INFLUENCE OF INTEGRATION OF INFORMATION AND COMMUNICATION TECHNOLOGY IN TEACHING BIOLOGY ON STUDENTS' PERFORMANCE IN MAKUENI COUNTY SECONDARY SCHOOLS, KENYA

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DECLARATION

I declare that this Thesis is my original work and has not been presented in any other university/institution for consideration. This Thesis has been complimented by referenced sources duly acknowledged. Where text, data (including spoken words), graphics, pictures or tables have been borrowed from other sources, including the internet, they are specifically accredited and references cited in accordance with anti-plagiarism regulations.

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We confirm that the work reported in this thesis was carried out by the candidate under our supervision and was submitted with our approval as the university supervisors.

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DEDICATION

To the Almighty God for His unending Love, Peace and Grace, to my lovely wife Liz and my two handsome sons Baserell and Espirance for their patience, joy, understanding and encouragement. To my Dad Patrick, to my late mum Maggy and my Father and Mother in-laws, Daniel and Josephine who wished me to further my studies.

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ABBREVIATIONS AND ACRONYMS

CBL	Computer Based Learning
CD	Compact Disc
CD ROMS	Compact Disc Read-Only Memories
DVD	Digital Video Disc
EFA	Education for All
E-Government	Electronic Government
E-mail	Electronic mail
ICT	Information and Communication Technology
IT	Information Technology
KCSE	Kenya Certificate of Secondary Education
KESSP	Kenya Education Sector Support Program
KICD	Kenya Institute of Curriculum Development
MDG	Millennium Development Goals
MoE	Ministry of Education
MoEST	Ministry of Education Science and Technology
MoHEST	Ministry of Higher Education, Science and Technology
NACOSTI	National Commission for Science, Technology and Innovation
QASO	Quality Assurance and Standards Officer
SCDE	Sub-County Director of Education
SPSS	Statistical Package for Social Sciences
TAM	Technology Acceptance Model
TV	Television
UNESCO	United Nations Educational, Scientific and Cultural Organization

ABSTRACT

There are great technological advancements in global application of ICT and hence the need for its use in teaching Biology. Lack of application of ICT in pedagogy might have led to poor performance in science subjects like Biology. The study sought to investigate the influence of integration of ICT in teaching Biology on students' performance in secondary schools. The specific objectives of the study were: to find out the ICT resources available in the schools for use in teaching Biology; to examine the use of ICT in teaching Biology; to find out the challenges faced by teachers in integrating ICT in teaching Biology; to determine the attitude of teachers towards integration of ICT in teaching Biology and to establish whether the use of ICT in teaching Biology influences students' performance. The study was underpinned by Technology Acceptance Model which is an information systems theory that models how users come to accept and use technology. The study adopted a descriptive survey design. It targeted Form 3 Biology students, Biology teachers and the school administrators in Mbooni-East Sub-County secondary schools. The research used purposive and random sampling techniques to sample the respondents. To collect data, the study used questionnaires for students and Biology teachers, interview schedules for the school administrators and Biology teachers and observation checklists. Pilot study was conducted in a school which was not involved in the main study. The data collected was analyzed using SPSS and presented in tables, charts and graphs. The study found the main ICT resources used in teaching Biology as desk top computers, projectors, laptops and smart phones but some schools did not have any ICT. The study also found out that, though some ICT resources were available in teaching Biology, most of the teachers rarely used them or actively engaged their students in the use of the ICT in Biology. The study identified the main challenges faced in integration of ICT in teaching Biology as: Lack of or insufficient ICT; Poor electricity supply; Limited space or no laboratories present in the school; Lack of skill or knowledge in the use of ICT; Financial constraints in acquisition of ICT resources; Insufficient time in the use of ICT and inadequate ICT. Most of the teachers were found to have negative attitude towards the use of ICT in teaching Biology. All these affected students' performance which was found to be good when ICT was used. The study recommends: School administrators to ensure that there is a variety of ICT; Teachers to vary the use of ICT in every Biology lesson; Integration of ICT to be done in every Biology lesson for effective conceptual understanding; Teachers to be sensitized on the role of ICT integration in Biology; The school administration to ensure that there is equipped and spacious ICT Resource Centre; Need for regular workshops and seminars for teachers or in-servicing of teachers on effective integration of ICT in teaching Biology and consider ways of improving the teachers' attitude towards the use of ICT.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Integrating technology into curricula with the intent of positively influencing teaching and learning has been in a state of evolution over the past 20 years (Dias and Atkinson, 2001) which to-date (2020) is now over 40 years. It is worth mentioning that there are rapid technological changes and global communication in the 21st century (Jamieson-Proctor, Burnett, Finger and Watson, 2006). Ajayi and Ojo (2010) clearly pointed out that the world is in the era of ICT where information is not restricted by time, space and channel. In this connection, Bransford, Brown and Cocking (2000) noted that computers began to be placed in schools in the early 1980s and several researchers suggest that integration of ICT will be an important part of education for the next generation.

