

**IMPACT OF THE USE OF TECHNOLOGICAL DEVICES ON HIGH SCHOOL
STUDENTS ACHIEVEMENT IN BIOLOGY IN STAREHE SUB-COUNTY,
NAIROBI COUNTY, KENYA**

**BY
UNGAYA SAM ANYULA
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DEDICATION

I dedicate this dissertation to my family and my university colleagues for their motivational support that enabled me to complete this project. God bless you!

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I acknowledge the support from my project supervisor Dr Oluoch Dan for his dedicated support during this research project. I also thank the principals and teachers of the surveyed secondary schools for their cooperation and support throughout the study not forgetting the African Education Development Trust that funded part of my studies and research.

DECLARATION

Student Declaration

Ungaya Sam Anyula

Signature  _____

Date 31/08/2020

Supervisor Approval

Dr Oluoch Dan


Signature _____

Date 31/08/2020

Department of Educational Studies, Odel Campus, the University of Nairobi

ABSTRACT

Science subjects, especially biology have suffered a declining performance compared to non-science subjects at the KCSE. Such performance has been linked to learners' perception that biology is uninteresting and difficult due to the abstract nature of its content. Research indicates that where there are sufficient technology resources, use of technology in biology instruction or teaching can simplify the abstract content and creates interest among students thereby enhancing performance in the subject. This project explored the effect of technology in high school learners' performance in biology in Kenya, a case study of high schools in Starehe Sub-county. The broad objectives of the research were to find out the availability of adequate educational technology resources in high schools in Kenya, the extent to which ICT tools are employed in teaching, particularly biology and how they affect students' performance in biology. The study involved seven schools, seven principals, and 10 biology teachers. A descriptive survey study design was employed. Random sampling technique was deployed to identify the seven schools while biology teachers and principals were chosen using a purposive sampling technique. Questionnaires and semi-structured interviews were utilized in data collection that was analyzed using content descriptive and qualitative approaches. The findings showed that the use of technology in teaching and also learning biology in high school can improve performance in the subject but its integration is still low. Therefore, the study recommends the provision of adequate technology resources in teaching to improve students' interests and performance in biology.

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CHAPTER ONE

INTRODUCTION

1.1 Introduction

This chapter is a preface of the dissertation. The main sections covered include background information, problem statement, research purpose, its objectives, study questions, as well as the rationale. Other sections include the significance of the research, limitations, and operational terms.

1.2 Background to the Study

Like other professionals, teachers and school administrators have sought ways to use technology in learning and teaching since the first-time computers started being used in the workplace decades ago. Despite attempts by aggressive teachers, the earliest technology devices lacked capabilities to facilitate learning. However, the invention of wireless technology, the advent of the World Wide Web, and another teacher/learner-friendly software which now exist have drastically changed what technology can do for students and teachers in the classroom (Kafyulilo, Fisser, & Voogt, 2016). Additionally, the availability and affordability of technology devices in form of small handheld computers such as tablets, smart phones and the software used by these devices, have created opportunities to broaden what students can learn and how they can do it.

Alves and Castro (2019) support Kafyulilo, Fisser, and Voogt's (2016) view that such opportunities exist and only limited by an individual's creativity and capacity to innovate. Indeed, in the next generation, to keep pace with the trends and offer the best learning environment for students, the main shift in the design of the classroom is required. Precisely, mobile technologies can offer educators noble opportunities and unique advantage to offer diverse and rich learning environments which encourage creativity, freedom, and independence thus eliminating barriers to learning in terms of space and time. Notably, most students continue struggling to perform well in science subjects including biology.

Previous research on technology and its impact on student performance has shown that researchers have different attitudes and perceptions about technology and its importance on learner performance (Rashid & Asghar, 2016). According to Rashid and Asghar (2016),

technology impact on student's performance depends on various factors including access to appropriate technology devices. However, Rashid and Asghar (2016) agreed that technology offers equal educational opportunities for learners and eliminates barriers to learning hence boosting performance.

Despite this study, little or no research has focused on how students view the deployment of technology in the study and their performance in biology. Additionally, little research exists on biology teachers' and students' experience using technology and the effects of technology on students' performance in biology. Moreover, no such study has been conducted in Starehe Sub-county. Therefore, although some studies exist that link technology to improved performance, none has been carried out in the target site focusing specifically on biology subject.

1.3 Statement of the Problem

A significant percentage of learner population not only in Starehe sub-county but in other areas across Kenya struggle to perform well in science subjects, especially biology (Ching, Himmelstein, Beaulieu-Jones, Kalinin, & Xie, 2018). Ching et al. (2018) attribute the struggle to some factors including lack of adequate appropriate curriculum resources. Advance in technology has proved to be useful in teaching and learning as acknowledged by Connell, Donovan, and Chambers (2016). However, technology use in learning is new to most learners since technology is not part of their daily practices. Connell, Donovan, and Chambers (2016) assert that although most students can use the Internet to research information and answer questions, the majority of them lack key technological capacities thus technology does not influence their performance.

Despite broad research in educational technology, little is known regarding high school students' experience with technology (Martin, Mansour, & Malmberg, 2019). More significantly, little is known regarding the influence of technology on high school students' performance in science, specifically biology. In this respect, the problem related to the current dissertation is the lack of adequate research on how ICT tools affect students' performance in biology, specifically in Starehe Sub-county.

Further research shows that lack of adequate research on why most high school students struggle in technology-focused science subjects or courses is an issue that is both meaningful and relevant to science education and the field of educational technology

(Costa-Silva et al., 2018). One reason why this problem is meaningful and relevant is that affects how biology students and teachers interact and also how biology teachers implement technology in the subject. Another reason why this problem is meaningful and relevant is that biology students might decide to pursue pure technology and science-related careers. Therefore, the availability of evidence-based research on the impact of technology on learner performance in biology can motivate them to choose such careers to take advantage of the progressive advance in technology (Costa-Silva et al., 2018). In this regard, the main goal of this dissertation is to develop a deeper understanding among learners, teachers, school administrators, and education policy-makers of how technology can be an essential catalyst for performance improvement in biology subject and also a tool for designing more appropriate instruction for high school biology courses.

