EFFECTS OF SIMULATION TEACHING TECHNIQUE ON CO-EDUCATIONAL SECONDARY SCHOOLS STUDENTS' ACHIEVEMENT AND ATTITUDE TOWARDS LEARNING PHYSICS IN BUURI-EAST SUB-COUNTY, KENYA

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DECLARATION AND RECOMMENDATION

Declaration

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

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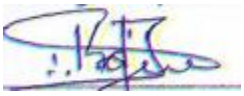
Recommendation

This Thesis has been submitted for examination with our approval as university supervisors.

Signature :  Date 25 – 8 - 2023

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DEDICATION

This thesis is dedicated to my parents Fredrick Ndegwa and Ruth Wanjiru and my daughter Amanda.

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I thank God for the far I have come and for his faithfulness in meeting my needs, financial, health and spiritual nourishment. I would also like to acknowledge the contribution of several people who have been supportive during my study. I am grateful to Egerton University for allowing me to pursue this course. My sincere gratitude to my supervisors, Dr Joel K. Ng'eno and Dr Grace C. Ndeke, for their guidance, patience, encouragement and contribution to this document. Toall my colleagues, the Master's Students (2018 class) in the department of Curriculum Instruction and Educational Management of Egerton University, for being a support system during the study. May the almighty God bless you abundantly.

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ABSTRACT

Science is a fundamental discipline on many grounds and it is credited for most of humanity's technological advances. Physics is a branch of science and is credited nearly all technological development at a national and global scale. As in most nations, Physics' prominence is revered in Kenya. Unfortunately, it is apparent significance does not reflect on academic performance in Kenyan secondary schools. This may be due to the inadequacy of conventional teaching techniques used for physics tutorage. Most physics concepts are abstract, and the techniques used may not allow learners to conceptualize such concepts. Conventional teaching techniques have led to student' slow achievement in physics and subsequently learners develop negative attitudes towards learning physics. This study aimed to investigate the effects of simulation teaching techniques on student achievements and attitudes towards learning physics. In this study, the Solomon four non-equivalent control group design was used. The target population was 1119 form two students in Buuri East sub-county in Meru County. The accessed population size was 542 form two students in co-education secondary schools in the sub-county. Purposive and Stratified sampling were used to select four co-education schools, the sample comprised of 123 participants. Physics Achievement Test (PAT) and Student Attitude Questionnaire (SAQ) were used to collect research data. Education experts validated the instruments at the Department of Curriculum, Instruction and Educational Management (CIEM). A pilot study was conducted in two co-education secondary schools, KR-20 was used to estimate the reliability of PAT, which was found to have a 0.84 coefficient. Cronbach alpha was used to estimate the reliability of SAQ, which was established to be 0.724, both reliability coefficients were accepted. Data was analysed using the analysis of variance (ANOVA) and t-test. All statistical tests were subjected to a significance test at an alpha level of 0.05. The study's findings revealed a statistically significant difference in achievement for students exposed to the simulation teaching technique, unlike learners exposed to convectional teaching. The findings also showed no statistically significant difference in physics achievement and attitudes towards learning physics between male and female learners. The findings of this study may inform educator training of higher education institutions and the Kenya Institute of Curriculum Development (KICD) while developing teaching materials. The findings may also be significant to physics teachers in their practice and to educational researchers.

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LIST OF ABBREVIATIONS AND ACRONYMS

AI	Artificial Intelligence
ANOVA	Analysis of Variance
CDE	County Director of Education
DNA	Deoxyribonucleic Acid
GPS	Global Positioning Systems
IoT	Internet of Things
KCSE	Kenya Certificate of Secondary Education
KICD	Kenya Institute of Curriculum Development
KNEC	Kenya National Examinations Council
NACOSTI	National Commission for Science, Technology and Innovation
PAT	Physics Achievement Test
RoK	Republic of Kenya
SAQ	Student Attitude Questionnaire
SGR	Standard Gauge Railway
SMASSE	Strengthening of Mathematics and Science in Secondary Education
STEM	Science, Technology, Engineering and Mathematics
TIMSS	Trends in International Mathematics and Science Study
4IR	Fourth Industrial Revolution
SPSS	Statistical Package for Social Science
VR	Virtual Reality

CHAPTER ONE
INTRODUCTION

1.1Background Information

Shumba (2003) upholds science as a driver for economic well-being of nations. Over the last couple of centuries, the world has seen rapid technological advancement, credited to the uptake of sciences in education. Science entails an endeavour to understand concepts and applying its principles in areas such as energy, medicine, transportation, security, industrial processes and food production (Keter, 2013). Therefore, science equips learners with the relevant knowledge and skills for innovation, which subsequently readies a country for future economically viable technological growth.

Among the three basic sciences, Physics is largely associated to technology which asserts its prominence in education as the world grows more reliant on technology. Physics deals with studying the nature and interaction of matter and energy. Ngatia et al. (2019) described physics as a science that describes how nature works using the language of mathematics. Buabeng et al. (2014) contend that physics has played a key role in the progress of humankind. That assertion is evidenced by the immense infrastructural, energy and transportation technology developed through the implementation of Physics concepts. Amando et al. (2012) affirm that Physics provides students with analytical, problem-solving and quantitative skills. Jayantha (2018) noted that Physics is the backbone of technological innovation. It has empowered 21st-century students with the relevant skills needed for technological innovation and practice. Hence, it is crucial to support and improve physics education.

Knowledge in Physics and technology has spectacularly and simultaneously impacted the society. Khan et al. (2005) noted that the most durable goods, public utilities, consumables and services would not exist without technology. Since Physics is the backbone of technology, the authors assert that the discipline has a developmental significance in the society. Motor vehicles, railways, aeroplanes, mobile communication devices, televisions, radios, household appliances, hospital and office machinery are all derivatives of physics principles. Freeman (2012) noted that physics has continuously influenced medical practices. The understanding of Physics has been integral in the development and implementation of imaging techniques, X-rays, CT-scanning, ultra-sound, and echo techniques. Amunga et al. (2011) profess that innumerable treatment modalities in commonplace use can be credited to

the discovery and application of radioactivity and other high-frequency radiations. Such advancements are credited to knowledge acquired from the study of Physics, which also informs their implementation.

Technological advancement has occurred in phases, with the current one being the Fourth Industrial Revolution (4IR). It has been built on foundations laid by the first three industrial revolutions. The dawn of the steam engine in the 18th century led to the first industrial revolution, allowing production to be mechanized for the first time, and driving social change as people became increasingly urbanized. In the second industrial revolution, electricity and other scientific advancements led to mass production. A third industrial revolution, beginning in the 1950s, saw the surfacing of computers and digital technology. This led to the increasing automation of manufacturing and the disruption of industries including banking, energy, and communications. The current phase is characterized by rapid advances in interconnectivity and automation of industry, leading to changes in industry, technology and social patterns. Schwab (2016) supports that premise by citing that 4IR has given rise to unprecedented processing power and storage capabilities. It's a fusion of advances in artificial intelligence (AI), robotics, the Internet of Things (IoT), Web3, block chain, 3D printing, genetic engineering, quantum computing, and other technologies. The easiest way to understand the Fourth Industrial Revolution is to focus on the technologies driving it. These include the following:

i. Artificial intelligence (AI): It describes computers that can "think" like humans. They can recognize complex patterns, process information, draw conclusions, and make recommendations. AI is used in many ways, from spotting patterns in huge piles of unstructured data to powering the autocorrect on your phone.
ii. Web3: It's the third iteration of the internet. Web1 allowed people to access and read information on websites, like Yahoo. In Web2, blogs, wikis, and social media like Twitter and YouTube got introduced, giving people more control over the information they created and shared. In Web3, the decentralized world puts ownership into the hands of the community. Web3 comprises block chain technology, crypto currencies, and token-based economics.
iii. Block chain: is a secure, decentralized, and transparent way of recording and sharing data, with no need to rely on third-party intermediaries. The digital currency Bitcoin is the best known block chain application. However, the technology can be used in other ways, including making supply chains traceable, securing sensitive medical data anonymously, and combating voter fraud.

iv. Faster computer processing: new computational technologies are making computers smarter. They enable computers to process vast amounts of data faster than ever before, while the advent of the cloud has allowed businesses to safely store and access their information from anywhere with internet access. Quantum computing technologies now in development will eventually make computers millions of times more powerful. These computers will have the potential to supercharge AI, create highly complex data models in seconds, and speed up the discovery of new materials.

v. Difference between VR and AR: The difference between them is that VR offers immersive digital experiences (using a headset) that simulate the real world, while AR merges the digital and physical worlds. Examples include L'Oréal's AI-powered virtual try-on tool, which allows users to digitally experiment with makeup products before buying them, and the Google Translate phone app, which allows users to scan and instantly translate street signs, menus, and other text.

vi. Biotechnology: harnesses cellular and bio-molecular processes to develop new technologies and products for a range of uses, including developing new pharmaceuticals and materials, more efficient industrial manufacturing processes, and cleaner, more efficient energy sources. Researchers in Stockholm, for example, are working on what is being touted as the strongest biomaterial ever produced.

vii. Robotics: It refers to the design, manufacture, and use of robots for personal and commercial use. While we're yet to see robot assistants in every home, technological advances have made robots increasingly complex and sophisticated. They are used in fields as wide-ranging as manufacturing, health and safety, and human assistance.

viii. The Internet of Things: The IoT describes everyday items from medical wearable's that monitor users' physical condition, to cars and tracking devices inserted into parcels connected to the internet and identifiable by other devices. A big plus for businesses is they can collect customer data from constantly connected products, allowing them to better gauge how customers use products and tailor marketing campaigns accordingly. There are also many industrial applications, such as farmers putting IoT sensors into fields to monitor soil attributes and inform decisions such as when to fertilize.

ix. 3D printing: It allows manufacturing businesses to print their own parts, with less tooling, at a lower cost, and faster than via traditional processes. Plus, designs can be customized to ensure a perfect fit.

4IR is the collective force behind many products and services that are fast becoming indispensable to modern life. Think Global Position Systems (GPS) that suggest the fastest route to a destination, voice-activated virtual assistants such as Apple's Siri, personalized Netflix recommendations, and Facebook's ability to recognize your face and tag you in a friend's photo. As a result of this perfect storm of technologies, the Fourth Industrial Revolution is paving the way for transformative changes in the way we live and radically disrupting almost every business sector. It's all happening at an unprecedented, whirlwind pace.

Kenya has been a beneficiary of advancement in physics over the years. An example is the establishment of media houses across the nation, leading to the sprouting of employment opportunities for the country's youth. There has also been improved infrastructure, such as the construction of the Thika Superhighway and modern railway lines, such as the 3,800-kilometer-long Standard Gauge Railway (SGR). While these projects used borrowed manpower, which was only because the Chinese developers responsible had better knowledge of engineering due to their decade's worth investments in physics.

Like China, Kenya's commitment to the highly reputed Vision 2030 initiative is reliant on significant investments in Physics at secondary school level and its related disciplines in higher learning. Some of the major pillars of this vision include infrastructure, energy production, technology, security, manufacturing, housing and health (Republic of Kenya [ROK], 2007). These pillars will be driven by people well-grounded in the knowledge of physics and related sciences.

However, despite the accentuation on the subject's significance, students' achievements have been below average, as attested by examining bodies. According to Trends in International Mathematics and Science Study (TIMSS, 2015) report, students' physics achievements were the lowest compared to other sciences for the countries participating. The participants included Canada, Finland, Malaysia, Thailand, South Africa, and Egypt.

In Kenya, students' achievements in physics are still below average as attested by the reports from Kenya National Examinations Council (KNEC, 2019, 2021, 2023) as shown in Table 1.

Table 1

KCSE Physics Results (%) for Year 2018 to 2022

Year	2018	2019	2020	2021	2022
Paper 1	24.57	22.98	25.63	21.58	21.12
Paper 2	26.22	22.13	20.43	25.93	20.43
Paper 3	19.33	19.43	19.13	23.55	17.59
Overall	35.05	34.27	32.59	35.52	29.70

Source: Kenya National Examination Council (2019, 2021, 2023)

The results from Table 1 show that student achievements in physics have declined progressively over the years. The highest overall score was 35.52% in 2021, and the lowest score was 29.70% recorded in 2022. The trend shows that student achievements in physics nationally are below average. In Buuri East sub-county, where this study was carried out, the same trend was observed.

Table 2

Physics KCSE results in Buuri Sub-County for years 2018 to 2022

Year	2018	2019	2020	2021	2022
Overall Score (%)	37.64	34.78	26.44	24.17	29.10

Source: Sub County Director of Education (2023)

Table 2 indicates a declining trend in Physics achievement. Poor achievement in Physics is a major concern, especially to the primary stakeholders of science education. Several probable explanations for the poor students' achievement in Physics have been theorized. These include the training of educators and their content knowledge since they play a crucial role in the implementation of the curriculum (Mwenda et al., 2013). This requires them to be well-trained in order to implement the curriculum effectively; this is also emphasized by (Spaull, 2013). Another factor is inadequate resources lack of adequate resources in schools is a matter of concern across the globe. Lack of resources, such as textbooks, physical infrastructure, human resource and laboratory equipment has led to the learners losing interest in the subject, and hence low achievement in academics (Mwenda et

al., 2013). Dhurumraj (2013) notes that for effective teaching and learning of science adequate and relevant resources need to be available, as they make up an essential component.

Parental involvement in another factor that may affect student performance Modisaotsile (2012) defines parental involvement will be used, as an activity where the parents are full supportive on their children's education, not only in assisting with homework but also in motivating their children to participate in extramural activities, guiding them in respect of social interactions around others and ensuring that their child is at school on time and at their best behavior. Other research have indicates that the parent's involvement in teaching and learning plays an important role in their children's academic performance (Dhurumraj, 2013).