Rana (2009) pointed out that ICT holds the key to modernizing of information services in the society and hence modernizing classroom practices. ICT is said to be important for kick-starting the ailing economies and in assisting development of the developing societies, including those groups that have lost out of the mainstream of development (Obijiofor, Inayatulla, and Stevenson, 2005). According to Adomi and Kpangban (2010), ICT are electronic technologies which are used for information storage and retrieval. Krubu and Osawara (2011) asserted that technological advancement of the past twenty-five years such as the electronic database, online services, CD-ROMS and introduction of internet has radically transformed access to

information. Computer is certainly one of the most versatile and ingenious developments of the modern technological age (Kothari, 2004) and Reid (2002) indicated that the use of ICT such as Internet applications, CD-ROMs, video technology, various computer attachments and software programs have caused many changes in society. Therefore, there is need for ICT to be used in schools for teaching and learning. The appearance of ICT in schools through improved provision of computer hardware, infrastructure and connectivity should therefore not be seen as an isolated example of change (Jamieson-Proctor, Burnett, Finger and Watson, 2006).

The ability to work with ICT is recognized as one of the key competencies necessary for success in life and for competition in the labour market (Salganik, 2001 and Eurydice, 2002). Thus, it is important for everyone to possess ICT skills. In this case, many countries now regard the mastering of the basic skills and concepts of ICT as an inevitable part of the core of education (African Virtual University, 2012).When scientists first started programming computers to interpret images they expected to make rapid progress in life (Glasbey and Horgan, 1995). This was therefore expected to be translated into education. According to Kothari (2004), problem solving is an age old activity, and so the development of electronic devices, especially computers has given impetus to this activity.

Andres and Roland (2006) observed that, with the advances in IT, fast inexpensive computer power, global networking, infrastructure and comprehensive databases, Mathematical modeling and simulation of complex Biological processes have become increasingly important and feasible. This makes learning of scientific

concepts easy and students can easily understand the concepts. Elisha (2011) pointed out that while ICT continues to advance in Western and Asian Countries, African countries still experience a lag of its implementation and thus this continues to widen the digital and knowledge divides. ICT in schools is has two important roles, first are to fulfill the expectations of the society for demanding ICT skills, and second, to raise the quality of education in the schools with the support of ICT (Sorgo, Verckovnik and Kocijancic, 2010). Therefore, the use of ICT is a major requirement in the society's day to day activities and globalization. ICT is working through schools; it is a major requirement for everyday life and plays an important role in society globalization (Kubiatko, 2006). ICT is therefore perceived as important in fulfilling the society's expectations of ICT skills and helps in improving the quality of education.

According to Watson (2001), technologies have the potential to support education across the curriculum and provide opportunities for effective communication between teachers and students in ways that have not been possible before. ICT should be used as a tool to support the educational objectives such as skills for searching and assessing information, co-operation, communication and problem solving which are important for preparation of children for knowledge society (Drent and Meelissen, 2007). Vogt and Johnson (2005) indicated that there are computer simulations which involve using a computer to build a model of what would happen in the real-world situation under certain conditions. In addition to this, ICT play a key role in student skills, motivation and knowledge and can be used to present information to students and help them complete learning tasks (Grabe and Grabe, 2007) and therefore making learning simple.

However, despite significant investment in training and resources, in reality schools are still far below the level of the use of ICT in teaching and learning science (Machin, McNally and Silva, 2007; Eteokleous, 2008). Kenya promulgated a National ICT policy in January 2006 that aims to improve the livelihoods of Kenyans by ensuring the availability of accessible, efficient, reliable and affordable ICT services (Farell, 2007). The ICT policies in Kenya and vision 2030 have the use of computer assisted learning clearly defined and the MoE is mandated to work with stake holders to achieve this goal (Mwangi, Nozaki, Ejima, Umeda, 2013). Kenya launched its five year ICT master plan on February 2014 with the main focus being to transform the country into a knowledge-based economy and the regional technology hub (Ochieng', 2014). According to Otieno (2015), the Ministry of Education, in conjunction with the KICD, is in the process of undertaking comprehensive curriculum reforms to align it with competency development and also incorporate ICT.

However, the universal implementation of the ICT policy is challenging given the lack of sufficient ICT resources, national ICT infrastructure and even electricity supply particularly in the rural areas (Farell, 2007). The Government has put in place the National ICT policy and e-Government strategy that provides guidelines for transformation of Kenya into a digital society (Ministry of Education, 2006). In addition to this, the MoE developed a KESSP in 2005 that featured ICT as one of the priority areas with the aim of mainstreaming ICT into the teaching and learning processes (Farell, 2007). The Government is also ensuring that every school including those that are in rural areas get electricity supply (Mwangi, Nozaki, Ejima,

Umeda, 2013). KICD had an ambitious task of developing a learner content management system with the government mission of a laptop per every child. Farell (2007) also indicated that the National ICT Policy embedded this intent as a national priority and provided the impetus in order for the Ministry of Education to develop its sector policy on ICT in education.

ICT has become one of the fundamental building blocks of the modern society (African Virtual University, 2012) and thus the use of ICT for instructional purposes has become a need for training individuals. Sabina (2012) noted that there was growing concern of ICT resources like computers, scanners, multimedia computers and projectors, internet, videophone systems, video and teleconferencing devices etc for use in education. In addition to this, Kingori (2016) indicated that educators are turning to cloud technology to enhance learning in children and prepare them for a highly advanced global economy that relies on rapid technological advancement and innovation.