1.4 Purpose of the Study

The drive for this dissertation is to explore the effects of technology devices on biology performance among high school students. To attain this purpose, the research will explore how students and teachers view the reliability and ease-of-use of technology in enhancing high school student's interests and performance in biology.

1.5 Objective of the Study

The prime objective of this dissertation was to examine how technological devices affect high school students' performance in biology in Kenya.

1.5.1 Specific Objectives of the Study

This thesis sought to attain the specific objectives below:

1. To assess the extent of technology access and use in public high schools in Kenya
2. To examine the impact of ITC tools on public high school students' performance in biology in Kenya
3. To determine teachers and principals' perception of the effectiveness of ITC tools in teaching biology in public high schools in Kenya
4. To determine factors that determine the integration of technology in teaching biology in public high schools in Kenya

1.6 Research Questions

The dissertation looked forward to answering the questions below:

1. What is the level of access and use of technology for teaching biology in public schools in Kenya?
2. What is the impact of ICT tools on high school students' performance in biology?
3. How do high school principals and teachers perceive the use of ICT tools in teaching biology?
4. Which factors influence the deployment of technology in teaching and learning biology in high schools in Kenya?

1.7 Significance of the Study

The results of this dissertation will advance knowledge, improve practice, and positively contribute to social change. Regarding knowledge advancement, the outcomes of the research will enable researchers and educators to develop a deeper understanding of ways in which innovative technology-based instructions affect high school student performance in science subjects, particularly biology. Regarding improving practice, the study will motivate biology teachers to enhance their instructions by using technology to offer hands-on, personal, and relevant learning. High school learners will also get further support from their biology teachers on how to effectively employ technology in biology classrooms. Equally important, education policy-makers school administrators may use the outcomes of this prospective research to offer more effective teacher training in how to enhance technology use in biology classrooms. The study may also have a positive social change in that it may improve the academic experience in science, especially biology not only for high school students in Starehe but also in other regions.

1.8 Study Scope

The scope of this dissertation will understand how the deployment of technology influences high school learners' performance in biology for schools in Starehe constituency. The schools in this area constitute students from an ethnically diverse background with a population of about 750,000 residents. The scope is further narrowed by time, resources, and participants. The participants will only include purposefully chosen high school biology students and teachers in this region. Regarding time, data will be gathered over a short period of 1 month during November of 2019. Resources will also be narrowed in this research because of being alone with inadequate time.

1.9 Study Limitations

The study has some limitations. The first one concerns the transferability of case study outcomes. Despite that the use of gathered and analyzed from varied sources of evidence will improve the reliability as well as validity of the case study; the findings might only apply to similar populations of students and instructors in Kenya. However, this limitation will be solved by ensuring a sufficient description of data gathering and analysis procedures as well as study setting, respondents, and outcomes. The other concern is researcher bias since my responsibility as the chief researcher will account for full responsibility for the gathering and analysis of the data. Nonetheless, this potential bias will be avoided by using various strategies including member checks, triangulation, and reflexivity.

1.10 Definitions of Key Terms

Information technology: Computer hardware and software applications to gather, process or analyze, and disseminate information which positively affects performance (Thatcher, Wright, Sun, Zagenczyk, & Klein, 2018).

Biology Technology: Technology employed in biological science to gather, analyze, measure scientific data, which include biology-specific devices such as the optic signal generator, hand-grip heart rate monitor, fiber optic systems, blood pressure sensor, and temperature probe among others (Kolodziejczyk, Kim, Svensson, Marioni, & Teichmann, 2015).

1.11 Summary

Chapter one is an introduction to the prospective study and comprises the background information as well as the problem statement, which highlights the urge for the proposed study. The dissertation aimed to examine how technology affects performance in biology among high school learners. The chapter also focused on the nature of the study, which entails the selection of case study design which has some limitations. Also discussed in this chapter is the significance of the research which includes advancing knowledge in the deployment of ICT tools in the study of biology, improving practice in this field, as well as contributing to social change.

The next chapter is a review of the literature related to this topic that has been conducted and compiled by reputable scholars previously. This chapter is followed by the third chapter which is the study methodology, which outlines the methods employed in the study

from respondent identification, data collection to analysis. The methodology leads to results and discussion and finally conclusion and recommendation for future studies related to this field.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The chapter explores the perspectives of different researchers concerning the effect of technology in high school learner performance in biology. The outcomes of the review help to identify existing controversies or disagreements among different scholars thereby forming the bases for the current study. The chapter consists of the theoretical framework, other subheadings based on research objectives, and the conceptual framework.

2.2 The Concept of ICT in Education

Ratheeswari (2018) defines ICT in education as the mode of education; acquisition of knowledge, attitudes, and skills which employ communication and information technology devices to enhance, support, and also optimize the delivery of instruction. Various devices used in education ICT include handheld computers, audio players, tablet computers, desktops, and projectors among others (Ratheeswari, 2018). The use of these devices depends on the availability of other resources such as sources of power and Internet connections.

2.3 The Extent of Technology Access in Public Secondary Schools

The availability of ICT facilities plays a major role in the integration and the extent of their use in teaching. In their study of the levels of schools' access to ICT in Cuban and Jandrić (2015) established that there was poor access to ICT by many schools. Given the lack of access, NEPAD was forced to establish e-schools to promote schools' access to ICT. The results of his study indicated that e-learning offers better outcomes in learning and teaching. Concurrently, Porter et al. (2016) noted that most schools, especially in developing countries do not have access to computers and desktops which could help in teaching.