Poverty has also been accredited as one of the factors that leads to low achievement Chinyoka and Naidu (2014) argue that the home environment has an impact on the academic achievement of the child because the home is where the child receives his/her initial education and socialization. Osagiobare and Edith (2013) in their research found out those children from poor families lack cognitive competence simply because they did not get early education, and this leads to a low vocabulary, IQ, and social skills. This agrees with Adesoji and Ogini, (2012) that a poor academic foundation for students in basic science in lower classes contributes to poor achievement López-Pérez et al. (2011) argued that the teacher's instructing technique affects students' achievement. The Strengthening of Mathematics and Science in Secondary Education (SMASSE, 2007) report support that premise by indicating that poor achievement in science subjects follows inappropriate teaching techniques. Makgato and Mji (2006) noted that application of outdated teaching techniques contributes directly to the poor performance of learners in the science subjects. They further argue that poor teaching techniques have a direct influence on the low achievement of learners in the science subjects. Therefore, the collaborative findings indicate the prominence of teaching techniques in student performance.

Another commonly cited factor is the learners. Ezeliori (2004) observes that in most countries, the stereotype of males performing better than their female counterpart in science subjects is prevalent. Such societal stereotyping denies females an opportunity to indulge in science, a prerequisite to hindrance to science learning. The stereotype allows males to study unencumbered while females are denied the same opportunity. Subsequently, most female learners shy away from science subjects, especially physics and develop an attitude that science subjects are meant for boys. The few that select the subject do not do well when

compared to the boys. In 2022 out of the 160,186 students who sat for the physics examination in KCSE, only 48,421 students were female, which is about 30% of all candidates (KNEC, 2023). In Buuri East, out of 126 students, only 17 were female, accounting for 13% of those who sat for the Physics examination in 2022. Thus, there is evidence of a gender bias against female learners in physics.

Various studies have shown mixed results on gender. TIMSS (2015) found no statistically significant difference between boys and girls in science achievement. However, they found that girls outperformed boys in most countries. Oluwatelure (2015), in his study on the gender difference in achievement in science, found a statistically significant difference in students' achievement in science in favor of girls. Inzahuli et al. (2012), in their study on gender disparities in attitude and perception in chemistry and physics, observed that boys reflected better academic achievement than girls. In Buuri East, sub-county girls' achievements in physics have consistently been below average, with a declining trend. This study seeks to fill this gap by delineating the effects of simulation teaching technique on students' achievement by gender in the sub-county.

Due to the continuous below average achievement in physics, most learners have developed a negative attitude towards learning the subject. Guido (2013) notes that one of the most significant factors affecting students' academic success is their attitude towards schools, lessons and the subject. Mushinzimana and Sinaruguliye (2016) observed that a student's positive attitude towards a subject leads to better achievement. The difference in the attitude of male and female students towards Physics has been an issue in many countries. Plenty of research has been conducted with varying findings. Medine's (2016 study on gender differences among high school students in Physics, established that male students were more interested in Physics and technology than female students. They also asserted that female students did not show affinity for physics-oriented careers. Fatoba and Aladejana (2014) observed a slight gender difference in attitude towards physics in favor of female students. According to Guido (2013), attitude can distort the perception of information and impact information retention among learners. Therefore, among other things, teachers need to instill positive attitudes towards a subject in students. Medine (2016) also argues that teachers can change the views of students towards physics in a positive way if they are equipped with appropriate teaching techniques and resources. This study seeks to fill this gap by determining the effects of simulation teaching technique on students' attitudes towards learning physics by gender.

Physics is a practical subject and calls for student engagement in the teaching process. Tamunoiyowuna and James (2016) note that physics is a practical subject requiring continuous demonstration and indulging laboratory activities. These activities help in explaining some seemingly abstract concepts. The practices also instill appropriate scientific skills, technological and economic understanding for advancement to higher education. However, the most popular methods used to teach physics are conventional techniques. Some of the concepts taught in physics are abstract, and the use of practical work may be too expensive, rendering them impractical. Scientific practicals are seldom risk free, which predisposes learners, the environment and educators to hazardous materials or procedures. Some concepts are also difficult to present in a classroom through demonstration or practical work. Examples of such concepts include those related to radiation, electric fields, magnetic fields, heat, and energy.

In this study, the concept of magnetism will be the primary focus area. The concept of magnetism is abstract to learners. Sederberg and Bryan (2009) point out that magnetism is as mysterious to learners of all ages as it is appealing, especially for a child without experience with magnets. Constantinou et al. (2001) observed that the idea of objects acting on each other without touching is counterintuitive for learners. They also noted that it was difficult for learners to understand that a magnet could attract and repel other objects. Learners also come with misconceptions about magnetism from their prior knowledge. Sederberg and Bryan (2009) noted that high school students believe that magnetism and charge are identical. The commonly held believe is that magnetism is a result of the distribution of electrons. Saglam and Millar (2006) noted that students believe that magnets are electrically charged and that magnetization involves the transfer of electrons. Collect and Mongan (2011) argue that to successfully replace a misconception, the student should be confronted with demonstrable facts to confirm that their models fail to predict or explain the phenomena. The simulation teaching technique exposes learners to models, allowing them to engage with reality and correct misconceptions.

The topic of magnetism has some abstract concepts that may be difficult to demonstrate in class. Teachers may demonstrate the effect of magnetic force but cannot show the magnetic fields causing the effect. The evidence calls for alternative techniques to assist students in conceptualizing such concepts. Magnetism also forms a foundation for other topics taught in forms three and four physics. Such topics include the Effect of a Magnetic Field on an Electric Current, Electromagnetic Waves and Electromagnetic Induction. Hence, an understanding of magnetism is needed to ensure ease in conceptualizing some advanced

topics. Campbell (2006) says electromagnetism is vital in generating electricity, mobile phone communication, optical and satellite communication, portable electronics, radio, radar perception and X-ray crystallography. These technologies portray the importance of knowledge in magnetism in our society's economic and technological development. However, despite its significance, student performance on the topic is still below average. In Kenya, magnetism is tested in paper two in the KCSE, which is generally poorly performed compared to the other disciplines (KNEC, 2022).

Some of the challenges that have contributed to the poor achievement are poor academic background in basic science, misconceptions and inappropriate teaching techniques (SMASSE, 2007). The poor achievement has led students to develop a negative attitude towards learning physics. Hence, this study sought to apply the simulation teaching technique as a solution for the teaching deficits. The simulation teaching technique entails using a computer model to predict the outcome of a real-life situation. Simulations are tools that facilitate learning through representation and practice in a repeatable, focused environment (Aldrich, 2004). Goldsim (2011) stated that simulation helps to identify and understand factors that control the system or predicts the future behavior of the system. It can be applied in physics by providing a real-life setting for the application of Physics concepts.

Studies have shown that the simulation technique in teaching and learning science helps in the mastery of abstract concepts. Chen and Howard (2010) observed that using the simulation teaching technique to teach chemistry gave positive results evidenced by improved performance and information retention among learners. Jayantha (2018) found that students taught using the simulation teaching technique in laboratory Physics had a higher mean of acquiring practical skills than their counterparts taught without computer simulations. Proprio (2008) experimented with the effect of simulation on male and female students' achievement in Physics. The results showed that the simulation teaching technique increased the achievement for both male and female students. However, there was no statistically significant difference in achievement between the two genders. The effects of the simulation teaching technique on students' achievement and attitude towards learning physics in Buuri East sub-county are unknown. This study, therefore, focused on investigating the effects of the simulation teaching technique on students' achievement and attitude towards learning physics.

1.2 Statement of the Problem

Physics is a science subject that plays a crucial role in any society's technological and economic progress. Today people grow increasingly dependent on machinery, technology and industry, which are all functioning due to the application of physics laws. In Kenya, the major pillars of Vision 2030 include energy production, infrastructure and housing. The achievement of this vision will require people with an extensive knowledge of physics. Despite the country's future being at the mercy of these experts, student achievements in the subject remain below average. Studies have shown that the gender gap in physics achievement has been reducing in some countries. However, this is not the case in Buuri East sub-county co-education secondary schools. The poor achievement in physics has been noticeable, particularly amongst the girls. Ineffective teaching techniques have been identified to contribute to students' below average achievements in Physics. Subsequently, this has led to a negative attitude towards learning Physics. An appropriate technique would be one that changes the student's attitude and simultaneously enhances achievements in the subject. This study was set to establish whether the simulation teaching technique affects the students' achievements and attitudes towards learning physics. In this study, the concept of Magnetism was used due to the abstract nature of its concepts. It is also a crucial topic since it forms a foundation for other topics taught in forms three and four physics.

1.3 Purpose of the Study

This study aimed to determine the effects of the simulation teaching technique on students' achievement in physics and attitudes towards the subject.

1.4 Objectives of the Study

This study was guided by the following objectives

(i) To compare students' achievements in physics between students taught through simulation technique and those taught through conventional techniques in Buuri East sub-county.

(ii) To find out if there was a difference in students' attitude towards learning physics between those taught through simulation technique and those taught through conventional techniques in Buuri East sub-county.

1.5 Hypotheses of the Study

The following hypotheses were tested during the study

Ho1: There is no statistically significant difference in students' achievement in Physics between students taught through simulation technique and those taught through conventional teaching techniques in Buuri East sub-county.

Ho2: There is no statistically significant difference in students' attitude towards learning physics between those taught through simulation technique and those taught using conventional teaching techniques in Buuri East sub-county.

1.6 Significance of the Study

The findings of this study may add to the pool of knowledge on teaching techniques applied for physics. The findings may also inform practice at the Kenya Institute of Curriculum Development (KICD), especially when reviewing the secondary school physics curriculum. The curriculum would benefit from simulations to be used in teaching abstract concepts. The Ministry of Education and physics subject specialists may use the findings from this research to recommend, develop and avail materials to dispense Physics knowledge using the simulation technique. The findings may also help policymakers to formulate relevant education policies that enhance meaningful learning. The study may also assist physics teachers in teaching hazardous concepts. Finally, these findings may also be of importance to researchers who would wish to explore more on the simulation teaching technique in other disciplines.

1.7 Scope of the Study

The study was confined to form two students in public co-educational secondary schools. This is because the study focused on Magnetism, a topic introduced at form two of the KCSE Physics syllabus. It also forms the foundation for other topics in forms two, three and four. These include the Magnetic Effect of an Electric Current, Electromagnetic spectrum and Electromagnetic Induction. The concepts in this topic are abstract, and the teacher may not accurately present some concepts through practical laboratory work. However, the topic can be taught using the simulation teaching technique to present abstract concepts.

1.8 Limitation of the Study

The study had the following limitations

(i) The study limited its subject matter to one topic, Magnetism. This is because it was not possible to carry out the study on several topics within the time available. Therefore, the findings are relevant to the topic of magnetism and can be generalised to other topics in physics with caution.

(ii) The study was also done in one sub-county. Therefore, the findings of the study can be generalized to other sub-county with similar characteristic with caution.

1.9 Assumptions of the Study

The following assumptions were made

a. All the respondents were honest in responding to the items of the questionnaire.
b. Those teachers with an experience of 3years and above have appropriate exposure to the physics content and syllabus.

1.10 Operational Definition of Terms

This section has operational definition of terms that will be used in this study.

Abstract Concepts: According to Dale (1946), abstract concepts are ideas which exist in thought but do not have a physical existence. In the study they are ideas and principles that are not tangible.

Achievement: According to Travers (1970), achievement is the result of what an individual has learned from some educational experience. De Cecco and Crawford (1977) define achievement as the expectancy of finding satisfaction in mastering challenging and difficult performance. In the study it refers to students' attainment in the Physics Achievement Test (PAT).

Attitude: According to Guido (2013), attitude is a tendency for individuals to organize thoughts, emotions and behaviour towards a psychological aspects. In the study it refers to the way one thinks and feels about physics which may be either positive or negative.

Co-Educational: According to Hacker (2011), in Merriam Webster.com...it refers to having male and female students being taught together in the same school or college rather than separately. In the study co-education means male and female students being taught in the same classroom.

Conventional teaching techniques: Refers to teaching techniques that involves instructors and the students interacting in a face-to-face manner in the classroom (Yap, 2016). In this study conventional teaching techniques will mean any teaching techniques that a teacher uses that does not involve models such as simulation or a practical and limits student's participation in the learning process.

Effects: It is a change as a result or consequence of an action or other cause as defined in the Longman dictionary. In this study, effects mean a result due to the application of simulation teaching approach.

Gender: According to Iwuchukwu (2008) it refers to social meanings associated with being a male or a female, including the construction of identities, expectations, power and relationship that derive from social interactions. In the study gender will mean being male or female in the sense of the roles that have been set up by society.

Magnetic field: According to Hacker (2011) in Merriam Webster. It's the portion of space near a magnet carrying body in which the magnetism can be detected. In this study it is the area around the magnet where a magnetic force can be felt

Magnetism: The properties of attraction and repulsion possessed by magnets. In the study it is the study of magnetic forces, magnetic fields and their effects

Simulation: Computer model that facilitate learning through representation and practice to represent the physical environment (Nelson,1997).In the study it is a technique for explaining issues and themes related to physics concepts using computer model to represent real processes.

Technique: According to Arvind and Kusum (2017) it refers to specific actions through which teaching is realized. In the study technique will refer to steps that will be followed in the teaching and learning of the topic Magnetism.

Simulation Teaching Technique: It refers to a structured teaching technique that utilizes customized computer models to dispense otherwise abstract physics concepts.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of literature relevant to the study. The literature includes the importance of physics globally and in Kenya. It also includes students' achievements in physics in general and by gender. The chapter also reviews student attitudes towards physics and techniques used to teach physics in Kenyan secondary schools. The use of the simulation teaching technique in teaching and learning abstract concepts in physics has also been discussed. Finally, a theoretical and conceptual framework to guide the study is discussed at the end of this chapter.

2.2 Physics and Society

Science is defined as applied knowledge (Science Council, 2009). In the age of the global village credited to technological connectivity, science is a subject that has an increasing impact on our everyday activities. It is also deemed integral for the survival and economic success of individuals and the nation (Mbugua et al., 2012). Science comprises different branches, and in the Kenyan secondary school system it is divided into three branches: biology, chemistry and physics which are taught independently.

Physics is a branch of science that deals with the relationship between matter and energy. It is crucial to understanding the world within and beyond us (Gibbs et al., 2003). Physics is offered in most high schools and universities across the world. Khan et al. (2006) assert that the present age differs from the previous eras due to rampant scientific inventions. Today people's lives are heavily dependent on machinery and industry. All electrical appliances used in houses, hospitals, offices and the transport sector; bicycles, motor vehicles, railways, aeroplanes and communication can be credited top physics laws. Technology results from physics concepts spearheading innovations. The current rate of advancement of these concepts has resulted to the rampant progress of technological connectivity, making the world a global village.