In fact, it should be noted that it is important to improve the use of ICT to make teaching of Biology more attractive and interactive to the learners (Kubiatko, 2006). According to Volman and Van Eck (2001), the use of ICT creates a powerful learning environment and transforms the teaching and learning processes in which students deal with knowledge in an active, self-directed and constructive way. Kenya has made a remarkable progress by putting in place ICT policy frameworks and implementation strategy, complete with measurable outcomes and time frames (Farell, 2007). Acikalin (2014) pointed out that the use of Instructional Technologies

in Education has been widely discussed with advancement of new technologies which can be used in teaching Biology.

However the use of ICT in teaching Biology is not clearly defined in secondary schools in Kenya although Biology is a major field in science. This has resulted to learners who are irrelevant to the ICT world. The traditional chalk and chalkboard is commonly being used in classroom teaching. There is therefore need to change and make teaching of Biology more attractive and interesting by use of ICT. Yapici and Hevedanli (2012) indicated that Biology includes complex relationships of unfamiliar and abstract concepts which are quite difficult to learn and teach and hence the use of ICT is increasingly important. This study was interested with the students' performance in Biology in KCSE which has been poor from the year 2013 to date. The study focused on performance in Biology which has also been poor in Mbooni-East Sub-county. Table 1.1 presents the KCSE results from the year 2013 to 2018 both at the Sub-county and National level.

Table 1.1: Overall Performance in Biology in Mbooni-East Sub-County and the National Performance in the Years 2013, 2014, 2015, 2016, 2017 and 2018

	YEAR	2013	2014	2015	2016	2017	2018	AVERAGE
MBOONI-EAST SUB-COUNTY	MEAN SCORE (%)	37.8	38.2	36.9	23.6	22.7	22.8	30.3
	MEAN GRADE	D-	D-	D-	E	E	E	E
NATIONAL PERFORMANCE	MEAN SCORE (%)	31.6	31.8	34.8	29.2	18.9	-	29.3
	MEAN GRADE	E	E	D-	E	E	-	E

Source; SCDE's Office (2019) and Year 2017 KCSE Kenya National Examinations Council Report (2018)

It may not be clear the exact reason why the students' performance in Biology has been continuously poor but it could be that one of the greatest contributors to this situation was lack of or inadequate integration of ICT in teaching Biology. Therefore, there was need for this study to be conducted to establish whether the integration of ICT was being sufficiently and effectively done in teaching Biology. This study was interested in investigating the influence of integration of ICT in teaching Biology on students' performance in Biology specifically in Mbooni-East Sub-county, Makueni county although it could also have been conducted in other sub-counties.

1.2 Statement of the Problem

Biology as a subject in secondary schools is important, for example, it helps in understanding humans and their biotic and abiotic environment in order to live successfully. But students' performance in Biology in National examinations has been poor from the year 2013. Integration of ICT in teaching sciences has been effective in the recent years. Van Rooy and Wilhelmina (2012) observed that the ubiquity, availability and exponential growth of ICT create unique opportunities for teaching Biology. The use of ICT is intended to facilitate teachers in teaching more effectively and enhance students' understanding of concepts resulting to good performance (Omollo, Indoshi, and Ayere, 2013). Therefore, when ICT is used, learning becomes interesting, attractive and learners become more relevant and competent resulting to good performance. Introduction of ICT in Biology lessons raises the level of knowledge and students attitudes towards Biology (Kubiatko and Halakova, 2009) resulting to good performance.

In consideration of the importance of integration of ICT in teaching sciences and by the fact that the performance of students specifically in Biology has been poor, it was imperative that a study be conducted to establish whether the integration of ICT is being sufficiently and effectively done in teaching Biology. The performance in KCSE Biology examinations in Mbooni-East Sub-county has remained poor from the year 2013 with percentage mean scores of 37.8, 38.2, 36.9, 23.6, 22.7 and 22.8 in the years 2013, 2014, 2015, 2016, 2017 and 2018 respectively resulting to average mean score of 30.3. Although nationally, the performance is still poor (refer to Table 1.1), there was need for the research to be conducted in the Sub-county. Mbooni-East Sub-county was chosen because it's a new Sub-county and no research of this nature has been conducted. In addition, the study was interested with the Sub-county due to the poor performance in Biology in the secondary schools. The study could also have been done in other Sub-counties but was done in Mbooni-East Sub-county. The study was therefore conducted to investigate the influence of integration of ICT in teaching Biology on students' performance in Mbooni-East Sub-county, Makueni County.

1.3 Purpose of the Study

The main purpose of this study was to investigate the influence of integration of ICT in teaching Biology on students' performance in secondary schools in Mbooni-East Sub-county, Makueni County, Kenya.

1.4 Objectives of the Study

The study was guided by the following specific objectives:

a. To find out the ICT resources available in the schools for use in teaching Biology.
b. To examine the use of ICT in teaching Biology.
c. To find out the challenges faced by teachers in integrating ICT in teaching Biology.
d. To determine the attitude of teachers towards integration of ICT in teaching Biology.
e. To establish whether the use of ICT in teaching Biology influences students' performance in Biology.

1.5 Research Questions

This study was guided by the following research questions.

a. Which ICT resources are available for teaching Biology in secondary schools in Mbooni East Sub-county?
b. Do teachers integrate ICT in teaching Biology?
c. What challenges do teachers face when integrating ICT in teaching Biology in secondary schools?
d. Do Biology teachers in Mbooni-East Sub-county have negative or positive attitude towards the use of ICT in their teaching processes?
e. Does the use of ICT in teaching Biology influence students' performance in Biology?