From a different perspective, Chirwa (2018) asserts that teachers skilled in ICT and can access the facilities for teaching often perform better than those without such access. Chirwa (2018) listed the types of technologies currently used in Tanzania secondary schools. These include mobile devices, online study, computers, and desktops in classrooms, online media, and interactive whiteboards among others. However, Garba, Yusuf, and Busthami (2015) hold a contrasting view that such devices are only common in

the US and Europe school but not in Kenya. Hossain, Salam, Shilpi, and Officer (2016) concur with Garba, Yusuf, and Busthami (2015) noting that most schools in developing nations are in the early stage of ICT integration in teaching, characterized by poor internet connect and uncoordinated provision and use. Hossain et al. (2016) also assert that access to ICT in most schools in Kenya depend on personal/family ownership of computers.

In his recent study, Salam et al. (2018) concluded that most schools in Kenya are deprived of ICT while some other schools which can access ICT facilities have not yet integrated it in teaching. A study carried out by the Computer Literacy Initiative of Kenya in 2003 showed that approximately 60,000 computers were required in all the 20,000 schools in the country. Given the increasing number of schools in Kenya, it is expected that a higher number of schools do not have access to ICT tools. Given such poor access, the level of deployment of the tools in teaching biology and other subjects is also low.

2.4 Impact of Technology on Public High School Students' Performance in Biology

Various scholars have explored how ICT affects students' interest and performance in biology. In his recent descriptive survey conducted in Nigeria, Crook, Sharma, and Wilson (2015) established that students use technology in learning which has increased their interest in learning biology but technology devices for learning biology are scarce in the schools. Crook, Sharma, and Wilson (2015) noted that technology tools help learners to acquire sufficient field and laboratory skills and knowledge in biology. Concurrently, Nikou and Economides (2016) in their study on the influence of technology on learner performance in science subjects found that technology, specifically desktops, and laptops connected to the internet helps students access simplified notes on abstract concepts and solved problems thereby helping students get better grades in biology and other subjects. From a different point of view, Jenö, Grytnes, and Vandvik (2017) found that secondary schools students do not necessarily find biology learning interesting as other subjects using technology except with the use of particular tools they find acceptable.

In another study, McCutcheon et al. (2015) compared the effectiveness of textbooks and technology on students' performance. Data was obtained using purposive sampling and analyzed using SPSS. The researcher concluded that with the increasing access to electronic books and PDFs, printed books are becoming obsolete and that using technology might increase students' motivation, interests, and eventually performance. Shute and

Rahimi (2017) in their study on the relation between technology use in teaching and students' performance in biology noted that technology helps biology students to solve problems, discover learning topics, and get a solution to solutions in the process of learning thereby not only increasing their interest on the subject but also boosting their performance. Shute and Rahimi (2017) hold a similar perspective that the deployment of ICT tools in teaching helps biology learners to access and share easily concepts related to learning thus boosting performance in the entire class.

2.5 Principals and Teachers' Perception of the usefulness of Technology in Teaching Biology

Uluçol and Şahin (2016) define perception as the way an individual thinks regarding something or how a particular thing is understood. Therefore, perception describes one's experience of a particular matter. On the other hand, Al-Samarraie et al. (2018) define attitude as a composition of several beliefs around a given situation or subject. Al-Samarraie et al. (2018) assert that the strength of attitudes determines the kind of perceptions, level of change resistance, and influence behavior. The strength of attitudes is associated with certainty, vested interests, importance, direct experience, and accessibility. Machado and Chung (2015) assert that the perception of principals on the effectiveness of technology in enhancing students' performance plays a key part in the successful acquisition and use of ICT in school. Machado and Chung (2015) also argue that principals and teachers are crucial agents in the deployment of ICT tools in teaching as they influence stakeholders. In a similar study to assess the importance of user views in the deployment of ICT tools in teaching in Australia, Ismail and Ibrahim (2018) found that teachers' and principals' attitudes towards the employment of ICT tools in teaching are positively related to the experience and extent of use of the technology. The outcomes of Ismail and Ibrahim's (2018) study linked the significance placed on ICT use in all areas of life including the classroom.

Another study by Nikolopoulou and Gialamas (2015) on teachers' views of technology tools used in teaching and the correlation between the perceptions and the extent of technology use in teaching biology in Turkey, the results showed that there is a high level of access and use of ICT in teaching. Nikolopoulou and Gialamas (2015) concluded that

user attitudes are essential as they determine the efforts put to access and usage of technology in learning and teaching. In a similar recent study on principals' and teachers' attitudes on the deployment of technology in teaching, Gil-Flores et al. (2017) found that the respondents showed favorable attitudes towards ICT deployment in the teaching.

2.6 Factors that Influence ICT use in Teaching Biology in Public Secondary Schools

The successful introduction of ICT tools in learning and teaching biology depends on various factors that need to be identified and addressed to realize the potential benefits. In their recent study on this topic, Lai (2015) outlined various factors that hinder the successful use of ICT in schools for instruction. The list included the high cost of acquisition, lack of funds, high maintenance cost, and unreliable power sources in remote areas, poor internet connection, and failure of teachers and students to take responsibility for taking care of the facilities. McKnight et al. (2016) concur with Lai (2015) asserting that the high cost of buying modern customized technology facilities for teaching is a key hindrance to the integration of ICT tools in education for most schools. McKnight et al. (2016) noted that some schools can only afford a few ICT facilities for teaching due to high cost hence they have not realized the benefits of ICT in boosting performance.

In a contrasting view, Briz-Ponce et al. (2017) assert that some schools have the funds set aside for ICT integration but negative perception and attitudes of principals on the effectiveness of ICT devices on students' performance hinders successful integration. Rienties et al. (2016) concur with Briz-Ponce et al. (2017) underlining principals' and teachers' perceptions as a major determining factor in the successful use of ICT tools in teaching. As such, Rienties et al. (2016) recommend training of principals and teachers on the essence of technology in teaching as this will change their attitudes and make them influence stakeholders for required support.