Ngatia et al. (2019) point out that those technologies that incessantly transforming the world can be directly traced back to research in physics. Such technologies include mobile phones, computers, and the television. These technologies have been achieved due to the development of transistors, which are based on physics concepts (Khalija, 2004). Global business transactions are now possible in a matter of seconds. Many people have accessed affordable education remotely through open learning and online programs offered by some

higher learning institutions. Such conveniences are possible due to the development of optic fibre, which is based on the law of optics in physics. The law describes how light behaves and has consequently led to communication advances, subsequently close knitting the world (Ngatia et al., 2019)

There has been an intense speed in technological innovation, which has ushered in the Fourth Industrial Revolution (4IR). The 4IR has materialized due to the knowledge and application of physics principles. Schwab (2016) notes that a unit of wealth today can be created with fewer workers compared to 15 years ago since businesses have marginal costs. Ordering a cab, booking a flight, buying products, making payments, listening to music or watching a film can all be done remotely. These developments have made life much easier. 4IR has also brought about AI and voice recognition, which have resounding impacts on digital security, personalization of technology and empowering automation in manufacturing lines. Talking to a computer will become a norm in the near future (Schwab, 2016).

Devices are increasingly becoming part of our personal lives, a fact that reinforces the reality of physics as crucial subject for the arousal and survival of the 4IR.

Breakthroughs have been made in the medical field by applying physics concepts. For example, the discovery of Deoxyribonucleic Acid (DNA) through bio-physics by James Watson was phenomenal. The discovery has been of great impact in society by aiding the identification of bodies of loved ones in cases of disasters and criminal cases. DNA has also been used to validate evidence (Stanely, 2000). In the war against cancer, laser and radioactive elements have been used, which are all derivatives of physics principles. All medical imaging modalities such as Magnetic Resonance Imaging, Computer Topography, PET Scans, Ultrasounds and X-rays are all based on physics principles. The fact that these technologies are applied in both diagnostics and treatment of a multitude of diseases accentuates the prominence of physics in medical practice (Campbell, 2006; Freeman, 2012).

Khan et al. (2006) noted that physics offers challenging, exciting, productive careers. It covers fields such as astronomy, medical physics and Engineering. Guido (2013) noted that physics is the most prevailing subject in the field of engineering. He argues that it is the foundation of every engineering course. It also offers a variety of job opportunities, such as researchers, technicians, teachers, and managers (Ezeudu & Okeke, 2013). Subsequently, it opens opportunities worldwide in government, academia and the private sector.

Kenya is a notable beneficiary of Physics knowledge. There has been massive development due to the application of Physics concepts. Examples of such developments include in infrastructure. Some notable infrastructural benefits include the completion of the

SGR, highways across the country and the construction of a third international airport in Isiolo County. Physics will continue to play a key role in Kenyans' development, especially considering the hype surrounding the Vision 2030 strategic plan. Some of the key agendas of Vision 2030 are; infrastructure, energy, health, housing, urbanization, water and sanitation, tourism and security (RoK, 2007). The implementation of Vision 2030 is heavily reliant on having a capable workforce. A key aspect of that capability is having knowledge and skills in Physics and physics-related concepts such as engineering and computer science. Commitment to Vision 2030 is, therefore, an incentive to support Physics education in Kenya.

Adeyemo (2011) noted that it is essential that every child should be given the opportunity to acquire knowledge and concepts in Physics. Despite Physics being important in society's economic and technological development, student achievements in the subject are still below average. In Kenya, Physics is a compulsory subject for the first two years of secondary education and elective afterwards. The below average performance has been attributed to several factors. One of the factors is the use of conventional teaching techniques which limit learners from conceptualizing abstract concepts taught in Physics. This study sought to determine the effect of the simulation teaching technique on student achievements and attitudes towards learning physics.

2.3 Teaching and Learning Techniques in Physics

Physics is a practical subject, student participation during the teaching and learning process is important. Tamunoiyowuna (2016) says that, to explain abstract concepts and instil appropriate scientific skills needed for technological advancement, Physics should be taught using continuous demonstration and many laboratory activities. Physics teaching techniques can be categorized broadly into passive and active techniques.

2.3.1 Passive Techniques

These are techniques where students are not actively involved, and the teacher is the only one active in the teaching and learning process. Students listen quietly and sometimes take notes. Learners' participation is limited to asking and responding to questions. These passive techniques are also referred to us as conventional teaching techniques. These teaching techniques mainly emphasise in recalling and reproducing facts, principles and theories of learning. Conventional teaching technique involves learning done by going to school and being physically present in class. There is interaction of face-to-face communication between the teachers and students. Teachers guide the students throughout the learning process.

Instructors are the main source for providing knowledge to the students in conventional technique. Such teaching techniques encourage rote learning. The conventional teaching technique has its own merits and demerits

Some of the merits are as follows: There is proper interaction and face to face communication between teachers and students. These ensures that certain rules and regulations that students are expected to follow are followed and these builds discipline in them. Higher level of competition exists among the students, since they also interact with their classmates and are aware of their performance. However, this competition may lead to unhealthy rivalry hence the teacher's guidance is paramount. It is easy to organize for learners who need to attend school at a particular location and time. This gives room for developing values such obedience and management of time properly. Students learn how to communicate in a proper way with others and how to behave in a society since there is a lot of interaction with their teachers and their peers. Learners understand the importance of team-work. Students get educated about important life lessons, which help in the growth and personal development of the students.

The conventional teaching technique have some demerits too, there is no flexibility as students are supposed to report to class at a particular location and at a specific time. The interaction between teachers and students is limited only inside the classroom and school. Students can't take the help of teachers outside school. This learning method is expensive as the tuition fee is high and many books need to be bought which makes it costly.

There may also be additional charges for students who travel from far. It is compulsory for students to attend all the classes even if they have no interest in some of the subjects. It also means once a learner misses a class they have lost what was taught on that day, since learning is not individualized. Since this technique emphasizes on recalling, most learners are not able to conceptualize abstract concepts when taught through this technique. In physics, the teacher delivers a lecture, gives notes and solves the problem with minimal participation from students. Examples of these techniques include lecturing and demonstration (Maera, 2016) as discussed as discussed in the subsequent paragraphs.

The Lecture method is a teacher-centred technique; thus, it is not useful for learning practical skills. Wachanga (2002) defines it as a process of verbally delivering a body of knowledge according to a pre-planned scheme. This technique is useful for large groups since it stimulates thinking to open discussion (Keter, 2013). However, the technique has several limitations. Since the learners are passive, it encourages rote learning; hence very little knowledge is retained by learners. It also denies learners the

opportunity to experiment and discover on their own. The lecture technique does not give room for immediate feedback to the teacher on the effectiveness of his or her presentation. This technique is also ineffective in the teaching of abstract concepts. The lecture technique can be classified as; a strait jacket lecture, where the student listens quietly and sometimes takes notes, or as an integrated lecture, the lecture technique is integrated by using questions and reading resources.

Demonstration is a technique where the teacher experiments on behalf of a large group. It is a popular technique in most schools. This technique is preferred when resources are limited, safety is a major concern, or the experiments involve using sophisticated or expensive apparatus. It is also appropriate when there is limited time and the experiment requires a specific skill the students have not acquired. Although demonstration is very useful, it has some limitations. One limitation is that it restricts learners from practising, especially hands-on skills. It is more teacher dominated, making the learners passive learners. When there is lack of communication between the teacher and the learners, learners may dissociate from the class activities (Maera, 2016). Teacher demonstration includes multiple stages. The rehearsing stage involves trying out or previewing the experiment. It helps to check on the availability of resources and their working conditions. The performance stage is the second stage when the actual demonstration is carried out. The essence of demonstration is that learners should be able to see what is happening without straining. The discussion stage focuses on the experimental set-up, apparatus, materials and possible alternatives. It also accounts for the accuracy of the results and likely sources of errors in the underlying concepts or principles. Finally, it considers the patterns and generalizations useful in concluding. When passive techniques are used, the learners retain very little knowledge as there is minimal understanding of concepts (Keter, 2013). McDermott (1996) notes that learning is not possible from solely reading, listening, and memorizing, hence there is need for more interactive techniques for teaching physics.

2.3.2 Active techniques

Active techniques entail the indulgence of learners in the learning process. Learners are involved in activities such as discussions, project work, and presentations. The techniques ensure students are more active, leading them to precisely defined learning targets. The emphasis is on learners building a habit of understanding; here, learning is a process of making meaning. Stebila (2011) argues that in active techniques the meaning of the word ‘to

know' equates to finding information and using it rather than simply remembering. Active learning techniques require students and teachers to undertake a dynamic partnership in which they share the responsibility for instruction (Karamustafaoglu, 2008). Active teaching works by involving students in doing things and thinking about the things they are doing. Rather than think about what they are watching, hearing, or reading, students are first encouraged to be "doing" something in class, and then apply critical thought and reflection to their own classroom work and activity. Therefore, the teacher is responsible for providing an environment, opportunities, interaction, tasks and instruction that foster active learners' participation in learning.

In a classroom where active learning techniques are used, the lesson becomes more interesting to the students, because they take part in the lesson attentively. Kristak et al. (2014), in their creative experiments, noted that the use of active techniques increases the level of understanding and attention of students by interconnecting physics theories with everyday life. Assigning responsibility to learners during the learning process helps develop students' creativity. An active learning technique emphasizes developing student skills and exploring their own attitude and values. Kalem and Fer (2005) searched the effects of a model designed for active learning on the students' view of learning, teaching, communication and learning environment. The researchers found that the teaching carried out through active learning had positive effects because of more effective learning, teaching and communication.

Students' success is highly improved by using active learning techniques. Amadalo et al. (2016), in their study on the influence of practical physics work on student academic achievement, they found that interactive practical activities positively influence students' achievements in physics. Karamustafaoglu (2008) notes that some physics concepts are poorly understood, leading to confusion. He continues and notes that it is possible to make them clear by teaching these concepts through active techniques. Active techniques include practical work, simulation, discussion, discovery techniques, and cooperative learning.

Student Practical Work is a technique which requires students to carry out important manipulations and other processes under the teacher's supervision. The teacher facilitates learning, where the learner intellectually engages in rigorous thinking. It is a heuristic teaching technique that allows the learner to learn and practice skills (handling and process skills). It motivates the learner in the given content being learnt. There is a high degree of retention of the lesson content compared to the lecture method (Maera, 2016). However, some abstract concepts may not be presented in a practical class. Concepts such as heat,

magnetization, and energy cannot be presented in a class due to their risky and volatile nature.

Cooperative Learning is an educational technique which aims to organize classroom activities into academic and social learning experiences. Learning involves structuring classes around small groups that work together so that each member's success depends on the group's success. Cooperative learning reduces competition and allows learners to capitalize on one another's ideas. The teacher's role changes from giving information to facilitating student learning.

(i) Think Pair Share: It allows students to contemplate a posed question or problem silently. The student may write down thoughts or just brainstorm in his or her head; when prompted, the student pairs up with a peer and discusses his/her ideas and then listens to her/his ideas. Following the pair's dialogue, the teacher solicits responses from the whole group.

(ii) Jigsaw: Students are members of two groups, a home group and an expert group; each student is assigned a topic in the home group. Once the topic has been identified, the student moves to the expert group with other students, each with their assigned topic. Students learn the material together in the new group before returning to their home group. Once in the home group, each student is accountable for teaching his/her assigned topic to the home group members.

(iii) Jigsaw II: Members of the same group are assigned the same material but focus on a different portion of the material. Each member must become an expert on his/her assignment portion and teach the other home group members.

(iv) Reverse Jigsaw: It differs from the original jigsaw. Here the expert group students teach the whole class rather than to their home group only.

(v) Inside-Outside circle: here, students from two concentric circles take turns on rotation to face new partners to answer or discuss the teachers' questions. This method can be used to gather a wide range of information.

Other active techniques include: One-minute papers in these technique learners are given a question on the course material covered during the lesson. They are given about a minute to answer individually or in small group. The submitted responses from the active learning activity can be used to gauge student learning and comprehension of the material covered in the class period.

Quick quizzes this is an active technique where a quiz can be administered at the start of class or part way through a lecture. It normally counts as formative assessment not for a

grade, but to assess comprehension. These quizzes provide an opportunity for students to reflect and recall information that was just covered before the instructor moves on to the next topic. Students can complete these quizzes at the start of class to challenge pre-existing assumptions. The same question may be asked at the end of class in order for students to compare their understanding to the start of class. It also allows the teacher to engage in a meta-analysis of students' performance.

Muddiest point is a type of active teaching technique that pinpoints the area/s that students are least confident about in the course material that was just covered. Students note the most confusing part of a lecture or course content and teacher can use these insights to determine how to engage students in active learning, and where to focus future teaching efforts. The major emphasis is to encourage participation, it's equally important to respond to student feedback during the next class or as soon as possible after. Responding to students faster when their curiosity is already primed helps them link ideas together and encourage them to critically reflect on what they do and don't understand. When using the muddiest point activity in your class, pause halfway or at the end of your lesson to let students submit topics they don't understand. In an online classroom, one can use video conferencing platform's live chat for students to submit their responses. Alternatively, create an online platform where learners can submit their response.

Debates this activity works well in small groups versus large classes. Learners are given an issue they are expected to defend different viewpoints pertaining the issue in an effective way and to engage the entire class. Debates help instructors check student comprehension and help students learn from one another. Case studies and problem solving in this active teaching technique, students work in small groups or individually and apply knowledge gained from lectures or reading materials to a given scenario. This is more spontaneous than setting multi-week, large group projects. Students are provided with a real-world contemporary case related to their curriculum and learning outcomes. The best case study or event is one that is relevant, timely and well-known to ensure all students are comfortable participating. Students are expected to respond to a set of questions prepared by the teacher, the questions guide the learners to link the case study intersects with course material. Large group discussions aren't always possible or easy to facilitate with remote learning.

