Ref No. MKU05/ IDD-ARA/ 005/2020/047

31st December, 2020

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

RE: KIBIWOTT K DANIEL REG NO, MED/2019/55219



This is to confirm that the above named is a bona-fide student in our institution in the School of Education pursuing Master of Education in Instructional Technology.

He has successfully completed his coursework and currently working on the Thesis.

Any assistance accorded to him is highly appreciated.

Thank you.

Yours faithfully,

Dr. Stephen Tomno C

DEPUTY DIRECTOR ACADEMIC AND RESEARCH AFFAIRS

APPENDIX H: MOUNT KENYA UNIVERSITY ERC CERTIFICATE

MOUNT KENYA



UNIVERSITY

REF: MKU/ISERC/2466

Date: 04 November 2022

TO: DANIEL K. KIBIWOTT

REG: MED/2019/55219

Dear Sir/Madam,

RE: INTEGRATION OF MOBILE TECHNOLOGIES TO ENHANCE TEACHING AND LEARNING OF PHYSICS IN SECONDARY SCHOOLS IN NANDI EAST, KENYA

This is to inform you that Mount Kenya University has reviewed and approved your above research proposal. Your application approval number is **1539**. The approval period is **27/10/2022 -26/10/2023**.

This approval is subject to compliance with the following requirements;

- i. Only approved documents including informed consents, study instruments, MTA will be used
- ii. All changes including amendments, deviations and violations are submitted for review and approval by **Mount Kenya University**
- iii. Death and life-threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to **Mount Kenya University** within 72 hours of notification
- iv. Any changes, anticipated or otherwise that may increase the risks or affect the safety or welfare of, study participants and others or affect the integrity of the research must be reported to **Mount Kenya University** within 72 hours
- v. Clearance for export of biological specimens must be obtained from relevant institutions.
- vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal
- vii. Submission of an executive summary report within 90 days upon completion of the study to **Mount Kenya University**

Prior to commencing your study, you will be expected to obtain, a research license from National Commission for Science, Technology and, Innovation (NACOSTI), <https://research-portal.nacosti.go.ke> and also obtain other clearances needed.

Yours sincerely,
The Chairman
Mount Kenya University
Ethics Review Committee
P. O. Box 342 - 0100, Thika
Dr. Peter G. Kirira

Dr. Peter G. Kirira

CHAIRMAN MOUNT KENYA UNIVERSITY ISERC

APPENDIX I: NACOSTI RESEARCH PERMIT



REPUBLIC OF KENYA



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

Ref No: **929415**

Date of Issue: **21/November/2022**

RESEARCH LICENSE



This is to Certify that Mr.. DANIEL K KIBIWOTT of Mount Kenya University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Nandi on the topic: INTEGRATION OF MOBILE TECHNOLOGIES TO ENHANCE TEACHING AND LEARNING OF PHYSICS IN SECONDARY SCHOOLS IN NANDI EAST, KENYA for the period ending: 21/November/2023.

License No: **NACOSTI/P/22/22195**

929415

Applicant Identification Number

Director General

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



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 condition

APPENDIX J: LETTER OF AUTHORIZATION



MINISTRY OF EDUCATION

STATE DEPARTMENT OF EARLY LEARNING AND BASIC EDUCATION

Telegrams: "EDUCATION",
Telephone: 053 643340/0208008140
Email: mocnandieast@gmail.com
When replying please quote

**SUB COUNTY EDUCATION
NANDI EAST
P.O. Box 13
NANDI HILLS**

20th JANUARY, 2023

REF: NED /ADM/R/V267/VOL1/57

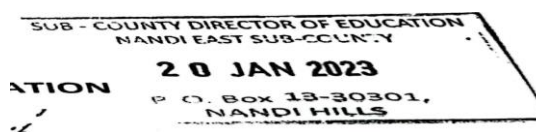
**DANIEL K. KIBIWOT
MOUNT KENYA UNIVERSITY
P. O. BOX 2591 - 30100
ELDORET.**

RE: AUTHORITY TO CARRY OUT RESEARCH


Reference is made to your letter dated 4/11/2022 requesting permission to carry out research in "Integration of mobile technology to enhance teaching and learning of Physics in secondary schools in Nandi East, Kenya".

I wish to inform you that you have been granted permission to carry out your research as stated above, in Nandi East Sub County.

You are further informed that you strictly conform to the research period ending 27/10/2023 and share a copy of your findings to this office. Wishing you luck in your research.



**JAPHETH N. OMARIBA
FOR SUB COUNTY DIRECTOR OF EDUCATION
NANDI EAST**

CC: 

COUNTY DIRECTOR OF EDUCATION - NANDI COUNTY

APPENDIX K: TURNITIN – SUBMISSION DETAILS REPORT

**INFLUENCE OF INSTRUCTIONAL
USE OF MOBILE
TECHNOLOGIES ON STUDENTS'
ACADEMIC ACHIEVEMENT IN
PHYSICS IN SECONDARY
SCHOOLS IN NANDI COUNTY,
KENYA**

by K DANIEL KIBIWOTT

Submission date: 15-May-2025 06:39PM (UTC+0300)

Submission ID: 2676689869

File name: THESIS_DOCUMENT-D.KIBIWOTT_APRIL_2025_Final.docx (1.68M)

Word count: 34632

Character count: 221077

APPENDIX L: TURNITIN – SIMILARITY INDEX REPORT

INFLUENCE OF INSTRUCTIONAL USE OF MOBILE TECHNOLOGIES ON STUDENTS' ACADEMIC ACHIEVEMENT IN PHYSICS IN SECONDARY SCHOOLS IN NANDI COUNTY, KENYA

ORIGINALITY REPORT

16%

SIMILARITY INDEX

12%

INTERNET SOURCES

12%

PUBLICATIONS

6%

STUDENT PAPERS

MATCH ALL SOURCES (ONLY SELECTED SOURCE PRINTED)

6%

★ ir.mu.ac.ke:8080

Internet Source

Exclude quotes Off

Exclude matches Off

Exclude bibliography Off

APPENDIX M: MAP OF NANDI COUNTY