2.7 Literature Summary and Research Gap

This section has presented literature related to technology use in teaching and its impact on high school learner performance in biology. The chapter has also discussed the extent of technology access and use in teaching, principal and teachers' perception of the effectiveness of technology on students' performance as well as factors that determine successful integration of technology in teaching biology. Researchers overwhelmingly

agree that technology is beneficial in teaching as it facilitates knowledge acquisition through research, problem-solving and sharing thus improving students' interests and performance. They also cited lack of funds, teacher skills in ICT, principal and teacher attitudes, lack of reliable power sources and unstable internet connection as the major issues leading to low access levels and deployment of ICT in teaching. However, little studies have explored how the employment of technology devices affects learner performance, specifically in biology. Moreover, no such study has been carried out in Starehe Sub-county. Therefore, this dissertation sought to bridge this research gap based on data from this region.

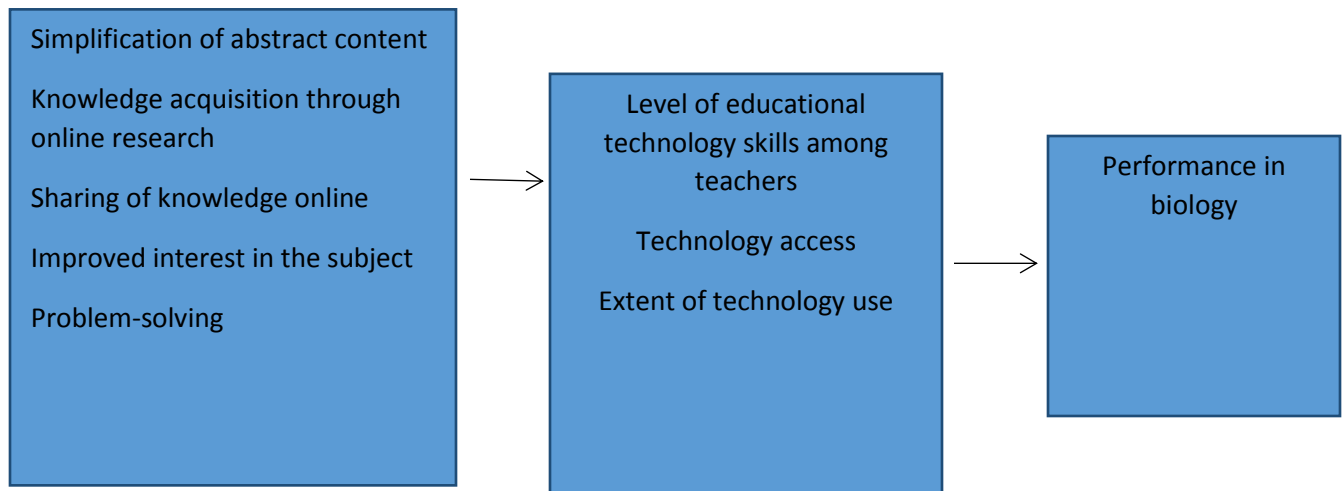
2.8 Conceptual Framework

Various factors interplay to influence the effects of technology on learner performance in biology. The figure shows the dependent, independent, and intermediary factors that influence the correlation between technology and performance.

Figure 1: Conceptual Framework

Independent variables
variables

Intermediary variables **Dependent**



(Author, 2019)

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the approaches deployed in this dissertation. The areas covered in this section include research site, study design, the population targeted, sample and the method used in sampling the population, research tools, as well as procedure employed in data gathering. The other sections include data analysis method as well as ethical matters taken into account in the study.

3.2 Research Design

KourGulzar and Bhat (2018) describe a study design as a manual that contains instructions on what the researcher did or will do to manipulate variables in a given research study. This study employed a descriptive survey design. According to KourGulzar and Bhat (2018), this research design involves description of traits of respondents in terms of their views, perceptions, or attitudes. This design was preferred as it provided answers and evidence to the research questions straightforwardly and simply as the research entailed the use of technology and its perception among respondents, which are accommodated by the design.

3.2.1 Variables

Research variables refer to the quantifiers in a particular study which are employed to offer directions as well as an index measure for the research findings of the research (Zeng, Fang, Lin, Huang, & Yao, 2019). This study consisted of dependent and independent variables. Zeng et al. (2019) define dependent variables as ones on which the study lays much interest. On the other hand, independent variables are the variables believed to affect or cause an effect on dependent variables (Zeng et al., 2019). In this study, the independent variable was the use of technology in teaching biology in high school while students' performance was the dependent variable. The intermediary variables included teacher skills in educational technology and access to technology. The study employed the correlation between the variables in Starehe Sub-county.

3.3 Research Method

The researcher used quantitative and qualitative research methods. The qualitative approach helped to capture respondent views and perceptions while the quantitative method helped in quantifiable data and their findings. A combination of the two allowed the researcher to obtain diverse and detailed data on presentation as well as the interpretation of the outcomes.

3.4 Research Site

The study covered public high schools in Starehe Sub-county. The region has diverse socio-economic status thus the outcomes were not twisted to any school economic level. Moreover, the region has all categories of public secondary schools including county, national, mixed day and boarding, and special schools.

3.5 Target Population

Hansen, Overgaard, Andersen, and Parner (2017) define the target population as all the subjects or items considered in a particular area of inquiry. The current study targeted high schools in Starehe constituency. The constituency has 13 schools. The researcher targeted participants in all the schools from which biology teachers and learners, as well as school principals, were chosen.

3.6 Sample and Sampling Techniques

Sampling alludes to the procedure of choosing a certain number of people for research from the larger target group or population to represent the entire population (Etikan, Musa,& Alkassim, 2016).According to Etikan, Musa, and Alkassim(2016), sampling offers a valid alternative where the researcher cannot cover the entire population due to time or budget constraints, especially when the findings of the study are needed quickly. Given that this research covered a wide population, sampling was appropriate. The current research deployed a purposive sampling method. That is, the purposive approach was employed in choosing principals and subject teachers. Etikan, Musa, and Alkassim (2016) approved the use of this method to ensure adequate representation of a given sub-sample.