Peer instruction is an active teaching technique where students prepare and present course material to the class or in small groups. This approach encourages interaction and

trust-building between students especially important at a time where a portion of learning may take place online.

Flipped classrooms here students watch pre-recorded lectures aligned with learning goals as homework and spend class time engaging in active learning activities. This alternative technique to the traditional classroom ensures students are actively involved in the learning process. Flipped classrooms not only position students as more active recipients of the learning journey, this model additionally save time. Rather than delivering an hour-long lecture, the flipped classroom favours short, concise lecture recordings that students can view on their own time. Flipped classrooms are dedicated to exploration, collaboration and interaction three pillars critical to any active learning environment.

In passive techniques, a learners' participation is minimal in the teaching and learning process, if any. This can make learners lose interest in the learning process, and the learners' retention of the knowledge learnt is also very low. It can also lead to low achievement in the subject. These techniques are appropriate in situations such as; large classes, where time is inadequate, in case of dangerous experiments and inadequate apparatus. Additionally, these techniques are overall inappropriate for the teaching of abstract concepts. Active techniques allow the learner to participate actively in teaching and learning. Learners can discover knowledge by themselves, which may boost their retention levels and increase their performance.

2.4 Students' Achievement in Physics

Despite the significance of physics, students' performance in the subject at the national level in many countries remains below average. According to Trends in International Mathematics and Science Study (TIMSS, 2015) results at eighth grade, more than half of the countries in the world that participated in the TIMSS test scored below centre point. Out of the 39 countries that participated, only students from 19 countries scored above 500, which is the centre point, while students from 20 countries scored below the centre point. The mean score of all the participating countries was 471, slightly below the centre point. However, a comparison of TIMSS 2011 and TIMSS 2015 shows an increase in science achievement. Results from 34 countries that participated in the TIMSS test in the two years were considered; 15 countries had a higher average achievement, 15 other countries had the same average achievement, and only four countries had a lower-than-average achievement. This trend, however, is not true in Kenya. According to Kenya National Examination Council (KNEC, 2022), student performance in physics in Kenya has declined.

Table 3

National Examination Mean Mark in Physics

Year	2018	2019	2020	2021	2022
Mean Mark	70.09	68.54	65.18	71.03	59.39
Overall Score	200	200	200	200	200

Source: KNEC (2019, 2021, 2023)

These results show a decline in students' Physics performance. The general decline in performance has been attributed to several issues. Masingila and Gathumbi (2012) argue that the poor performance is due to a lack of well-trained teachers. The researchers observe that teachers are mainly trained theoretically, leading to insufficient practical work. SMASSE report (2007) lists some of the reasons for poor performance in science as; inappropriate teaching techniques, poor distribution of school resources, low student motivation to learn physics and incompetence in science process skills among secondary school physics students. Kipng'eno (2018), in his study on factors influencing a learner's academic performance in physics. Found that many teachers were inexperienced since they had an experience of less than five years in practice. He also found that completion of the physics syllabus on time builds students' confidence; hence students passed highly when the syllabus is cleared than when the syllabus is not completed. Physics' importance in a nation's technological development is crucial. Therefore, physics achievement is a concern to many people. This concern has motivated the researcher to determine the simulation technique's effects on students' physics achievement.

2.5 Student Attitudes towards Learning Physics

Mueller (1986) argues that attitude is simply the extent of liking or disliking something. He adds that attitude is an internal state that influences an individual's choice of action. According to Guido (2013), attitude is an individual's tendency to organize thoughts, emotions and behaviour towards a psychological object. He further notes that it can distort the perception of information and affect retention. Adesina and Akimbola(2005) shares the same sentiments they argue that People constantly form a new attitudes and modify old ones when they are exposed to new information and new experience. Schunk and Hanson (1985), suggested that the attitude of pupils is likely to play a significant role in any satisfactory explanation of variable level of achievement shown by students in their school science subjects. Ogunleye (1993) in his study found that many students developed negative attitudes

towards learning science. Researchers have shown that most students have a negative attitude towards sciences, particularly physics. Students traditionally considered physics one of the most difficult areas of science (Hugh & Robert, 1981). One reason is that physics teachers tend to instil a negative attitude towards physics in learners (Kiruki, 2007). Following the nature of transference, the teachers' negative attitudes towards a subject could lead to learners similarly losing interest. Curry et al. (1986) noted that when a teacher's attitude towards a subject is negative or unfavourable, students will take little to no interest in learning and subsequently achieve substandard results in examinations.

Sogomo (2001) noted that the students' attitude mirrors the teachers' attitude. Guido (2013) observed that, unless the teacher has the attitude, she/he desires to foster, attempts in communicating to his or her students will be equally futile. Some students form a negative attitude towards physics long before they enrol in secondary school due to the opinion they get from their parents, elder siblings, friends and even teachers (Kahare, 2011). Researchers have shown a relationship between students' achievements and their attitudes towards physics, classroom environment and even their teachers' (Guido, 2013). Students with a positive attitude towards physics had a positive attitude towards their science teachers, science curriculum and science classroom (Miller et al., 1961).

Crawley and Black (1992) noted that students' attitudes towards physics are a subsequence of their attitude towards the learning environment. Morse and Morse (1995) agree with these findings, accentuating that student attitudes towards science are more likely to influence success in science courses. Xavier et al. (2016) found that the performance of physics students is poor at the department of physics in Nyarugenge campus, Rwanda, due to negative attitude towards the subject. Kahare (2011) further observed that once an attitude is formed, learners may be resistant to change since it is wrapped up within their feelings, needs and self-concept. It has been noted that many students in Kenya have a negative attitude towards sciences compared to art subjects, especially among girls (Aduda, 2003). A positive attitude has been linked to increased achievement. Guido (2013) observed that attitude is the most significant factor affecting students' academic success. Therefore, this study sought to determine the effects of the simulation teaching technique on student attitudes towards learning physics.

2.6 Gender Difference in Science Achievement

Gender refers to the social meanings associated with being a male or a female. This includes the construction of identities, expectations, behaviour, power and relationship that

derive from social interactions (Iwuchukwu et al., 2008). Individuals tend to fit into societal expectations without questioning since the system has worked for them in their respective roles. Oluwatelure (2015) noted that gender is closely monitored by society. He observes that practically everything in society is assigned a gender; toys, colours, clothes and even behaviour. Studies have shown that these gender disparities have led to the gender gap in students' performance and even in professional careers, where some subjects and jobs are male-dominated while others are female-dominated. Reinking and Martin (2018) noted that there is a gender gap in STEM professions in favour of males. However, it was observed that while there is still a gender gap, girls have been joining the STEM field at an increasing rate over the last twenty years.

TIMSS (2015) report showed the difference in achievement by gender in the content domains asserting that there was a large advantage for girls in biology and chemistry. However, boys had an overwhelming advantage in physics and earth sciences. The trend of gender achievement for the last 20 years showed a great reduction in boys' historical advantage in science. In Nigeria, Olasehinde and Olatoye's (2014) study which compared male and female senior secondary school students learning outcomes in science, found no significant difference between male and female students' general achievement and attitude towards science. Asare et al. (2018) observed that gender difference has no significant effect on student attitude regarding their participation and performance in science subjects. Some studies have shown gender differences in students' attitudes towards learning.

Fatoba and Aladejana (2014) studied the effect of gender on student attitude, and they found a slight gender difference in attitude towards physics in favour of females. Oluwatelure (2015) disagreed with this finding in his research and found a significant gender difference in the attitudes of males and females towards learning science in favour of male learners. These studies have shown mixed results concerning gender differences in achievement and attitude. It is, however clear, that the historical advantage of boys in science is fading. This should concern education stakeholders to not close one gender gap and create another. Based on the literature review, gender is a variable that may interfere with the results of the study. Therefore, the researcher studied its effects on student's achievements and attitude towards learning physics when taught through the simulation teaching technique. Hence, gender is an extraneous variable in the study.

2.7 Simulation Teaching Technique

Simulation teaching technique is the use of a computer to predict a real-life situation's outcome using a model in a learning environment. Jamil and Isiaq (2019) establish that

simulation can facilitate students' active engagement in constructing and reconstructing conceptual knowledge in their learning of abstract concepts in the physical world. In the simulation teaching technique, the teacher places a 'world' which represents reality for the learner to interact with it. The teacher manipulates the parameters of the 'world' to change different factors and learners are able to observe the effects of different factors.

Simulation can be categorised into four categories as follows. Live Simulation it involves actual people and equipment who interact in a real-world setting. Just as in the real world, the simulation runs in real-time. Learning value in live simulation depends on the sophistication of the simulated equipment. Virtual Simulation, this includes simulated people and equipment in a computer-simulated setting. It runs in simulated time which allows learners to practice specific activities. Immersive Simulation, here several learning objectives are addressed at once and real people interact with simulated people in a simulated environment to develop particular skills. System Simulation, this is the process of experimenting and studying how changes to characteristics of a complex system impact the whole system. It involves simulated people operating simulated system.

Physics is a subject with a wide range of abstract concepts that are difficult to explain theoretically and some are challenging to teach them through practical work. Concepts such as energy, heat, magnetism, and electricity cannot be presented in the laboratory. Students can only observe their effects during such practical sessions. Radiation and some electromagnetic waves are can be dangerous to human health, imposing a necessity for safer techniques to teach these concepts. McDonald (2016) observes that the simulation teaching technique provides opportunities to visualize and interact with dangerous, time-consuming or complex events in class or the laboratory. Ramasundarm et al. (2005) observed that the simulation teaching technique has the potential to make instruction more interactive and make learning abstract concepts more concrete. Thiongo et al. (2014) agree with Ramasundarm et al. (2005) that computer-based simulations with animated colour graphics can present the dynamic nature of magnetic fields and electric current that lacks in conventional teaching techniques. The simulation teaching technique contributes to transforming physics concepts from theoretical to practical form. This makes the abstract concepts to be more concrete, hence increases the student's attitude towards learning physics positively.

Physics teaching techniques are continuously evolving with the dynamic world conditions. Sitotaw and Tadele (2016) observe that new learning media in the educational

program improves students' achievements and attitudes towards physics lessons and physical practice. Simulation teaching technique is among the teaching techniques that use media and have resulted in students' success in achievement. Thiongo et al. (2014) studied the effect of computer-based Simulation (CBS) on students' achievement in the magnetic effect on an electric current; they found that those students taught using CBS performed better than those taught using conventional teaching technique. The use of the simulation teaching technique significantly and positively impacts student academic achievement (Sulaiman et al., 2016). Ngatia et al. (2019) used an interactive multimedia simulation advance organizer teaching technique on students' achievement in measurement and observed a positive effect on student academic achievement.

Different researchers in their studies have shown that using simulation teaching techniques improves the learners' understanding, creating a positive attitude towards learning physics. According to Pfefferova(2015), simulation is a technique that helps students better comprehend basic features of oscillatory motion. He continued to argue that after the simulation teaching technique, students could use knowledge to solve creative tasks that required combining knowledge from different fields of Physics. Students taught using computer simulation teaching techniques in Physics had a higher mean acquisition of practical skills and an improved positive attitude towards learning Physics according to (Jayantha,2018).

Simulation teaching technique has been used in different disciplines. The technique has shown success in achievement and nurtured a positive attitude towards learning. This is because it contains a system model that allows learners to explore the phenomena by manipulating variables and observing the subsequent change. This study intended to use a simulation teaching technique to teach the topic of magnetism in physics and find its effect on students' achievements in physics and attitudes towards learning physics.

2.8 Theoretical Framework

The study was guided by Dual Coding Theory (DCT), proposed by Allan Paivio in 1986. He developed this theory from the idea that the formation of mental images aids in learning. According to this theory, there are two ways a person could expand on learned materials. These are through verbal associations and visual imagery. Visual and verbal information are processed differently along the human mind's distinct channels. They create separate representations for information processed in each channel (Sternberg, 2006).

However, human cognition can simultaneously deal with verbal and visual objects and events. The human mind can code information as visual, verbal or both. The codes organize incoming information that can be acted upon, stored and retrieved for use. Coding information in two ways increases the chance of remembering that information compared to coding in just one way.

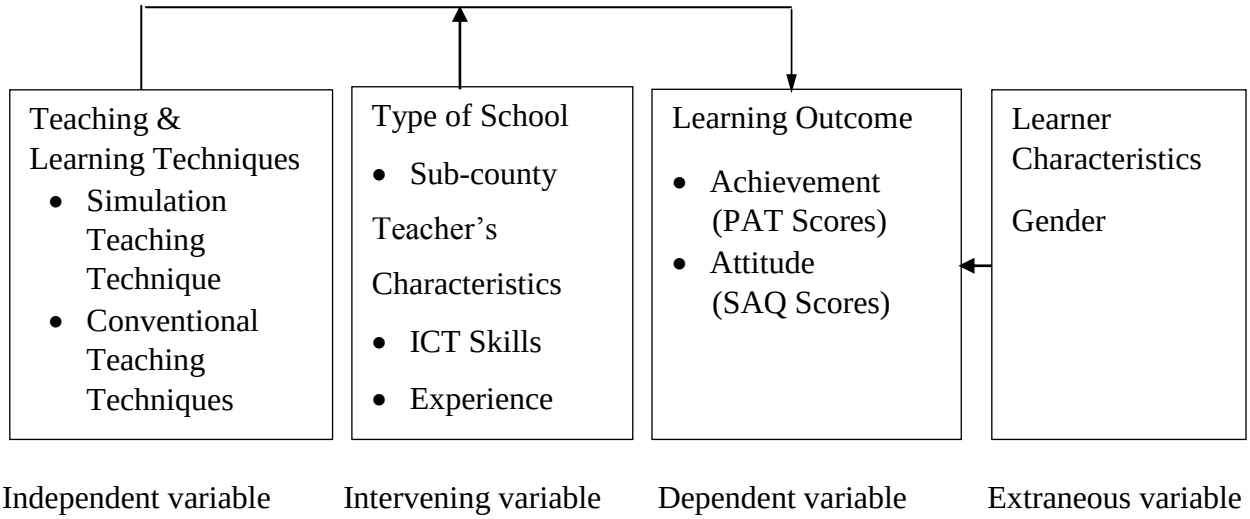
Brunye et al. (2008) observed that this theory could be applied to the use of multimedia presentations. Multimedia presentation requires both spatial and verbal working memory. Hence, individuals who dually code information presented are more likely to recall the information when tested at a later date. The simulation teaching technique is a technique that provides knowledge through both verbal and visual form. This allows learners to code the information received as either verbal, visual, or both. Abstract concepts in physics can be presented using visual images supports the verbal presentation by using simulation teaching technique, this makes the abstract concepts more concrete. Brunye et al. (2008) point out that memory of some verbal information is enhanced if a relevant visual is presented or the learner can imagine a visual image to go with the verbal information. The Brunye et al. (2008) study informed this study through its accentuation on the efficacy of DCT and the fact that simulations have both audible and visual output.