1.6 Significance of the Study

The study findings will be significant to the teachers because it might be an eye opener in imparting ICT skills and in promoting computer literacy among the teachers and learners. The findings might also help in guiding the teachers and even the learner's attitude towards use of ICT in teaching and learning. The results of this study might be helpful to the ministry of education in guiding decision in policy making and in the process of ensuring quality of teaching and school management. It will also encourage the ministry of education to improve on its ICT infrastructure in the schools and encourage in the structuring of the teacher training programs on ICT pedagogies in teaching and learning. The findings and suggestions of this study will also add to the already existing literature in the field of integration of ICT in teaching Biology.

1.7 Scope and Limitations of the Study

The study was conducted within the following scope and limitations.

1.7.1 Scope of the study

The study confined itself to influence of integration of ICT in teaching Biology on students' performance in secondary schools. The study focused on the integration of ICT by teachers in teaching Biology. The study did not consider examining the integration of ICT in teaching other sciences since these might require a different type of study all together. Further, the study was conducted only in Mbooni-East Sub-county. It would be better for this study to be carried out in the whole country but due to the limitations detailed hereunder, the study was only done in this Sub-county.

1.7.2 Limitations of the Study

This study was conducted under the following limitations.

a. Given the poor road conditions in the county, there was a problem of accessing some of the schools selected for this study and therefore the collection of accurate and in-depth data for the purpose of the study took longer time than was expected. This might have affected the control of some extraneous variables which could have otherwise been controlled better within the stipulated time for the study.

b. The study used the descriptive survey design. Though this design is useful where it is not possible to test and measure the large number of samples needed for more quantitative types of experimentation which was the case of this study, it has some weakness. For instance, because there were no direct variables manipulated, there were no in-depth statistically analyzed results. In addition, the result of the observational studies is not easily repeatable and so there should be a more careful generalization of the result of this study.

c. This study was conducted by a part-time researcher. The implication was that the researcher was faced by both time and finance constraints.

   This means that the study could have been exhaustive and probably conducted in a wide locale for the purpose of generalization of the results if the researcher was not faced by the constraints.

1.8 Assumptions of the Study

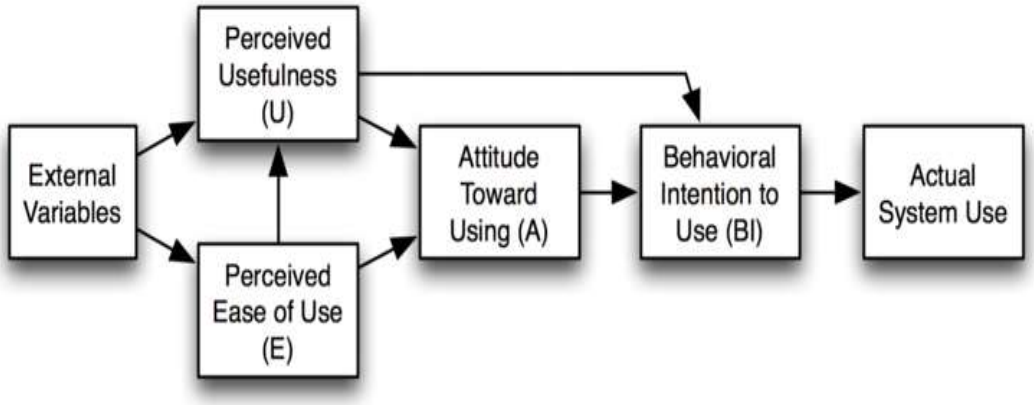
The study was done based on the following assumptions:

a. That there were ICT resources available in the schools for teaching Biology.
b. That the Biology teachers were using ICT in teaching Biology.
c. That there were some challenges faced by teachers in integrating ICT in teaching Biology.
d. That the Biology teachers had certain attitudes on integration of ICT in teaching Biology.
e. That students' performance in Biology was good when ICT is used in teaching Biology.

1.9 Theoretical Framework

Theoretical framework is a collection of interrelated ideas based on theories; a reasoned set of predispositions derived from and supported by data or evidence (Kombo and Tromp, 2006). This study was underpinned by Technology Acceptance Model (TAM) by Davis (1989). The TAM is an information systems theory that models how users come to accept and use technology; it suggests that when users are presented with technology, a number of factors influence their decision about how and when they will use it (Davis, Bagozzi and Warshaw, 2015). This theory helps to measure perceived usefulness and ease of use as predictors of a user's intent to use ICT. Davis, Bagozzi and Warshaw (1989) construed that technologies like computers are complex and there is uncertainty in peoples' mind with respect to their successful use; People form attitudes and intentions towards trying to learn the use of the technology.

The study was concerned with integration of ICT in teaching Biology and so this theory was relevant to the study. The Biology teachers might have been introduced to ICT to use in teaching Biology and therefore they might have formed different attitudes towards the use of the ICT in their teaching processes. The suitability of the TAM in predicting the general teachers' acceptance in teaching should be explored. The model (figure 1.1) helped to explain the process the teachers undergo in using ICT in pedagogy.