3.7 Research Instruments/tools

Walliman (2017) outlines several primary data gathering methods including focus groups, questionnaires, interviews, and observation. In this study, the researcher employed observation to determine school access to technology, undertake in school computer rooms

and resource centers to determine the ratio of functional computers to biology students as well as their levels of operations. On the other hand, questionnaires were employed to gather important data from different participants from each school. Students' questionnaire sought to show their knowledge, level of interest in using technology, and their impact on performance in biology. Regarding teachers and principals, their questionnaire sought to establish their skills in educational technology and the frequency of its use in instruction, specifically biology. On the other hand, interviews helped to understand respondents' perceptions of the reliability of ICT tools in improving biology teaching.

3.8 Data Collection Procedures

Following the approval of the proposed research, several steps were undertaken to carry out the study. The dissertation was carried out between November 2019 and August 2020. After approval by the supervisor, the researcher physically visited the schools and requested to conduct the study. Upon acceptance by the schools, the teachers, principals, and students who were available during the study were contacted. Permission was then sought from each party and questionnaires and interview forms distributed to the sampled schools. The observation was made during the same day as the interview and filling of the questionnaires.

3.9 Data Analysis and Presentation

The researcher deployed descriptive content and quantitative data analysis methods. After receiving questionnaires from the participants, the data was sorted and those with incomplete information descanted (Nassaji, 2015). Qualitative data were analyzed based on a literature review to identify emerging issues based on research questions. The descriptive approach was employed to determine the extent of technology adoption as well as respondents' views of the use of ICT in teaching biology. The resulting quantitative data were analyzed quantitatively by presenting them in figures and tables for easier understanding and interpretation (Nassaji, 2015).

3.10 Ethical Considerations

This study involved people hence several ethical considerations were paramount. First thing, the target respondents were informed regarding the purpose and nature of the study thus allowing them to choose whether to partake in it or not as recommended by Hammersley (2015). To ensure confidentiality, interviews, and completion of

questionnaires undertaken in closed doors and was voluntary all the time. Privacy was also maintained by not including any personally identifiable data on the documents during the survey, the analysis of the data, or even publication. This also helped to maintain anonymity as suggested by Hammersley (2015). Respondents were also allowed to skip any questions or withdraw from the survey before completion as part of the requirements for ensuring the autonomy and liberty of participants.

CHAPTER FOUR

DATA ANALYSIS, RESULTS, AND DISCUSSION

4.1 Introduction

This chapter consists of the results of the study on the impact of technology on high school learner performance in biology. The chapter consists of an analysis of the data gathered via observation, questionnaires, as well as interviews.

4.2 Instrument Return Rate

The study targeted 17 participants; 7 principals and 10 biology teachers from the public schools involved. Notably, the schools had closed for the December holiday hence it was difficult to access students since teachers do not students' contacts. The respondents' characteristics considered in this study included age, gender, and education levels. The researcher issued 10 questionnaires to the chosen participants and got back 10 questionnaires. Notably, questionnaires were only used with teachers and interviews carried out with the principals of the 7 schools. The figure summarizes the response rate details.

Table 1: Response rate

Participants Category	Sample Population	Response Rate	Percent (%)
Principals	77	100	
Teachers	1010	100	
Total	1717	100	

(Author, 2019)

The response rate was 100 percent. The rate of response implies that the data gathered precisely met Patten (2016) recommended a response rate of at least 60 percent as adequate to conclude the assessment of the entire research area. Such a response rate was attained due to positive rapport that the researcher first established with the participants to instill confidence.

4.3 Demographic Data

The study involved both genders to avoid issues of biases. The gender parity of the participants was distributed as shown in table 3.

Table 2: Gender Parity of Participants

Gender	Principals		Teachers	
	Freq	%	Freq	%
Male	45	74.40	7	70.00
Female	34	25.60	3	30.00
Total	79	100	10	100

(Author, 2019)

Based on the results in table 3, the majority (57%) of the principals were males. Similarly, the majority (60%) of the biology teachers engaged in this study were male. Notably, the difference does not show any biases hence it did not affect the results in any way. Nonetheless, efforts should be made in future studies on this topic to ensure gender balance by using purposive sampling. The researcher also recorded the age of biology teachers and principals. The findings were as demonstrated below.

Table 3: Respondents' Age

Age (Yrs.)	Principals		Biology Teachers	
	Freq	%	Freq	%
29 and below	0	0	1	10
32-37	0	0	22	220
38-43	1	14.33	3	30
44-49	68	85.67	7	70
Above 50	0	0	1	10
Total	69	100	10	100

(Author, 2019)

Data in table 4 indicate that most (86%) of the school principals engaged in this survey were aged 44 to 49 years whereas the majority (30%) of biology teachers was aged 38 to 49 years. The researcher also considered the education levels of the respondents. A high number of participants had remarkable qualifications as indicated in table 6.

Table 4: Principals and Biology Teachers Academic Qualifications

Level of Education			
Principals		Biology Teachers	
Freq	%	Freq	%
Diploma	0	0	10
Bachelor's Degree	343	6	60
Master's Degree	457	330	
Total	7100	10	100

(Author, 2019)

Based on table 6, the principals and teachers in the region had diverse academic qualifications. The results indicate that the majority (57 percent) of the principals had masters' degrees whereas (43 percent) had bachelor degrees. On the other hand, most (60%) of the biology teachers had a bachelor's degree, 30 percent masters' degree, and the rest (10%) diploma. Given that the majority of the teachers have high qualifications, they have reliable knowledge of the use of technology in teaching and learning.

4.4 Technology Available for use in teaching Biology in Secondary Schools in Starehe Sub-County

The first objective of this research was to assess the availability of education technology in high schools in Starehe constituency. In addition to observation, the participants (principals) were asked to show the ICT tools available in their schools for teaching biology. Table 7 indicates the responses.