2.9 Conceptual Framework

From the discussion above, the following conceptual framework was developed. The main focus of this study was to assess the effect of the simulation teaching technique on students' achievements and attitudes towards learning physics in Buuri East sub-county on the topic of magnetism. It also sought to determine if there was any gender difference in achievement and attitude towards learning physics when the technique was used.

Figure 1

The Conceptual Framework showing the relationship among Variables



The dependent variables in the study were students' achievement and attitude towards physics. The independent variable was the simulation teaching technique and conventional teaching techniques. Previous studies have established the efficacy of the simulation teaching technique in elevating attitudes and performance within varying environments. The application of the technique to Physics tutorage, where negative attitudes undermine performance, would likely result to a similar elevation. The study had one extraneous variable, that is, gender.

The extraneous variable, gender was controlled by studying it. This was done to determine its effects on students' achievement in physics and attitude towards learning physics. The study also had two intervening variables; the type of school and the teacher's experience. Types of schools differ in terms of entry behaviour and resources. These factors may affect student's achievement in their studies. A teacher with extensive teaching experience may be more conversant with the syllabus and may also be more effective in teaching as compared to a less experienced teacher. The two variables were controlled by selecting Physics teachers with ICT skills and with an experience of at least three years they were the ideal choice for this study. The types of schools were controlled by selecting sub-county schools with access to computers and a projector.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the methodology the researcher used in carrying out the study. It comprises research design, study location, target population, accessible population, sampling procedures and sample size. It also describes instrumentation, validity and reliability of research instruments, data collection and analysis procedures.

3.2 Research Design

This study employed a quasi-experiment, specifically the Solomon four non-equivalent control group research design. Research participants were not randomly assigned to the experimental and control groups. This is because secondary school classes exist as intact groups, and school authorities do not allow the classes to be dismantled and reconstituted for research purposes (Fraenkel & Wallen, 2011; Gall & Borg, 2007). This design uses two experimental and two control groups. One experimental and one control group are given a pre-test and post-test, while the other two are only given a post-test (Sekaran, 2010).

The design helped to achieve the following purposes: first, to assess the effect of the experimental treatment relative to control conditions and secondly, to assess the effect of the pre-test relative to no pre-test (Mugenda & Mugenda, 2003). One of the advantages of this design is that the use of both a pre-test and post-test establishes the temporal precedence of the independent variable to the dependent variable. This gave the researcher confidence when inferring that the independent variables were responsible for the changes in the dependent variable. The pre-test also allowed the researcher to measure group differences before exposure to the intervention. This could substantially reduce the threat of selection bias by revealing whether the groups differ on the dependent variable prior to the intervention (Fraenkel & Wallen, 2011).The research design is presented pictorially in Figure 2

Figure 2

Solomon's Four Non-Equivalent Control Group research design

Group	Pre-test	Treatment	Post-test
E1	O1	X	O2
E2	-	X	O3
C1	O4	-	O5
C2	-	-	O6

Source: Fraenkel and Wallen (2011)

E1- Experimental group one

E2- Experimental group two

C1- Control group one

C2- Control group two

O- Indicates observations or outcomes at pre-test and post-test phases

X - Indicates treatment

----------Non-Equivalent Control Group Design

Figure 2 shows four groups of participants, Experimental group one (E1), Experimental group two (E2), Control group one (C1) and Control group two (C2), which were used. Groups E1 and E2 formed the experimental groups which received the treatment (X), while C1 and C2 were the control Groups and they were not exposed to the treatment. Groups E1 and C1 received the pre-test (O1 and O4), while O2, O3, O5 and O6 represent the post-test which was administered to all groups. The teachers in the experimental groups used simulation teaching technique to teach the concept of Magnetism in physics, while the control groups C1 and C2 were taught through the conventional teaching technique.

3.3 Location of the Study

Buuri East sub-county is located in Meru County in the former Eastern province. It was a part of Buuri sub-county until 2017, when the sub-county was divided into two; Buuri East and Buuri West. It borders Buuri West, Meru Central sub-county and Isiolo County. It has 24 secondary schools, of which 16 are public co-educational schools. The sub-county director's office is located at Kiirua market, approximately 19 kilometres from Meru town. The sub-

county was selected due to its consistently poor performance in science subjects, especially physics. However, the effects of the simulation teaching technique on student achievements and attitudes towards learning physics in this sub-county are not known. This study intended to fill this particular gap in this sub-county.

3.4 Population of the Study

The population is the entire group of individuals, events or objects with observable characteristics of interest to the researcher (Mugenda & Mugenda, 2003). The study's target population was 1119 form two students from all secondary schools in Buuri East sub-county. The accessible population was 542, comprising form two students in Buuri East sub-county in co-education secondary schools. The sample was drawn from the accessible population. Form two students were chosen because, in Kenya, physics is an elective subject as from form three. Therefore, form twos have not yet selected, and this technique may influence them to choose the subject. Magnetism, the topic used in this study is also taught in form two.

3.5 Sampling Procedures and Sample Size

Four co-educational secondary schools participated in the study. Purposive sampling was used to select schools with the same characteristics. Resources and physics teacher experience were factors that were considered when selecting these schools. Buuri East sub-county has three existing zones. However, for the purpose of this study one of the zones, Kibirichia, was divided into two since it is larger than the other two zones. It also has more co-educational secondary schools than the other two zones. This created four zones that were used as the strata. Stratified sampling was then used to group the qualifying schools into the four strata to control the diffusion effect. One school was selected randomly from each stratum, yielding four sample schools that were used in the study.

Simple random sampling was used to allocate the four schools into the experimental and control groups. The sampling unit was the schools rather than individual learners because secondary schools operate as intact groups. Each school provided one form two class to participate in the study. For experimental schools with more than one stream, all form two classes were taught using the simulation teaching technique. Simple random sampling was used to select one stream after the post-test had been administered for data analysis. According to the Ministry of Education regulations, the average number of students in Kenyan secondary school classes is 45. Therefore, the expected number of participants

was 180. However, all the four sample schools had less than 45 learners, hence the number of participants in the study was 123 students. Of these, 60 were eventually placed in the experimental groups while 63 were in the control groups.

3.6 Instrumentation

Data for this study was collected using Physics Achievement Test (PAT) and a Student Attitude Questionnaire (SAQ). PAT was used to collect data on achievement, while SAQ was used to collect data on attitude towards learning physics.

3.6.1 Physics Achievement Test (PAT)

The researcher developed the Physics Achievement Tests (PAT), the achievement test used to collect student achievement data. It comprised twenty items in the form of short answer questions. They were structured to start with those of low-order thinking and progress to more complex ones. These items tested knowledge, retention and application of learned materials. The minimum score was zero, and the maximum possible score was one point per item. It was first administered as a pre-test to one experimental and one control group. It was also used to assess the students' prior knowledge. The items of the Physics Achievement test were rearranged and then administered as a post-test to all groups after the treatment.

3.6.2 Student's Attitude Questionnaire (SAQ)

The researcher adapted the attitude questionnaire from Nyakan (2008). According to Ary and Razavieh (2002), questionnaires are good because standard instructions are given to all subjects, and the researcher's appearance, mood, or conduct will not affect the results. A questionnaire also upholds confidentiality. The questionnaire had two sections: a section for the participants' details and another comprising 22 close-ended items. These items were used to establish the students' attitudes towards learning physics. All the items were rated on a continuous scale ranging from zero to five, where zero meant no agreement and four meant the highest degree of agreement.

3.6.3 Validity of Research Instruments

The validity content was formulated by Remmeret al. (1927), who stated that a test is valid if it measures what it claims to measure. Validity is, therefore, the extent to which an instrument achieves the purpose for which it was designed. In this study, content validity was

considered. The research instrument had to be appropriate; that is, the appropriateness of the sample and the learning level. Content validity is the most important type of validity, which can be achieved by carefully examining the test content. It provides the most useful subjective information about the appropriateness of the test. The test items in PAT and scoring key were validated by the secondary school physics teachers and moderated by the Department of Curriculum Instruction and Education Management (CIEM) experts. Comments from the experts were used to improve the instrument, thus making it appropriate for the research study. For SAQ, the researcher consulted and got expert judgment from the CIEM department's experts to validate and enhance the value and content of research instruments.

3.6.4 Reliability of Research Instruments

All instruments were pilot-tested in two co-educational secondary schools in Buuri-East sub-county; the schools used for piloting were not used as sample schools during data collection. The data collected was used to test the reliability of the instruments. According to Kombo and Tromp (2006), reliability is a measure of how consistent the results from a test are. The reliability of PAT was estimated using Kunder-Richardson 20 (KR-20) formula since it is suitable for items that are scored as either right or wrong with a different difficulty index (Fraenkel & Wallen, 2011). The reliability coefficient was found to be 0.84. The reliability of SAQ was estimated using Cronbach's alpha (α). Cronbach alpha is used to estimate the reliability of an instrument containing close-ended items. The reliability coefficient of the instrument was found to be 0.724. These values of the reliability coefficients were accepted for the study since α value of 0.7 and above are considered appropriate to make possible predictions that are sufficiently accurate.

3.6.5 Teacher Training Session

The study considered physics teachers teaching form two with three years and above of teaching experience. The researcher assumed that these teachers had enough exposure to the syllabus and experience. Form two physics teachers from the four sample schools were used in the study. The teachers teaching physics in form two from the experimental schools were trained in the simulation teaching technique and used it in teaching Magnetism. The training was conducted for one week. The simulation was audio-visual and was stored in a flash disk, which was given to the teachers in the experimental group to be used as treatment. The other

two teachers used the conventional teaching techniques to teach the same topic. The teaching exercise lasted for three weeks.

3.7 Data Collection Procedures

The researcher first got an introductory letter from the Board of Post-Graduate Studies, Egerton University and an approval letter for ethics from the Egerton University ethics committee. A research permit from the National Commission for Science Technology and Innovation (NACOSTI) was sought. The researcher also notified the Meru County Director of Education (CDE). Further, the principals of the respective schools were notified about the study, and the principals introduced the physics teachers to the researcher.

A pre-test was conducted in one experimental group (E1) and one control group (C1) to measure the students' prior knowledge before the treatment. In experimental groups, E1 and E2 teaching through the simulation was used, while in control groups, C1 and C2, the conventional teaching technique was used. At the end of the treatment period, there was an administration of the post-test for all groups. Physics Achievement Test and Questionnaire were used to measure the students' general achievement, gender and attitude towards learning physics. The researcher monitored the teaching and administration of the pre-test and post-test.

3.8 Data Analysis

Analysis was done using the Statistical Package for Social Sciences (SPSS) version 22. Both descriptive and inferential statistics were used to analyse the data. Descriptive statistics such as mean and standard deviations were used. Further analysis was obtained using inferential statistics to analyse the data and test the research hypotheses. ANOVA was used to analyse differences in the four means of post-test scores. A t-test was used to test the effect of the extraneous variable that is the gender effect on student achievement in physics and attitude towards learning physics is significant. Hypotheses were tested at $\propto$=0.05 level of significance.

Table 4

Summary of Data Analysis

Hypotheses	Independent variable	Dependent variable	Methods of data analysis
$H0_1$: There is no statistically significant difference in students' achievement between students taught physics through Simulation and those taught through conventional techniques in Buuri sub-county	Simulation Teaching Technique & Conventional Teaching Technique	Students' Achievement	One Way ANOVA
$H0_2$: There is no statistically significant difference in attitude towards learning physics between student taught physics through Simulation and those taught through conventional techniques in Buuri sub- county.	Simulation Teaching Technique & Conventional Teaching Technique	Students' Attitude	One Way ANOVA

3.9 Ethical Considerations in Conducting Research

The research was approved by the Egerton University ethics committee, enabling the researcher to apply for a permit from NACOSTI, which was granted. The researcher also orally informed all the participants about the research objectives and the procedures of the study. She also requested them to consent to participate in the research before data collection. Participant opinion was confidential, and all respondents were assured that the information was for academic purposes only. Participants were informed that no name was required during the study and to feel free to withdraw from the study at any stage if they wished to.

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

This chapter entails the study results, findings and discussion on the effects of the simulation teaching technique on form two students' achievement in physics and attitude towards learning physics. The first section comprises the pre-test results, the other sections contain the results, a discussion of the two objectives and discussion of effect of gender on student achievement in physics and attitude towards learning physics. The data generated from the study is presented in tables. Analyses of variance were used to test the study's hypotheses at α=.05 level of significance, while t-test was used to test effect of gender.

4.2 Results of Pre-test

Solomon four non-equivalent control group design was used in this study. Pre-testing was carried out, and two groups sat for the pre-tests, one control group and one experimental group. The pre-test aimed to ascertain whether or not the students selected to participate in the study had comparable characteristics before presenting the treatment. Table 5 shows the results of comparing pre-test SAQ and PAT scores between the experimental and control groups.

Table 5

SAQ and PAT Pre-test Results Between Experimental and Control Groups

Variable	Group	Mean	SD	t-value	p-value
SAQ	Control 1	2.7419	0.239	-.190	0.417
	Exp 1	2.7502	0.221		
PAT	Control 1	8.1761	1.974	0.046	0.964
	Exp 1	8.1056	1.833		

The results from Table 5 show that the SAQ pre-test mean score was not statistically significant different since at the level of .05 significance p=.417. Similarly, the PAT pre-test score results were also not statistically significant since p=.964, and both values were greater than .05. This means that the groups used in the study were comparable. They had similar

entry behaviour, making them appropriate for the study. A similar analysis was done based on gender.