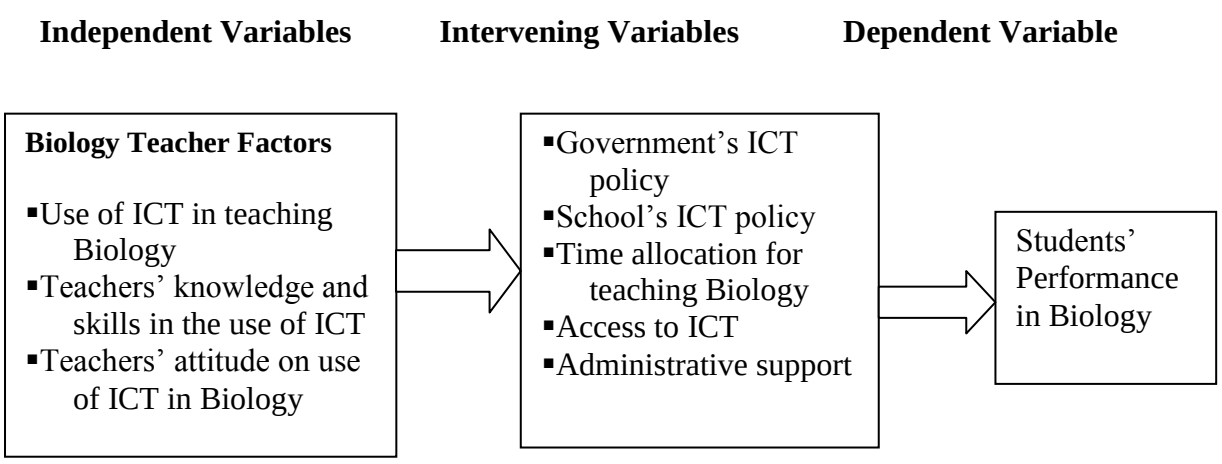


Source: Davis, Bagozzi and Warshaw (1989)

Figure 1.1 Technology Acceptance Model (TAM).

1.10 Conceptual Framework of the study

A conceptual framework is a model of presentation where a researcher presents the relationship between variables in the study and shows the relationship graphically or diagrammatically (Orodho, 2009). The conceptual framework (Figure 1.2) shows the way the variables of this study interacted.



Source: Researcher designed (2019)

Figure 1.2 Conceptual Framework of Integration of ICT in teaching Biology

Performance of students in Biology is influenced by several factors some of which operate independently (independent variables). As shown in figure 1.2, adoption of ICT in teaching Biology will depend on the school and the Biology teachers. The independent variables for this study include teachers' use of ICT in teaching Biology, teachers' knowledge and skills in the use of ICT and teachers' attitude on the use of ICT in teaching Biology. The intervening variables for the study are the Government ICT policies and the school factors like the school's ICT policy, time allocation for teaching Biology, access to the ICT and the administrative support on the use of ICT in teaching Biology. They influence the adoption of technologies by the teachers and the school and so affecting integration of ICT in teaching Biology. The dependent variable is the students' performance in Biology Examinations.

Use of ICT in teaching improves the learning outcomes by making the learning processes more interesting, easy and attractive and therefore raising the learner's motivation towards learning Biology. In this regard Volman and Van Eck (2001)

stated that “their use creates a powerful learning environment and transforms the teaching and learning process in which students deal with knowledge in an active, self-directed and constructive way”. Omollo (2013) also noted that the use of ICT is intended to facilitate learning more effectively and enhance students’ understanding of concepts which are expected to translate into expansion of knowledge and improved examination outcomes. In addition to this, Aina (2012) observed that methods of teaching have gone beyond the traditional method of talk and chalk and hence Shedd (2004) indicated that anyone preparing to become a teacher must incorporate technology in the classroom. Drent (2005) concluded that innovative use of ICT can facilitate student centered learning, hence easy understanding of concepts resulting to good performance.

1.11 Definition of Terms

Attitude- Perception of person(s) towards something or complex mental state involving beliefs and feelings and values and dispositions to act in certain ways.

Biology- A science subject that deals with the study of living things.

Communication-Transfer/exchange of information from one person to another/from one place to another/: transfer of ideas, thoughts and messages from a sender to a receiver.

Computer-A device used to process information and to perform calculations by using specific programs.

Data- Information which is collected by a researcher from respondents.

Descriptive Research Design- Its where the researcher investigates views of respondents/collection of data by administering questionnaires or by interviews.

Form 3- A class of students in their third year of learning in a secondary school.

Information and Communication Technology (ICT) - are Computers and related electronic devices and media.

Instructional Technology- It is anything a teacher uses to help the learner acquire new dispositions or master concepts, retain, retrieve and use the knowledge, skills and values to solve problems in real life situations.

Integration- The act of incorporating: for example, incorporating ICT into teaching.

Population-This is the total number of respondents under study.

Sample- It is a subsection of a population, which is chosen in such a way that its characteristics reflect those of the entire population from which it is chosen.