Table 6: ICT Facilities Available for Teaching Biology in the Schools

Facility	Freq Percentage (%)	
The Internet	571	
Desktops	7100	
Printers	7	100
Laptops	571	

(Author, 2019)

Table 7 indicates that secondary schools in the covered region had the most important ICT resources. All the secondary schools representing 100%, as reported by the school principals had desktops for study purposes. All three principals reported that their schools had functional printers representing 100 percent of the study sample. Further 5 of the 7 participants (principals) reported that their schools had some laptops as ICT instruction tools and these were also 71% of the sample study. The figure also shows that 5 of the 7 schools had Internet connection representing 71 percent of the principal participants.

Based on the results in table 7, most of the schools in the surveyed region had the technology necessary for instruction thus improving the use of technology in teaching biology might not be challenging. As Cuban and Jandrić (2015) stated, with schools having desktops or laptops and an internet connection, accessing quality teaching content and instructions can be easy hence making the subject interesting to students. Concurrently, Porter et al. (2016) asserted that the internet is crucial in seeking extra knowledge and researching online on new content and understanding how problems are solved. However, the study established that the internet connection in one of the schools was weak hence sometimes teachers preferred teaching using books to save time. Garba, Yusuf, and Busthami (2015) noted that despite having essential ICT tools, cases of limited access to the Internet limit the introduction of ICT tools in teaching since teachers have limited access to information and research platforms available online.

4.5 Level of Access to Technology in the Schools

Having technology resources does not imply that teachers and students can access the resources for teaching. Therefore, the researcher sought to establish the level of access to technology for teaching as well as learning in the surveyed schools. The question was posed to biology teachers.

The findings were as demonstrated in table 8.

Table 7: Level of Access to Technology in the Schools

Statement	Agree		Uncertain		Disagree	
	Freq	%	Freq	%	Freq	%
Biology teachers have 30% Computers, desktops, Internet and other technology Resources for teaching	7	70%	0	0%	3	
Students have access to 60% Technology and Internet For research in school	3	30%	1	10%	6	

(Author, 2019)

Table 8 illustrates that at least 7 out of the 10 biology teachers of the schools surveyed agreed that they had essential education technology including personal computers, desktops, Internet and other technology resources for teaching representing 70% of the sample study. However, the rest (30%) disagreed that they had access to educational technology. Only 3 (30%) of the teachers agreed that students have access to essential ICT tools for learning biology in their schools while the majority (60%) disagreed that their biology students can access essential ICT facilities for learning biology.

The outcomes as presented in table 8 demonstrate that the schools are aware of the benefits of technology in learning and enhancing performance in biology. As such, most of the schools surveyed have provided biology teachers with essential technology for instruction. However, most of the schools have not enabled learners to access the Internet and other important technology resources to search and acquire knowledge to enhance their performance in the subject. This implies that the schools do not involve learners in technology use in learning and this has adversely affected the overall performance of the learners in biology. The results are in line with findings of Chirwa's (2018) study who established that the high cost of ICT facilities and the Internet was the barrier to integrating

technology in learning in schools. Garba, Yusuf, and Busthami (2015) also noted that school principals, stakeholders, and teachers acknowledge the benefits of technology in enhancing school performance but lack of adequate capital to buy and maintain the technology resources prevents them from acquiring the tools.

4.6 Perception of Technology use in Teaching by Principals

Perception is an important indicator of whether or not teachers can effectively use technology in teaching. As noted by Machado and Chung (2015), if instructors perceive technology as useful, they will use it. Based on Machado and Chung’s (2015) view, the researcher examined principals’ perceptions of the usefulness of technology in teaching. The results were as shown.

Table 8: Principals’ Perception of Technology use in Teaching

Statement	Agree		Uncertain		
	Freq	%	Freq	%	Freq
Technology is useful in teaching	5	71%	2	29%	0
Technology can help to acquire knowledge hence making learning easy	6	86%	1	14%	0
The use of technology has improved students’ performance in biology	5	72%	1	14%	1

(Author, 2019)

Table 8 presents the views or perceptions of teachers on technology deployment in teaching, specifically teaching biology. Based on the outcomes, 5 principals representing 71% of the study sample agreed that technology is very useful in teaching and 2 disagreed with the statement. About technology use to acquire knowledge, 6 (86%) principals agreed that technology is an important tool for acquiring information thereby making teaching easy. However, 1 of them representing 14% of the study sample disagreed that technology helps acquire knowledge to facilitate learning. On the effect of technology on performance,

5 principals representing 72 percent of the sample agreed that technology can improve students' performance in biology, 1 (14%) of them were uncertain, and 1 (14%) disagreed with the statement.

From the results, it is clear that most teachers interviewed have positive attitudes on the use of ICT in teaching and learning. Ismail and Ibrahim (2018) assert that a positive attitude towards the technology deployment in teaching can make implementation easy hence improved students' performance. Concurrently, Nikolopoulou and Gialamas (2015) pointed out that increased teacher interest on technology use in teaching and positive attitude makes integration of technology in teaching easy. Similarly, a research by Gil-Flores et al. (2017) on teachers' attitudes towards ICT use and their perceptions towards the impact of ICT on performance in secondary schools of Chicago showed that teachers, including principals, had a positive impact on the reliability and effectiveness of technology in teaching. Gil-Flores et al. (2017) further concluded that academic qualification and computer experience influenced teachers' attitudes towards ICT. These findings, literature review and primary outcomes underscore the role of principals' perceptions and attitudes on ICT use in teaching. That is, attitudes and perceptions play a leading role in determining whether or not ICT is integrated and are determining factors on principals' motivation to integrate ICT or not.