The differences in Physics achievement pre-test scores and attitudes towards learning physics pre-test by gender were also examined during the pre-test analysis. Boys' and girls' pre-test scores in PAT and SAQ from the control group1 and experiment group 1 were compared. Table 6 shows a summary of the pre-test scores on PAT and SAQ based on students' gender.

Table 6

Independent Sample t-test Mean Scores on PAT and SAQ Based on students Gender

Scale	Group	N	Mean	SD	t-value	df	p-value
PAT	Boys	28	12.84	4.55	0.541	58	.590
	Girls	32	11.89	2.33			
SAQ	Boys	28	2.69	0.18	1.002	58	.320
	Girls	32	2.55	0.17			

The results in Table 6 indicate that the male students had higher mean scores than the female students in the PAT scores. However, the p> .05 indicates that the scores are not statistically significant by gender. The results for SAQ showed a difference in boys' and girls' mean scores in favour of boys. This difference was, however, not significant since the p-value was .32, which is greater than .05 at a level of α=.05 significance. Only one control group and one experimental group were subjected to the pre-test. This helped the researcher establish the groups' similarities before introducing the intervention and generalising the findings to the groups not given the pre-test.

4.3 Effects of Simulation Teaching Technique on Students' Achievement

To determine the effect of simulation teaching technique on students' achievement an analysis of students' post-test PAT scores was carried out. The first hypothesis of the study sought to find out whether there was any statistically significant difference in students' achievement between students taught physics through Simulation teaching technique and those taught through conventional teaching techniques in Buuri sub- County. Analysis of variance was used to establish whether there was a statistically significant difference among

the four study groups. Table 7 shows PAT post-test mean score which were obtained by students in the four groups.

Table 7

Students' PAT Post-test Mean Scores

Group	Mean score	N	SD
Control 1	9.31	32	2.79
Control 2	9.03	31	2.26
Exp 1	12.88	32	2.67
Exp 2	13.61	28	2.56

The results in table 7 show that the post-test mean scores for control group were lower than those of experimental groups. To establish whether the difference was statistically significant, a one-way ANOVA was performed. Table 8 shows the ANOVA results.

Table 8

ANOVA Results for PAT

Sources of Variation	Sum of Squares (SS)	Df	Mean Squares	f-ratio	p-value
Between groups	511.345	3	170.448	25.610	.000*
Within groups	792.021	119	6.656		
Total	1303.366	122			

* Significant at $p<.05$

The results from Table 8 show that the p-value is less than 0.05. This indicates that there is a statistically significant difference among the four groups. However, these results don't show which group or groups are different. Bonferroni post hoc test was conducted to reveal which group or groups were different since it reduces type I error Richard (2014). Table 9 shows results obtained from the post hoc analysis

Table 9

Post-Hoc Results for Post-test Scores

Group	Mean Differences	p-value
Control 1 and Control 2	0.28	1.000
Control 1 and Exp 1	-3.56	.000*
Control 1 and Exp 2	-4.29	.000*
Control 2 and Exp 1	-3.84	.000*
Control 2 and Exp 2	-4.57	.000*
Exp 1 and Exp 2	-0.73	1.000

* Significant at p<.05

Table 9 results indicates that Control group 1 has a statistically difference with Experimental 1and Experimental 2, it also indicates that Control 2 has a statistically significant difference with Experimental 1 and Experimental 2. This indicates that there is a statistical difference between the control groups and the experimental groups. This implies that the null hypothesis Ho1 which stated that there is no statistically significant difference in students' achievement between those taught through simulation technique and those taught using conventional techniques is rejected.

4.4 Discussion on Effect of Simulation Teaching Technique on Students' Achievement

The results from the study indicated that students taught through simulation achieved relatively higher scores in PAT than those taught through conventional teaching techniques. Experimental groups 1 and 2 attained a mean of 12.8 and 13.6, respectively. Control groups 1 and 2 had a mean of 9.3 and 9.0, respectively. This indicates that the simulation teaching technique improves learners' achievement in physics more as compared to conventional teaching technique.

The simulation teaching technique involves using computer simulation to represent abstract concepts, which may be challenging to present theoretically. The simulation provides a visual dimension to present the abstract concepts. This allows learners who understand better through the opportunity to grasp abstract concepts. According to Jimoyiannis and Komis (2000), the simulation teaching technique provides new educational environments. The new education environment aims to enhance teachers' instructional potential and facilitate students' active engagement. They also argued that the Simulations teaching

technique bridges the gap between students' prior knowledge and new physics concepts, helping students develop scientific understanding.

The findings of this study agree with other studies that the use of simulations in learning enhances students' achievement. Thiongo et al. (2014) study on the effects of computer-based simulation modules on secondary school students' achievement in understanding the magnetic effect of electric current found that computer simulation was a more effective teaching technique in enhancing students' achievement than the standard teaching techniques. Mwei et al. (2011) showed the effects of Computer-Assisted Instruction (CAI)on students' attitudes and achievement in matrices and transformations in mathematics, indicating a higher achievement with CAI treatment groups. They further recommended Computed Assisted Instruction as a valuable means of improving knowledge and skill hence higher achievement.

Research studies have revealed a positive effect on learners' achievement. Results from this study also agree with Talan (2020), who sought to find the effect of Simulation on Academic achievement. He found that the simulation teaching technique positively and significantly affected student academic achievement. Akhigbe and Ogufere (2019) investigated the effect of the Computer Simulation Instructional Strategy on students' attitudes and academic achievement in genetics. Their findings revealed that computer simulation significantly improved the achievement of low-ability learners who recorded higher mean grades than the medium and high-ability groups. This implies that the simulation teaching technique is a suitable technique to help students who attain low grades. They further noted that computer simulations could be used as a pedagogical tool to maximise the cognition of difficult and abstract concepts. This would ensure that learning takes a paradigm shift from abstract to a more concrete reality.

Ouahientl (2021), in his study, sought to find out the effect of Using Computer Simulation on Students' Performance in Teaching and Learning Physics. Their study revealed that simulation teaching technique had a positive impact on the performance of the students in the experimental group and refined their understanding. These enabled learners to overcome certain learning difficulties.

The simulation teaching technique has shown remarkable positive results not only in physics but also in other subjects. It presents abstract concepts a more relatable way, making them concrete. It also makes it possible to learn concepts that are challenging to present in real life due to their expensive nature, time-consuming, hazardous, and complicated to do in real environments. Such experiments can be performed safely and repeated as frequently as

desired until the learner understands the concepts being presented. Simulation teaching technique should be embraced, especially in today's world, where a pandemic forced most countries to rethink their teaching techniques. This would be an appropriate technique since it would be easier to observe Covid-19 protocols such as social distancing.

4.5 Effects of Simulation Teaching Technique on Students' Attitudes

The study's second hypothesis sought to determine whether there was any statistically significant difference in students' attitudes towards learning physics between students taught physics through Simulation teaching technique and those taught through conventional teaching techniques in Buuri sub- County. To determine the effect of the simulation teaching technique on students' attitudes towards learning physics, an analysis of students' post-test SAQ scores was carried out. Table 10 shows SAQ post-test mean score obtained by students in the four groups.

Table 10

Students SAQ, Post-test Mean Scores

Group	Mean Score	N	SD
Control 1	2.78	32	0.20
Control 2	2.75	31	0.24
Exp 1	2.89	32	0.24
Exp 2	2.86	28	0.24

Table 10 shows that the post-test mean scores for the control groups (Control 1 MS=2.78, Control 2 MS=2.75) were lower than those of the experimental groups (Exp 1 MS=2.89, Exp2 MS=2.86). The results indicate that the experimental groups had a better attitude towards learning physics than the control groups. A one-way ANOVA was performed to establish whether the difference was statistically significant. Table 11 shows the results obtained from the analysis of one-way ANOVA

Table 11

ANOVA Results of the SAQ Post-Test Scores

Sources of Variation	Sum of Squares (SS)	Df	Mean Squares	f-ratio	p-value
Between groups	.364	3	.121	2.291	.082
Within groups	6.304	119	.053		
Total	6.668	122			

Table11 shows that the p-value is .082, which is above .05. This indicates that there is no statistically significant difference among the four groups. The analysis from this study implies that the null hypothesis two which states that there is no statistically significant difference in students' attitude towards learning physics between those taught through simulation technique and those taught using conventional techniques," is accepted. The study's findings showed a difference in attitude towards learning physics for those exposed to the treatment in favour of those who were exposed to the treatment. However, after further analysis, the difference was not statistically significant.

4.6 Discussion on Results

The study results indicated that experimental groups 1 and 2 had a mean score of 2.89 and 2.86, respectively. Control group 1 and 2 had a mean score of 2.78 and 2.75, respectively. The study assessed students' attitudes towards learning physics using a student attitude questionnaire. The items used in the questionnaire sought to understand learners' attitudes towards learning physics before being exposed to the simulation teaching technique and after being exposed to Simulation Teaching Technique. The study's hypothesis sought to determine whether there is a statistically significant difference in students' attitudes towards learning physics between those taught by simulation and those taught through conventional teaching techniques.

In the simulation teaching technique, the teacher guided learners to conceptualize the abstract concept by presenting the abstract concepts using computer simulations prepared before the lesson by the researcher. The simulation teaching technique enables learners to code information in two ways, verbal, visual or both. The coding would increase the learners' ability to retain the information gained and trigger the learners' interest to learn. However, in the study, there was a difference in the means of the experimental and control groups in

favour of the experimental groups. However, the difference was not statistically significant. The experimental groups' attitude improvement towards learning physics can be attributed to the simulation teaching technique.

On further analysis, the difference was established as statistically insignificant. Capar and Tarim (2013) say that a study implemented for five weeks may not be sufficient to change students' attitudes. The implementation of this study took three weeks, less than the period established by the Capar and Tarim study. Shaw and Okey (1985) claimed that the study's duration time should be longer, to significantly change students' attitudes. The findings of this study agree with other studies, where the attitude change observed was not statistically significant during the simulation-based learning. Cetin's (2018), study on the effects of Simulation-Based Cooperative Learning on achievement, science process skills, attitudes towards physics and usage of interactive whiteboards. The study found that the attitude towards physics had no significant difference before and after the treatment. Cetin also noted that learners tend to view the simulation teaching technique as a game; hence this did not affect their attitudes towards learning Physics.

Other studies have shown a significant difference in learners' attitudes when exposed to the simulation teaching technique. Dennis et al. 2021 showed an improvement in students' attitudes and academic achievement in Entrepreneurship Education. This aligns with the Omoniyi (2006) findings, which state that simulation teaching and learning stimulate curiosity and reduces the abstract nature of concepts for easy dissemination by learners, improving learners' attitudes.

4.7 Effects of Simulation Teaching Technique on Boys and Girls Achievement.

To test if simulation teaching technique had a statistically significant difference between girls' and boys' achievement in physics for students taught physics through the simulation teaching technique. The results from the experimental groups were analysed to determine if there is a difference in achievement for boys and girls. Table12 shows the independent sample test of the PAT scores for boys and girls exposed to simulation teaching technique.

Table 12

PAT Scores for Boys and Girls Exposed to Simulation Teaching Technique

Gender	N	Mean	SD	t-value	Df	p-value
Boys	28	13.03	2.75	-0.496	58	.401
Girls	32	13.06	1.83			

Table 12 shows the post-test PAT mean score for boys and girls as 13.03 and 13.06, respectively. From the results, the girls performed slightly higher than the boys. The results from the independent sample t-test show that the p-value was .401, implying that the difference between the girls' and boys' mean scores was not significant at α=.05. The results obtained imply that the simulation teaching technique showed no partiality between boys and girls. The findings of this study also assent with the findings of Gambari (2014), on a study on effect of computer animations and geometrical instructional model on mathematics achievement and retention among the junior secondary school students in Minna, Nigeria. In his study the researcher examined the influence of gender on achievement of students taught geometry with computer animation packages and geometry instructional model respectively. He found out that there was no gender effect on the achievement of males and females students taught geometry using computer animations and geometry instructional model. This indicates that irrespective of the teaching technique, male and females students benefit equally.

The finding of the study contrast with the findings by Olumide (2013), in his study he reported a significant effect on gender on student academic achievement in biology when taught using computer assisted teaching strategy. Male students attained significantly higher scores in biology than females after being taught genetic using computers simulations. Kiboss et al. (2004) on their study on effect of computer mediated simulation program in school Biology on pupils learning outcomes in cell theory. The study findings showed no relationship between the participant's gender and the learning outcomes. However, the finding of this study also concurs with those of Chinywe and Chinyere (2010) who reported that there was no gender effect on academic achievement in basic ecological concept in biology.

4.8 Discussion of the Result

The analysis of PAT scores indicated that girls performed slightly better than boys. Further analysis showed that the difference between the girls' and boys' mean scores was not statistically significant. This indicates that the simulation teaching technique has no effect on students' achievement by gender since the boys and the girls had no statistically significant difference in their achievement. Other studies have shown different results of science performances between boys and girls. Akuaku (2015) found that girls' participation in science subjects is low compared to boys. The teaching technique used by teachers was among the factors that contributed to girls' low participation. Amunga et al. (2011) found out that boys' achievement in physics was much higher than girls. They recommended a change of teaching techniques to improve physics achievement among the girls. From the results obtained in this study, the simulation teaching technique is a technique that would be favourable for both genders.

The results of this study agree with other studies. Ouhai et al. (2021) in their study on the Effect of using computer simulation on students' performance in teaching and learning Physics, revealed a significant difference in achievement for those exposed to the treatment. Those exposed to simulation had higher scores. However, they also noted no statistically significant difference in achievement between boys and girls. Computer simulations bridge the gap in the attitude and achievement of male and female students. In his work Akhgibe (2019) found that gender differences in achievement did not yield any statistically significant results. This finding supports the view of Asogwa et al. (2016), who posited that gender does not influence students' achievement in genetics when exposed to computer simulation instructional strategy. Similarly, Amedu (2015) reported that gender significantly impacts the achievement of students who are taught using simulations.