School Administrator-Is the person in charge of the running/management of the secondary school. Can be the Principal, Deputy-Principal or the Senior Master

Sub County Director of Education (SCDE) - Is the officer in charge of Education in a Sub-County.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter is concerned with review of the literature relevant to the study. The literature presented here focuses broadly on the research done worldwide on integration of ICT in teaching. The focus was on the following questions: (a) Which ICT resources are available in the schools for teaching Biology in the secondary schools in Mbooni East Sub-county?, (b) Do teachers integrate ICT in the teaching Biology?, (c)What challenges do teachers face when integrating ICT in teaching Biology in the secondary schools?, (d) Do Biology teachers in Mbooni-East Sub-county have negative or positive attitude towards the use of ICT in their teaching processes?, (e) Does the use of ICT in teaching Biology influence students' performance in Biology?

The literature is organized into the following sections based on the objectives of the study: (a) ICT resources available in the study schools, (b) The use of ICT in teaching Biology (c) Challenges faced by teachers in integrating ICT, (d) Attitude of teachers towards integration of ICT in teaching Biology and (e) Influence of the use of ICT in teaching Biology on students' performance in Biology. The chapter ends with a summary of the existing gaps in literature that served as the focus for the study.

2.2 ICT resources available in teaching Biology

Research reveals the availability of a variety of ICT resources that can be used in teaching Biology. Sarkar (2012) stated that ICT are hardware, software, networks and media for collection, storage, processing, transmission and presentation of information (voice, data, text, images) and related services. According to Torruam and Abur (2013), ICT resources are information handling tools that are used to produce, store and process, distribute and exchange information. UNESCO (2006) also highlighted some of the available ICT resources like radio, television, video, DVD, phones, satellite systems, computer and network equipment and software as well as the equipment and services provided by these technologies like video-conference and electronic mail. Valasidou (2008) indicated that there are different kinds of ICT implemented at teaching and learning such as tele-conferencing, video-conferencing and e-learning tools. Sabina (2012**)** noted that there was growing concern of ICT resources like computers, scanners, multimedia computers and projectors, internet, videophone systems, video and tele-conferencing devices etc.

According to the recommendations of Kubiatko (2006), all schools should be equipped with software and hardware including educational discs of Biology, establishing ICT rooms for Biology teaching etc. Vogt and Johnson (2005) also recommended the use of computer programs which involves set of instructions written in a form a computer can read ("machine readable") that tell it how to perform specific tasks. ICT tools include computer laboratory networks, digital microscopes with sensors for science subjects like Chemistry and Biology, data show/projectors, electronic whiteboards, digital cameras, audio visual devices and

soft-wares to allow for distributed teaching amongst networked computers (Osama, 2008). Others include the smart phones, ordinary mobile phones, digital televisions, laptops, smart boards, iPads and tablets, scanners, printers, internet, wireless application protocols(WAP),videophone systems, tele-conferencing devices, radio and microwaves, television and satellites, multimedia computer and projector.

The curriculum content can also be in the form of texts and visuals like pictures, posters, audio-visual multicolor images and videos, maps, and graphics which can be simultaneously presented to the students while in class. According to Kingori (2016), teachers and students can interact through web-based portals and access the latest curriculum content with the help of e-learning platforms through personal computers, laptops and tablets. He further states that with the help of webcams and applications like Skype and Zoom students can exchange ideas online and even take exams in real time. Bingimlas (2009) observed that in order to have excellent integration of ICT in teaching, teachers should be provided with ICT resources including software and hardware, effective professional development, sufficient time and technical support. Ouma (2015) pointed out that tablets-for-schools programme can revolutionize learning and Kingori (2016) supported this by stating that with tablets, teachers can direct students to various educational resources such as web links and case studies during class.

This section dealt with the question: Which ICT resources are available for teaching Biology in secondary schools? The glaring findings were that there were some ICT resources which can be used in teaching Biology. So this study was justified to gather information from Biology students, Biology teachers and the administration

from the study schools to find out the ICT resources available in secondary schools for teaching Biology in Mbooni-East Sub-county. At this point, one would also be eager to find out what research has found on the use of ICT in teaching Biology. The following section looks at what researchers and scholars have said about the use of ICT in teaching Biology.

2.3 Use of ICT in teaching Biology

Research confirms that ICT is to some extent used in teaching Biology. Basri, Alandejani and Almadani (2018) confirmed that application of ICT has become a critical part of the learning process. According to Afshari et al (2009), ICT is seen as an important instrument to support new ways which can be used in teaching Biology but it is not regarded as a tool to replace the existing teaching methods. Van Rooy and Wilhemina (2012) indicated that use of ICT creates unique opportunities for teaching Biology. Following the observations of Aina (2012), methods of teaching have gone beyond the traditional methods of talk and chalk and therefore according to Valasidou (2008), ICT is generally accepted as a modern instructional tool that enables the teachers to modify their teaching methods in order to increase the students' interest in Biology. In addition to this, Van Rooy and Wilhemina (2012) stated that digital technologies have made it possible for the emerging knowledge in Biology and in better understanding of Biological processes which were previously too small or too large, too slow or too fast or even too complex to be taught.