4.7 Impact of Technology on Students' Performance in Biology

Students' use of technology in learning biology has increased their performance and interest in the subject (Crook, Sharma, & Wilson, 2015). One teacher said, "Technology enables learners to acquire field and laboratory skills in biology thereby making the subject easy." Another one added that "Technology helps learners to access useful notes on abstract concepts and guide the in problem-solving thereby helping them to get better grades in biology." In a consensus statement, another respondent underlined that "using technology increases students' motivation, interests, and performance." Technology also helps biology students to solve problems, discover learning topics, and get a solution to solutions in the process of learning thereby boosting their performance (Nikou & Economides, 2016). Finally, an empirical study reviewed that technology use in teaching helps biology learner access and share knowledge thus boosting performance in the entire class.

4.8 Factors that influence the Integration of Technology in Education

The study indicated that some factors affected the integration of technology in teaching in the surveyed schools. Some of the factors included lack of adequate funds to purchase and pay maintenance for ICT facilities, poor management of the available ICT resources, and irresponsibility of ICT facilities' users, both teachers and learners. The outcomes are in line with the literature review by Lai (2015) and McKnight et al. (2016) who underlined that teachers and learners should be accountable enough to care for the available learning and teaching resources in schools.

4.9 Interviews

Interviews were conducted with the principals of the 7 sampled schools and the following outcomes were compiled. On the accessibility of ICT tools for teaching, principals overwhelmingly said that capital is the major hindrance with most of the schools lacking adequate ICT facilities. One of them said, "I have only managed to buy ICT resources for teachers only and the maintenance cost is becoming a major challenge." Another principal said, "I bought adequate ICT resources a while ago but most of them now are not functional due to high cost of maintenance." Regarding the extent of ICT use in teaching, 6 of the principals representing 86% of the sampled population said that ICT use in schools was of average level during this study.

Overall, all the principals said that their schools had no adequate ICT facilities thus biology teachers were forced to share computers and desktops which led to wastage of time in preparations, instruction, and consequently low performance. Regarding ICT skills among teachers, all the principals said that they had encouraged all teachers to undertake part-time computer training courses and paid experts to train teachers within the schools. One of the principals said, "Most of my teachers can now use computers to search teaching materials online and are enjoying it."

The researcher also asked the principals of the surveyed schools on the major hindrances they faced in the schools in the acquisition and ICT deployment in teaching and how they plan to address the issues. One of the issues the principals mentioned include lack of adequate funds to buy the ICT facilities, change in technology in the country and globally, failure to take responsibilities by students, poor Internet access, and unreliable power sources in the region. The interview results are in line with literature review findings where,

McKnight et al. (2016) and Lai (2015) underlined poor internet access, unstable sources of power, and lack of funds as the leading hindrances to ICT integration in teaching, especially in developing countries. Lai (2015) also noted that high maintenance cost and lack of user responsibilities leading to demand discourages most school principals from investing in educational ICT facilities.

4.10 Observation

The researcher wanted to personally confirm the availability of ICT facilities for teachers and their functionality. In so doing, the researcher could identify the extent to which the teachers employed ICT in teaching biology. One of the tools observed was CPUs which found that 60 percent of them were functional while 40% were non-functional during the time of the study. On the other hand, 90% of the monitors in the schools were operational. The other item on the researcher's observation list was the laptops, printers, projectors, and smart boards. 85 percent of the laptops found in the schools were operational while only 45% of the printers were operational. Only one school had an operational smart board and four schools had operational projectors. From these findings, it is evident that a good number of the schools had the essential ICT facilities though it was not observed whether or not they use them in teaching biology. The results are in line with those of Hossain, Salam, Shilpi, and Officer (2016) who established that despite many secondary schools buying ICT facilities, they rarely use them in teaching on daily basis.

CHAPTER FIVE

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

5.1 Introduction

This chapter summarizes the results and presents the conclusion as well as study recommendations based on the study objectives which guided the whole research. The findings and analysis in chapter four inform the conclusions while the recommendations are based on the conclusions made following data analysis.

5.2 Summary of the Findings

5.2.1 Perceptions of Principals on the usefulness of technology in Teaching

The outcome of the study indicates that a significant proportion of respondents agreed that technology is useful in learning hence improving students' interests and performance not only in biology but also in other subjects. They also acknowledged that ICT training has improved their confidence in technology use in learning and teaching. The results further show that most principals have favorable attitudes towards the improvement of ICT despite facing various challenges on the acquisition, implementation, and maintenance. Scholars such as Machado and Chung (2015) and Al-Samarraie et al. (2018) underlined that; school principals' attitudes towards ICT deployment in learning play a key role in the successful integration of ICT in education.

5.2.2 Impact of Technology on Public High School Students' Performance in Biology

There was an overwhelming consensus among scholars that technology enhances students' interests and performance in a particular subject (Shute & Rahimi, 2017; McCutcheon et al., 2015; Crook, Sharma, & Wilson, 2015). That is technology help students acquire field and laboratory skills in biology. Technology, specifically the Internet helps students access simplified notes and solved problems thereby improving their performance. However, some students do not find biology learning interesting using technology. Using technology increases students' motivation, interests, and performance. Technology helps students to discover learning topics and get solutions to solutions in the process of learning thereby boosting their performance.

5.2.3 Extent of Technology Access and use in teaching

Research shows limited access to technology in most schools. Despite having ICT tools, instances of limited access to the Internet and unstable power sources limit the use of technology in teaching. Most schools, especially those in developing nations do not have access to reliable technology. Hossain, Salam, Shilpi, and Officer (2016) added that most schools in developing countries are in the initial stages of ICT integration in teaching hence limited access and use. Hossain et al. (2016) found that most schools in Kenya lack ICT while other schools with ICT facilities have not yet integrated it into teaching. Given poor access to ICT in most schools, the level of use of technology in teaching biology is also low.

5.2.4 Factors that Influence Integration of ICT in Teaching

The study revealed that some factors affected the integration of technology in teaching in the surveyed schools. Some of the factors included lack of adequate funds to purchase and pay maintenance for ICT facilities, poor management of the available ICT resources, and irresponsibility of ICT facilities' users, both teachers, and students. The findings are in line with the literature review by McKnight et al. (2016) and Lai (2015), who underlined that teachers and learners should be accountable enough to care for the available learning and teaching resources in schools.