There has been an existing gap between boys' and girls' achievements, especially in science subjects. The gap has been attributed to factors such as societal orientation, resources, prior knowledge before coming to school, and teaching technique. This study has revealed that the simulation teaching technique does not discriminate against any gender regarding achievement. Therefore, teachers, curriculum developers and other education stakeholders should champion this method to be used more frequently in our schools because of the absence of gender bias. The government should also facilitate human resources and other necessary resources to ensure that the implementation is inclusive, especially to the needed community.

4.9 Effects of Simulation Teaching Technique on Boy's and Girl's Attitudes.

The researcher sought to determine whether there was any statistically significant difference between girls' and boys' attitudes towards learning physics for those taught through the simulation teaching technique. The results from the experimental groups were analysed to determine if there is a difference in attitude towards learning physics for boys and girls. Table 13 shows the independent sample test of the post-test SAQ scores for boys and girls exposed to the simulation teaching technique.

Table 13

SAQ Scores for Boys and Girls Exposed to Simulation Teaching Technique.

Gender	N	Mean	SD	t-value	df	p-value
Boys	28	2.89	0.263	0.588	58	.250
Girls	32	2.85	0.220			

Table 13 shows the post-test SAQ mean scores for boys and girls as 2.89 and 2.85, respectively. From the results, the boys performed slightly higher than the girls. The results from the independent sample t-test show that the p-value was .250, implying that the difference between the girls' and boys' mean scores was not statistically significant at α=0.05. Regarding the results obtained there was no statistically significant gender difference in students' attitude towards learning physics when taught through simulation technique. This means that boys and girls exposed to simulation teaching techniques have similar attitudes towards learning physics.

4.10 Discussion of Results

The findings revealed no statistically significant difference in attitude between boys and girls exposed to the simulation teaching technique. However, findings from the study reveal that male students had an improved attitude towards learning physics than their female counterparts. The findings of this study agree with the Hussaini et al. (2015) study, which also affirmed that male and female students do not differ in their attitude towards science.

Previous studies in education science indicate that there have been differences in attitudes towards science and technology between boys and girls. Boys' attitudes are more positive than girls' toward science and technology (Miller et al., 2006; Ramsden, 1998). Chen and Howard (2010) posited that gender influences students' attitudes towards science after

exposure to live instructional simulation techniques. Girls' negative attitudes can be credited to several factors. Most girls, especially from the African community, were stereotyped to certain roles way before they started formal education, and they tend to shy off from science subjects and STEM-related careers, such as medicine, engineering, and technology. Stoilescu and Egoda(2010) assert that girls like science less than boys because they find it more often uninteresting, unpleasant, or too costly in time or effort. Cavallo and Laubach (2001) attributed girls' attitudes to the wrong teaching techniques by teachers. These are some of the factors that research pointed to explain the negative attitude from girls.

However, this study shows that computer simulation instructional technique bridges the gap in the attitude of male and female students towards learning physic. This is because there was no statistically significant difference in the attitudes of male and female students exposed to the treatment. This study agrees that high-inquiry learning makes learning science significantly more interesting than traditional teacher and textbook-dominated instruction (Leverink, 2013; Stannard, 2016). (2008) argues that another possible measure to influence girls' attitudes towards science and technology is to insert online learning environments in the science and technology lessons in school. Kay notes that girls respond very positive to online learning environments. The simulation teaching technique does not show gender partiality, giving girls an equal opportunity to learn physics and get placed in STEM careers without leaving the boys behind.

CHAPTER FIVE
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This study aimed to determine the effect of the simulation teaching technique on students' achievement in physics and attitude towards learning physics, particularly concerning magnetism. This final chapter presents the summary of the findings, conclusion, recommendations and suggestions on the possible areas for further study.

5.2 Summary of the Findings

The following is a summary of the findings:

i. The study findings revealed that students exposed to the simulation teaching technique achieved highly in physics as compared to those who were not exposed to the treatment.
ii. Students exposed to Simulation teaching technique had an improved attitude towards learning physics though the difference was not statistically significant
iii. The findings of the study revealed that there was a gender difference in students' physics achievement in favour of girls however the difference was not statistically significant.
iv. The study found out that there was a gender difference in students' attitude towards learning physics in favour of boys however the difference was not statistically significant.

5.3 Conclusions of the study

Based on the findings of this study, the following conclusions were made:

i. The simulation teaching technique enhanced students' physics achievement more effectively than the conventional teaching technique.
ii. The simulation teaching technique showed a positive attitude towards learning physics for those who were exposed to the treatment however it was not statistically significant.
iii. Simulation teaching technique enhanced physics achievement for both boys and girls in favour of the girls. However, the improvement was not statistically significant for both genders. This technique appealed to both boys and girls.

iv. Simulation teaching technique increased students' attitude towards learning physics in both girls and boys, with a slight favour to the boys. The increased attitude was however not statistically significant. This technique therefore, reduces gender disparities.

5.4 Implications

The results of this study have shown that the use of the simulation teaching technique resulted in higher learners' achievement in physics. When the technique was used, achievement in physics for boys and girls did not show any disparity but enhanced achievement for both. The technique, however, did not show any enhancement in attitude towards physics. However, this technique is likely to improve the achievement in physics, which would lead to better results in physics examinations.

5.5 Recommendations

The results of this study have revealed that the Simulation teaching technique has an effect on enhancing the achievement of learners in physics and shows no partiality in gender. Therefore, the following recommendations have been made based on the study's findings;

i. Physics teachers should be encouraged to use the simulation teaching technique in teaching physics.
ii. The curriculum developer should develop materials that would assist teachers in incorporating simulation teaching techniques in their teaching.
iii. The government should provide the necessary resources to enable teachers to easily incorporate this method in their teaching.
iv. The teacher employer should team with the government to organize workshops to train teachers on how to use this method to ensure all teachers are well-equipped with the right skills.
v. Finally, teacher training institutions should offer the skills of simulation teaching techniques to teachers in training.

5.6 Suggestion for Further Study

Though the findings of the study have shown improvement in Physics achievement, the researcher identified the following areas that require further investigation:

i. A study on how simulation teaching technique would affect learner's motivation in Physics.

ii. A study on the effect of simulation teaching techniques on students in other science subjects.

iii. A study on the effect of simulation teaching technique on students in practical work in secondary school.

iv. A study to determine how well schools are prepared to use simulation teaching techniques in terms of skills and resources

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APPPENDICES

Appendix A: Physics Achievement Test (PAT)

School Name…….

Class……

Gender…….

Instructions

Please answer all questions

Write the answers in the spaces provided in the question paper

1. State the basic law of magnetism (1 mark)

Give the meaning of the following terms

2 Magnetic materials (1mark)

3 Non-magnetic materials (1mark)

4 Ferromagnetic materials (1mark)

Repulsion is the only sure way for testing polarity

5 is this statement correct (1mark)

6. Explain your answer in 5 above (1mark)

7 What is magnetisation? (1mark)

8 Name two method of magnetisation (1mark)

9 Describe how you can magnetize a magnetic material by double stroking and (1 mark)

10 Indicate the poles in (9) above (1mark)

State two properties of magnetic field lines

11..... (1mark)

12..... (1mark)

Sketch magnetic field lines on the following arrangements

13 

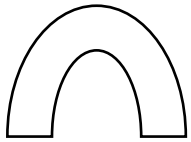
(1 mark)

14 

(1 mark)

15 

(1 mark)

16  (1mark)

N S

17 Describe one way of demagnetization (1mark)

18 Between iron and steel which material is easier to magnetize (1 marks)

19 Using a diagram explain how a material is magnetised by electrical Magnetisation (1marks).

20 Explain the difference between magnetic and non-magnetic materials using domain theory (1marks)

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Appendix B: Surdents' Attitude Questionnaire (SAQ)

Instructions

1. This is not a test and there are no correct or wrong answers
2. It is important that you give your honest views
3. Read the items carefully and rate the degree to which you agree with the statement. The rating scale ranges from zero to four, where the highest degree of agreement is four and zero represent no agreement.
4. Please circle the number that reflects your extent of agreement

Admission No……...

Gender Male ( ) Female ( )

1	I don't get upset when working out Physics problems	**0**	**1**	**2**	**3**	**4**
2	Physics is very worthwhile and necessary	**0**	**1**	**2**	**3**	**4**
3	I like Physics	**0**	**1**	**2**	**3**	**4**
4	Physics is dull and boring	**0**	**1**	**2**	**3**	**4**
5	I like to solve problems in Physics	**0**	**1**	**2**	**3**	**4**
6	Physics is especially important in everyday life	**0**	**1**	**2**	**3**	**4**
7	Trying to understand Physics doesn't make me anxious	**0**	**1**	**2**	**3**	**4**
8	Physics is not of the most important subject for people to study	**0**	**1**	**2**	**3**	**4**
9	Physics has contributed greatly to the progress of civilization	**0**	**1**	**2**	**3**	**4**
10	Other subjects are more important to people than physics	**0**	**1**	**2**	**3**	**4**
11	Physics is not interesting	**0**	**1**	**2**	**3**	**4**
12	I have seldom liked studying Physics	**0**	**1**	**2**	**3**	**4**
13	I usually enjoy studying Physics	**0**	**1**	**2**	**3**	**4**
14	I am very calm and unafraid when studying Physics	**0**	**1**	**2**	**3**	**4**
15	Physics help to develop the mind and teaches a person how to think	**0**	**1**	**2**	**3**	**4**
16	I feel bad every time I have a Physics lesson	**0**	**1**	**2**	**3**	**4**
17	My success in Physics is due to luck	**0**	**1**	**2**	**3**	**4**
18	I do not want to take anymore Physics than I already have	**0**	**1**	**2**	**3**	**4**
19	Physics makes me feel nervous and uncomfortable	**0**	**1**	**2**	**3**	**4**
20	I am interested in acquiring further knowledge in Physics	**0**	**1**	**2**	**3**	**4**

21	I plan to take as much Physics as I possibly can	**0**	**1**	**2**	**3**	**4**
22	I want to develop my Physics skills and study this subject more	**0**	**1**	**2**	**3**	**4**

Appendix C: Simulation Teaching Technique Training Manual

The purpose of this manual was to help the physics teacher plan and implement the teaching learning programme based on Simulation Teaching Technique. This technique integrates computer models that represent real situation in the teaching of the topic Magnetism in the Form Two Physics. Includes the use of computer-based technology integrated in some concepts not necessarily all concepts in the topic. This included text, sound, animation and video. In this teaching technique learners were involved actively in the teaching and learning process. This manual was used throughout the treatment period. The subject matter was divided into small subtopics. Instructional objectives were developed for each subtopic at the end of the units that the learners were tested.

1.0 Instructional Objectives

Instructional objectives are statements that describe what a student will be able to do after completion of a prescribed unit of instruction. They are concerned with the results and not the learning process, hence there were stated in terms of the learning outcome. Wachanga (2005), notes that objectives should be stated in terms of the terminal behaviour of the learner. He continues to say that terminal behaviour should be measurable.

A well stated instructional objective should have the following features

Participant-this is the target individual whom the objective is intended

Behaviour-the specific expected behaviour that indicates the student has met the objective

Product-learning outcome which is the focus of the objective

Condition-this specifies the condition under which the behaviour will occur

Measurement Criterion-the objective should be stated in measurable terms.

1.1 Reasons for Stating Objectives

a) Give direction to teachers in the selection of instructional methods and instructional resources
b) Provide teachers the opportunity to design proper assessments procedure through tests and evaluation
c) Inform students what they are supposed to learn and to what extent.
d) Assist in determining the resources, course materials, and curricular activities etc. which are vital to make the learning teaching process functional.

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

Identify magnetic and non-magnetic materials

(a) Describe the properties of magnets

(b) State the basic law of magnetism

(c) simple compass

(d) Describe and sketch magnet field patterns

(e) Explain the domain theory

(f) To make magnets by: Induction and Stroking

(g) Magnetize a material by an electric current

(h) Describe the methods of demagnetization

(i) Describe how to care for magnets

(j) Describe the uses of magnets

2.0 Teaching Using Simulation Teaching Technique

Simulation Teaching Technique is an instruction method where the teacher in cooperate computer models in the teaching and learning process to represent real life situation. The researcher provided the teachers with the simulations that were used in the teaching and learning process. The simulation was on the topic of magnetism and presented the concepts both verbally and visually. This provided an opportunity to the learner to code the information received both verbally and visually. Coding information in two different ways increases the chance of remembering that information as compared to coding in just one way. Teachers were trained by the researcher on how to use the simulations teaching technique, and project the simulations using power point presentation format. The teacher cooperated the simulations in the teaching and learning process where applicable. This simulation can also be used in a computer lab where learners will interact personally with the materials. The teacher guided the learners on how to use the simulations.

2.1 Guide on Magnetism.

In this study, the topic: Magnetism was covered, with use of simulation teaching technique. The topic was subdivided on the subtopic as follows.

(a) Magnetism

(b) Property of Magnetism and Law of magnetism

(c) Magnetic and Non-magnetic materials

(d) Magnetic field pattern
(e) Magnetization
(f) Demagnetizations
(g) Hard and soft magnetic materials and application of magnets
(h) Domain Theory of Magnetism

Each of these units had its own objectives and was clearly stated in the scheme of work. During the lesson students participated actively and interact with the learning materials available. Learners made relevant conclusions based on the observation made while working in the classroom. At the end of the unit the learners were tested to determine if the objectives have been achieved

Topic : Magnetism
Duration : 12 lessons
Period :3 weeks

Specific Objectives

After covering the topic, the learner should be able to:

(a) Identify magnetic and non-magnetic materials
(b) Describe the properties of magnets
(c) State the basic law of magnetism
(d) Construct simple compass
(e) Describe and sketch magnet field patterns
(f) Explain the domain theory
(g) to make magnets by: Induction and Stroking
(h) Magnetize a material by an electric current
(i) Describe the methods of demagnetization
(j) Describe how to care for magnets
(k) Describe the uses of magnets

During the first lesson learners were told that they will be learning a new topic 'Magnetisation', using a new method of learning for three weeks. This new method involved the use of computer simulation. A real situation which may not be possible to represent them in reality was represented by use of simulation. Learners were given time to construct their own meaning and discuss their opinion among each other, after watching the simulations. The class was informed that the new method demanded their participation in term of group discussion. Hence learners were arranged in groups.