Science is dynamic and new discoveries are coming up every day in science and in teaching methodology and thus we can benefit from these developments when we

are connected to the world through ICT (Aina, 2013). Teacher accounts emphasized both the use of ICT to enhance and extend existing classroom practice and change in terms of emerging forms of activity which complimented or modified the classroom practice (Hennessy, Ruthven and Brindley, 2007). Therefore, problems which could not be solved earlier due to sheer amount of computations involved are now tackled accurately and rapidly with the aid of computers (Kothari, 2004). Aina (2013) indicated that computers help students to visualize objects that are difficult or impossible to view; for example, they can be used to display human anatomy, internal structure of human and animal cells, reproductive systems in Biology. Indeed, much of Bioscience can now be effectively taught via digital technology, because its representational and symbolic forms are in digital formats (Van Rooy and Wilhemina, 2012). ICT does not replace learning but it is a critical factor that allows teachers to tap into students' differentiated potential.

Abichandani (2012) clarified that ICT simulations can be used in science education for understanding of theories, principles, ideas and concepts. Examples of such simulations in Biology are population Biology simulations like natural selection simulation (Holsinger, 2014), simulated Virtual Electron Microscope which can be used for practicing magnification calculations (Word Press.com, 2014) and interactive three-dimension animations of the human body (Flores, 2014). Through the use of ICT, ideas can be shared globally and this can help to support schools in Kenya to improve learning and hence improved academic performance. Wainaina (2016) was categorical that modern learning integrates ICT and we must let-go-off the old pedagogies since the real transformative potential of ICT in education lies in evolving new and modern approaches of teaching.

ICT is usually perceived as a catalyst for change in teaching style, learning approaches and change in access to information (Watson, 2001). Software developers are coming up with computer applications that aim at capturing the attention of the learner and also help the teacher to make teaching more interesting and interactive (Wamari, 2014). Bingimlas (2009) observed that the use of ICT in the classroom is very important in providing opportunities for students to learn to operate in an informative age. Aina (2013) also observed that effectiveness of teaching is required in science education through the use of ICT. Computer simulations are used in a wide variety of fields (Vogt and Johnson, 2005) and so Shedd (2004) emphasizes that anyone who is preparing to become a teacher must incorporate technology in their class. It is worth noting that, ICT are important instruments, which can transfer the present isolated, teacher-centered, book-centered learning environment into a rich student-centered environment (Dash, 2007).

Van Rooy and Wilhemina (2012) indicated that if professional development opportunities are provided where the pedagogy of teaching Biology and its digital representations are available, then teachers see the immediate pedagogic benefit to student learning. According to the observation of Kothari (2004), "people use computers in almost every walk of life". Abichandani (2012) recommended that ICT has to become as important as literacy in language and mathematics. Therefore ICT is an indispensable part of the society since it allows access to information anywhere in the world, promotes networking that is not restricted to boundary, language and culture and fosters communities' empowerment and spread knowledge (Adebayo, 2010).

According to Kariuki (2014), science teachers have extensively integrated digital sources like power point slides and video clips available for free in the internet. The application content is spiced with animations, videos, songs, music, games, and quizzes to make learning process more interactive, interesting, fun and engaging for students (Merab, 2014). Selinger (2004) observed that ICT can improve the quality of education because multimedia content helps to illustrate and explain difficult concepts in ways that were previously in-accessible through traditional teaching resources and methodologies. The provision of connected devices in school allows students to develop inquiry skills, which are highly necessary in navigating the world's knowledge economy. Therefore, given the varying backgrounds of students, technology promoted sharing; those with extra gadgets can be encouraged to assist their schoolmates.

Abichandani (2012), further recommended that biological systems, industrial chemical plants and concepts such as radioactive decay and interactions within ecosystems, populations and food chains can be explained using CD ROMS which are available with interactivity. According to Kingori (2016), learning is also made more interactive with educational videos, which Biology teachers can download and share with their students on their tablets. Wainaina (2016) stated that pedagogical approaches in a modern classroom include but are not limited to inquiry based or investigative learning, flipped classrooms, peer instruction and active learning which can be effectively used in teaching Biology.

Improving the use of ICT, information about how to apply personal computers, digital projectors, camcorders and digital cameras among others, is important for

teachers (Kubiatko, 2006). There are Soft-wares which are already developed which show actions of viruses and bacteria which if the teacher were to teach about these micro-organisms they cannot be learnt well without seeing them in action (Aina, 2013). Therefore, Abichandani (2012) pointed out that the teachers of the future must not only be accomplished in the use of ICT but also integration of ICT into their teaching processes. Wainaina (2016) noted that there is need for a consensus on the need to transform and modernize the way we are teaching the next generation since practice of ICT revolves around transformation of pedagogy rather than merely integrating ICT in teaching. Based on the recommendations of Mwunda and Ogutu (2018), there is therefore need for the government to develop policy guidelines on integration of ICT in teaching and learning processes.

This section dealt with the question: Do teachers integrate ICT in teaching Biology? With respect to the studies reviewed in this section, one would argue that ICT is to some extent used in teaching Biology. It would therefore be interesting to conduct a research to examine the extent into which ICT is used in teaching Biology in Mbooni-East Sub-county. At this point it would also be important to find out from research the challenges faced by teachers in integrating ICT in teaching Biology. The following section reviews what scholars and researchers found out on the challenges faced in integrating ICT in teaching Biology.