5.3 Conclusion

Technology is essential in school. First, it helps students and teachers acquire knowledge through research on abstract concepts and problem-solving thereby making learning interesting. However, some schools are yet to buy adequate functional technology tools for use in teaching. In this regard, this study concludes that technology enhances students' interests and performance in biology. However, despite that most schools acknowledge the essence of technology teaching, most schools have not yet integrated technology in teaching to the expected standards. The delayed integration of technology is attributed to various factors including lack of adequate funds for purchase and maintenance as well as resistance by teachers.

5.4 Recommendations

Based on the results, the research recommends that proper technology should be provided to schools by buying the required ICT tools that require minimal maintenance to improve

biology teaching using current technology. Considering the lack of interest in biology among students, technology can make the subject interesting and easy by enabling learning to acquire knowledge on biology abstract content thus improving their performance in the subject. The study also recommends school principals to adopt fully ICT in teaching by encouraging students and instructors on the positive impact of ICT on performance. This step will enhance the extent to which ICT is integrated into teaching and learning in secondary schools across the nation.

Regarding factors that hinder effective use of ICT in teaching biology, the researcher recommends schools to find solutions to some of the issues by engaging students and teachers about ICT in the schools and also consult experts outside the schools. The school management should also ask for financial support from the national and county government to aid in the purchasing and maintenance of ICT facilities required for teaching.

- a) Further, the research concludes that school principals should facilitate the training of teachers to help them to gain the latest knowledge on the use of ICT in teaching.
- b) Finally, the study recommends principals and teachers have a positive perception of the utilization of ICT in teaching as this will make them invest more in other resources and time in the integration of ICT in teaching and learning.

5.5 Recommendations for Further Research

The researcher suggests that further studies should be carried out on factors that can improve access to technology for teaching in public secondary schools. Notably, this study only covered public schools in Starehe sub-county. Further studies on this topic should cover other parts countrywide to improve the integration of technology in all secondary schools.

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APPENDICES

Appendix I: Introduction Letter

Dear Participant,

RE: Questionnaire on Assessment of the Effect of Technology on High School Students' Performance in Biology

My name is Ungaya Sam Anyula a postgraduate student at the University of Nairobi pursuing a postgraduate diploma in Education. I am undertaking a study on the above topics part of the requirement by the University for this Course. Your Honest Assistance and co-operation in this regard are highly appreciated to enable me to complete the exercise. I have chosen you as an interviewee in this survey because you are in a better place to describe the impact of technology on students' performance in biology.

Therefore, I appeal to you to complete this questionnaire independently and objectively, with an assurance that all data collected will be treated confidentially. Thanking you in advance.

Yours sincerely,

Appendix II: Questionnaire for Biology Teachers

Kindly choose appropriate response by ticking or marking inside the box

Section A: Demographic Data

1. Gender

Female.....[] Male.....[]

2. Age Bracket

29 and below..... []

32-37..... []

38-43..... []

44-49..... []

Above 50.....[]

3. Highest Education Level

Diploma..... []

Degree..... []

Masters[]

Section B: Data on Technology use in the School

1.. Kindly indicate the technology device available for use in your school

Desktops.....[] CPU..... [] Laptops.....[]

Printers..... [] Internet cables [] Keyboard..... []

Smartboards.....[] Projectors.....[] Other.....[Specify]

2.. How do you rate the availability of technology in your school

Poor.....[] Average[] Good.....[]

4.. Give your level of agreement or disagreement with these statements

The use of technology enhances students’ interests and performance in biology

Agree.....[] Partially.....[] Disagree[]

The cost of technology hinders its successful integration in education

Agree.....[] Partially[] Disagree.....[]

5.. How frequently is the technology used in the following activities?

a) Teaching

Often..... [] Rarely [] Never..... []

b) Students' revision

Often.....[] Rarely[] Never..... []

c) Lesson preparations

Often.....[] Rarely[] Never..... []

Section C: Information on Benefits of Technology on Students' Performance and Factors that influence Technology use in Teaching

6.. Kindly show the extent to which these benefits have been attained from the use of technology

a) Technology promotes learning

Strongly agree [] Uncertain []

Disagree.....[]

b) Technology facilitates problem-solving

Strongly agree [] Uncertain []

Disagree..... []

c) Technology helps in acquiring and sharing knowledge

Strongly agree [] Uncertain []

Disagree..... []

d) Kindly list major factors that hinder the effective use of technology in teaching

.....
.....

Appendix III: Observation Checklist

1. Is there a computer lab (an information resource center)

Yes..... [] No..... []

If yes, how many? []

2. General comments on the extent of technology use in teaching biology

.....
.....

3. The proportion of operational hardware and software parts of the technology devices

Hardware/Software part	percentage of operational parts	Percentage of non-operational parts
------------------------	---------------------------------	-------------------------------------

CPU

Laptops

Printers

Monitors

Projectors

Internet cables

Keyboards

Smart boards

Appendix IV: Principals Interview Guide

1. How do you rate the use of technology in teaching in your school?

Low.....[] Average.....[] High.....[]

2. Apart from desktops what other technology devices for teaching are present in your school? List them

1.....

2.....

3.....

4.....

5.....

3. Is the computer laboratory in your school well equipped with functional technology devices?

Yes.....[]

No..... []

4. How many laptops and desktops are there in school?.....

5. What are their uses?

.....

6. Are they enough? Yes.....[] No.....[]

Why.....

.....

.....

7. Do biology students and teachers access technology devices for learning and teaching in your school?

Yes..... []

No.....[]

8. What are the main hindrances your school faces in the use of technology in teaching?

9. How can these challenges be addressed?

10. What is your view on the effects of technology on students' performance?