Task 1

Experiment integrated with simulation

Magnets are materials that attract magnetic materials. Every day the question of why and what cause the magnets to attract is asked. Present magnets are made of a material called lodestone a form of iron that occurs naturally. This material lodestone attracts some materials when brought near it. Magnets are made from these magnetic materials.

Experiment : Determining magnetic poles

Requirement

Iron fillings and magnets

Procedure

Dip the bar magnet into iron-filling and observe

Repeat the procedure with different types of magnets

Learners were encouraged to take part in the experiment. The teacher displayed simulation showing magnetic poles using different types of magnets. The learners recorded and explain the observation.

Task 2

Directional property of magnet

Experiment ; Investigating the directional property of a magnet

Requirement

Bar magnet, Cotton thread, stand

Procedure

1. Suspend a bar magnet with a cotton thread from a wooden stand, so that the magnet swigs freely in the horizontal plane. Give it time and observe the direction in which it comes to rest.
2. From rest position turn the magnet and release it at about 90degree and again the direction in which it comes to rest.
3. From the rest position turn the magnet through about 180 degrees. Release it and note the direction in which it comes to rest.

Learners observed, recorded and discussed the observation.

Task 3

Magnetic and Non-magnetic materials

Experiment ; Classifying objects into magnetic and non-magnetic materials

Requirements

Rod made of different materials, magnets

Procedure

1. Suspend a rod with a thread
2. Bring the north pole of a magnet towards one end of the rod and observe what happens
3. Repeat the experiment using the south pole of the magnet
4. Repeat the experiment using rods of different materials.

Objects	Observation	
	North pole	South pole
Glass rod	Repelled	Repelled
Steel pin Copper wire		

A conclusion was made on materials that were attracted towards a magnet and those that were repelled

Task 4

Magnetic Field Pattern

Experiment : Investigating magnetic field pattern of a magnet

Requirements

Bar magnet, horse shoe, iron fillings and cardboard

Procedure

1. Place the bar magnet on a table and cover it with the stiff cardboard
2. Sprinkle a thin layer of iron fillings on the board and tap it gently and record the observation
3. Repeat the experiment with the horse-shoe magnet under the board.

The teacher displayed simulation of different magnetic field patterns. Learner observed and discussed the patterns among themselves.

Appendix D: Schemes of Work

Form two physics schemes of work on magnetism							
WEEK	Lesson	Topic	Sub – topic	Objectives	Learning/teaching activities	Learning/teaching resources	References
1	1-2	MAGNETISM	Magnetism	By the end of the lesson, the learner should be able to: Describe a magnetic materials	• Observing attraction and repulsion of magnets on simulation • Describing natural and artificial materials	• Magnets • Nails • Pins • Wood • Plastics • Tins • Spoons • Strings • Razor blade • Stand	• Comprehensive secondary physics students book 2 pages 1-2 • Comprehensive secondary physics teachers book 2 pages 1-5 • Secondary physics KLB students

							book 2 page
	3	MAGNETISM	Properties of magnets and the law of magnetism	By the end of the lesson, the learner should be able to (i) Describe the properties of magnets (ii) State the logic law of magnetism	• Investigating properties of magnets • Stating the laws of magnetism	• Magnets • Charts on properties • Iron fillings • Strings • Stand	• Comprehensive secondary physics students book 2 pages • Secondary physics KLB students book 2 page 1-4 • Principles of physics (M.Nelkom) pages 14
	4	MAGNETISM	Magnetic materials	By the end of the lesson, the learner should be able to	• Identifying the test for magnetic materials	• Magnets • Nails • Pins • Wood	• Comprehensive secondary

				Identify magnetic and non-magnetic materials	• Carrying out experiments to identify magnetic and non-magnetic materials	• Plastics • Tins • Spoons	physics teachers book 2 pages 1-5 • Secondary physics KLB students book 2 page • Golden tips physics page 127
2	**1-2**	MAGNETISM	Magnetic field patterns	By the end of the lesson, the learner should be able to: (i) Describe magnet field patterns	• Plotting the field of a bar magnet using a compass and iron filings	• A compass • Iron fillings • Bar magnets • Can with lid • Card board • Sheet of papers	• Secondary physics KLB students book 2 page 6-7 • Principles of physics (M.Nelkom) pages

							444 • Golden tips physics page 124-125
	3	MAGNETISM	Making magnets by induction and stroking	By the end of the lesson, the learner should be able to make magnets by : (i) Induction (ii) Stroking	• Observing magnetization using simulation • Magnetizing a steel bar by stroking single and double strikes • Defining hard and soft magnets	• Bar magnets • Steel bars • Nails • Iron bars	• Secondary physics KLB students book 2 page 19-22 • Principles of physics (M.Nelkom) pages 441-442 • Golden tips physics page 125-126
	4	MAGNETISM	Making magnets by an electric	By the end of the lesson, the learner	• Magnetizing a steel bar by an electric	• Insulated wire	• Comprehensive secondary

			current	should be able to: (i) Magnetize a material by an electric current	current	• Battery cell • Steel bar	physics students book 2 pages 8 • Comprehensive secondary physics teachers book 2 pages 1-5 • Secondary physics KLB students book 2 page 23-24
3	**1-2**	MAGNETISM	Demagnetization and caring for magnets	By the end of the lesson, the learner should be able to (i) Describe	• Describing ways of demagnetizing of magnet • Observing	• Battery/cell • Keepers • Bar magnets • Chart on	• Secondary physics KLB students book 2 page

				the methods of demagnetizative (ii) Describe how to care for magnets	demagnetization by use of simulation • Carrying out experiments to demagnetize and care for magnets	demagnetization and care for magnets	25-26 • Principles of physics (M.Nelkom) pages 442 • Golden tips physics page 126-127
	3	MAGNETISM	Uses of magnets	By the end of the lesson, the learner should be able to (i) Describe the uses of magnets	• Describing uses of magnets • Discussions • Using magnets	• Magnets • Metallic bars • Non-metallic bars	• Comprehensive secondary physics students book 2 pages 9 • Comprehensive secondary physics teachers book 2 pages

							1-5 • Secondary physics KLB students book 2 page 27
	4	MAGNETISM	The domain theory of magnetism	By the end of the lesson, the learner should be able to: (i) Explain the domain theory	• Describing the domain theory of magnetism • Explaining the application of the domain theory of magnetism • Observing arrangement of dipole in a magnet that have been simulated	• Charts on domain theory • Bar magnets • Iron fillings • Test tubes • Cork	• Comprehensive secondary physics students book 2 pages 9-10 • Comprehensive secondary physics teachers book 2 pages 1-5 • Secondary physics KLB

							students book 2 page 17 • Principles of physics (M.Nelkom) pages • Golden tips physics page 127

Appendix E: Clearance from Ethics Committee

EGERTON UNIVERSITY
TEL: (051) 2217808
FAX: 051-2217942
P. O. BOX 536
EGERTON

EGERTON UNIVERSITY RESEARCH ETHICS COMMITTEE

EU/RE/DVC/009
Approval No. EUREC/APP/112/2021 **27th January, 2021**

Agata Wangari Ndegwa
P O BOX 536-20115,
EGERTON
Telephone: +254720355301

E-mail: agata0215.af@gmail.com

Dear Agata,

RE: ETHICAL CLEARANCE APPROVAL: EFFECTS OF SIMULATION TEACHING TECHNIQUE ON CO-EDUCATIONAL SECONDARY SCHOOLS STUDENTS' ACHIEVEMENT AND ATTITUDE TOWARDS LEARNING PHYSICS IN BUURI-EAST SUB-COUNTY, KENYA

This is to inform you that ***Egerton University Research Ethics Committee*** has reviewed and approved your above research proposal. Your application approval number is ***EUREC/APP/112/2021***. The approval period is ***27th January, 2021 –28th January, 2022.***
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 ***Egerton University Research Ethics Committee***.
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 ***Egerton University Research Ethics Committee*** within 72 hours of notification
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to ***Egerton University Research Ethics Committee*** within 72 hours
v. Clearance for Material Transfer 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 ***Egerton University Research Ethics Committee***.

Appendix F: Research Authorization Document

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: 206224

Date of Issue: 09/August/2021

RESEARCH LICENSE

This is to Certify that Miss.. AGATA WANGARI NDEGWA of Egerton University, has been licensed to conduct research in Meru on the topic: Effects of simulation teaching technique on students achievement and attitude towards physics in Buuri East subcounty for the period ending : 09/August/2022.

License No: **NACOSTI/P/21/12224**

206224

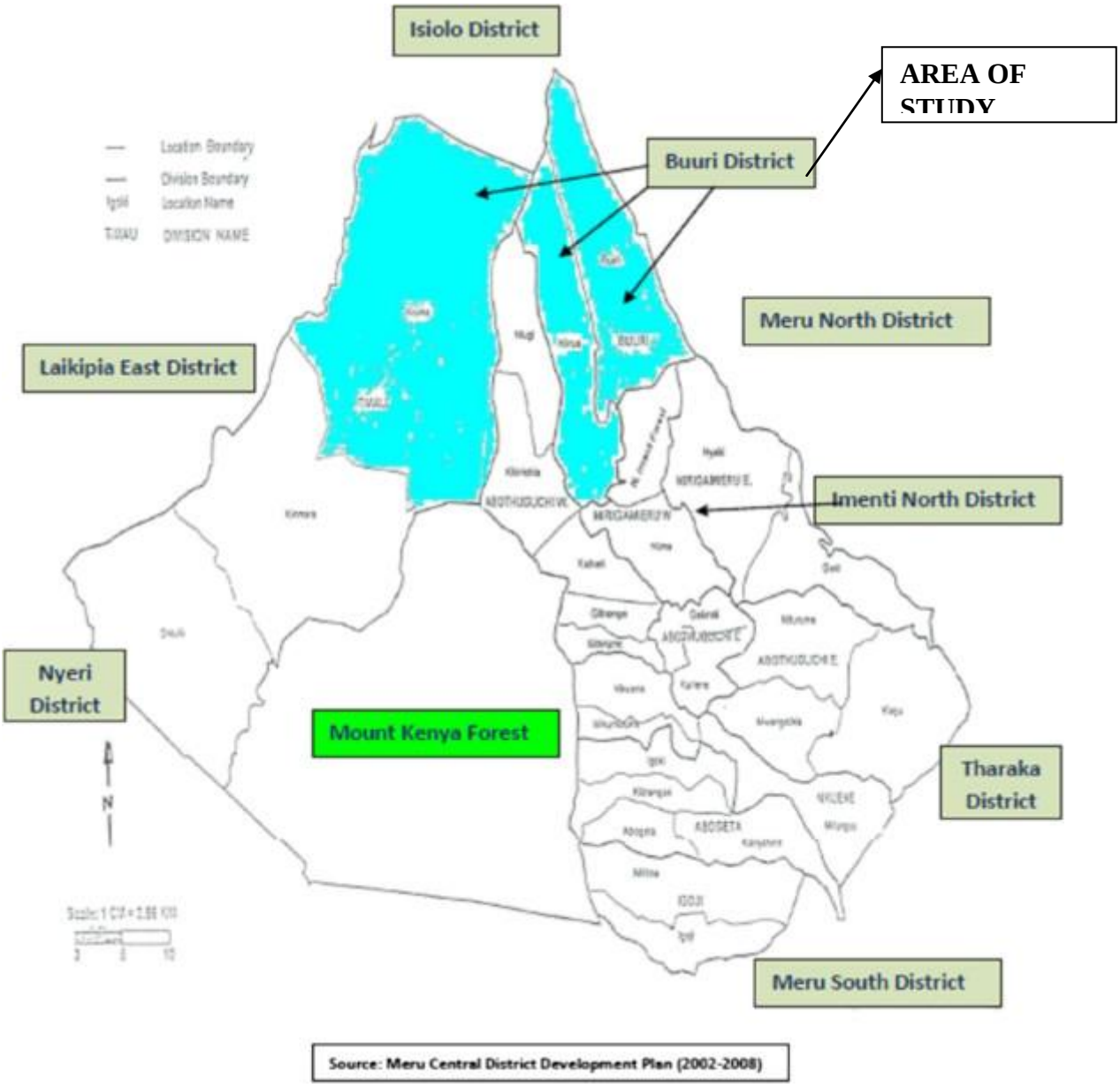
Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

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

Appendix G: Map showing study Area



Source: Google

Appendix H: Snapshot of Abstract of Publication

Journal of Educational Research in Developing Areas (JEREDA) Vol. 4. Issue 1, Pp. 65 – 77, 2023 http://www.jeredajournal.com E-mail: info@jeredajournal.com

EFFECTS OF SIMULATION TEACHING TECHNIQUE ON ACHIEVEMENT OF STUDENTS IN PHYSICS CONCEPTS IN BUURI-EAST SUB-COUNTY KENYA.

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Egerton University, Kenya

ABSTRACT

Introduction: Physics is a science subject that is fundamental for developments in any country. Students' achievement in Physics concepts in the Kenya Certificate of Secondary Education (K.C.S.E) has been below average. Most physics concepts are abstract in nature and the techniques used to teach do not allow learners to conceptualize such concepts. This has led to poor student achievement in physics.

Purpose: The purpose of the study is to investigate effect of simulation teaching technique on secondary school students' physics concepts achievement in Buuri East sub-county, Meru County, Kenya.

Methods: Solomon four non-equivalent control group design was used. Both purposive and stratified sampling techniques were used to select four co-educational schools that were used in the study. The sample of the study consisted of 123 form two students. Physics Achievement Test (PAT) was used to collect data on students' achievement in Physics. The instrument was validated and pilot tested for use in data collection. KR-20 was used to estimate the reliability of PAT, a coefficient of 0.84 was found. Data were analyzed using both descriptive and inferential statistics, which included mean score, t-test, and ANOVA. The hypotheses were tested at 0.05, alpha level of significance.

Findings: The results showed that the difference in physics achievement was statistically significant in favor of experimental group. There was no statistically significant difference in the achievement between male and female students in physics, based on the results.

Recommendations: it was recommended that physics teachers embrace the use of simulation in teaching. The government and education stakeholders should encourage the use of simulation teaching technique in teaching physics in secondary schools.

Keywords: Dual Coding, Gender, Physics, Simulation and Students' Achievement

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