2.4 Challenges faced by teachers in integrating ICT in teaching Biology

Research shows that there exist some challenges in the integration of ICT in teaching Biology. Khalid (2009) highlighted the major challenges to ICT integration

among teachers as lack of confidence, lack of competence and lack of access to resources. A research done by the School of Business and Management Studies at Technical University of Kenya confirms a glaring shortage in Information Systems Analysis (ISA) despite the large pool of the country's ICT workforce (Kairu, 2014). Microsoft worldwide Education vice-president, Anthony Salcito asserted during his keynote statement at an official opening of a forum that a good chunk of the present generation of learners all over the world is already exposed to ICT devices and applications that give them access to all manner of information outside learning environments (Wamari, 2014).

The universal implementation of the ICT policy in Kenya is challenging given the lack of resources, national ICT infrastructure including electricity supply particularly in the rural areas (Farrell, 2007).

There are also problems like poor policy and project implementation strategies and poor infrastructure which militate against the efforts in ICT integration in schools (Torruam and Abur, 2013). In addition to this, Manyindo and Muthini (2014) highlighted challenges like computer illiteracy among most teachers making handling of the ICT difficult, insecurity of the ICT and hence the need for a strong room for storage of computers and laptops and finally lack of electricity to run the ICT. According to Buabeng-Andoh (2012), it is believed that if teachers perceived technological programs as neither fulfilling their own needs nor the students' needs, they will not integrate the technology into teaching and learning.

According to the findings of Aladejana (2008), various barriers to ICT use in African schools have been identified. They include poor infrastructure, epileptic

power supply, lack of electricity, lack of trained personnel, poverty, inadequate funding and limited or no internet access. Bingimlas (2009) also identified the major barriers to successful integration of ICT in teaching among teachers such as lack of confidence, lack of competence and lack of access to ICT. The study findings of Obijiofor, Inayatulla, and Stevenson (2005) identified challenges to use of ICT in teaching as issues of infrastructural support, access to the ICT, training and skills development and hierarchical social relations which determine who has access to ICT. Elisha (2011) noted challenges that face integration of ICT in Kenyan schools as lack of qualified teachers to teach ICT in school, lack of computers, lack of electricity, computers are still expensive in Kenya, broken down computers, burglary, fear by the teacher, and lack of internet or slow connectivity, lack of initiative by community leaders, obsolete computers and increased moral degradation. Therefore, Bitok (2014) recommended training of teachers who are not ICT competent so that they are able to use the various ICT used in teaching and learning Biology. This is because lack of skills in using ICT is one of the reasons why teachers do not use ICT in teaching and learning Biology (Kubiatko, 2006).

This section dealt with the question: What challenges do teachers face when integrating ICT in teaching Biology? From the studies reviewed in this section, several challenges have been identified in the integration of ICT in teaching such as computer illiteracy in teachers, lack of ICT resources like computers, lack of electricity, poor infrastructure financial constraints, burglary, and fear by the teacher among others. It was therefore interesting to find out whether the same challenges and others affect integration of ICT in teaching Biology in secondary schools in Mbooni-East Sub-county. It was also important at this point to find out the attitude of teachers

towards integration of ICT in teaching Biology. The following section reviews what scholars and researchers found on the attitude of teachers towards integration of ICT in teaching Biology.

2.5 Attitude of teachers towards integration of ICT in teaching Biology

The attitude of teachers towards integration of ICT in teaching Biology is important because integration of ICT in an educational environment to a great extent depends on the teacher's attitude towards the use of ICT (Selewyn, 1999). This is supported by Rhoda and Gerald (2000) who pointed out that positive attitude towards the use of ICT is widely recognized as important for the effective integration of ICT in teaching and learning. Myers and Halpin (2002) clearly indicated that the attitude of the teachers towards the use of ICT is a major predictor of the future classroom use. If teachers' attitudes towards the use of educational ICT are positive, then they can easily provide useful insight about the adoption and integration of ICT into teaching processes (Buabeng-Andoh, 2012).

Kubiatko and Halakova (2009) observed that attitude towards use of ICT in teaching was as a result of its impact in the teaching and learning processes. A more important barrier to the use of computers is the teacher's perception of the importance of an application, as well as teacher's proficiency on the application (Sorgo, Vercknovnik and Kocijancic, 2010). Kubiatko (2006) stated that while using ICT, we encounter a number of problems like the teachers' fear of using ICT and so if teachers go through these problems, they will discover the new possibilities

brought in teaching Biology using ICT. Slout and Barton (2007) observed that ICT can motivate students in learning by bringing in a variety into the lessons and also sustains the teachers' and students' own interest in teaching and learning. Rhoda and Gorard (2000) indicated that positive attitude towards the use of ICT is recognized as a necessary condition for effective integration of ICT in teaching.

BECTA (2004) reported that negative attitude was a major barrier towards integration of ICT in teaching and learning. According to Bitok (2014), most teachers occasionally use ICT and so need to be sensitized on the value of ICT because many tend to perceive themselves to be technologically incompetent. Acikalin (2014) indicated that teacher education programs play a key role in preparing well-informed teacher with positive attitudes towards using ICT in teaching and learning Biology.

This section dealt with the question: Do Biology teachers in Mbooni-East Sub-county have negative or positive attitude towards use of ICT in their teaching processes? These studies confirm that positive attitude in teachers towards the use of ICT in teaching Biology is important for effective integration of ICT but negative attitude is a major barrier to integration of ICT in teaching Biology. So it was of paramount importance to conduct a study to determine the attitude of teachers towards integration of ICT in teaching Biology in Mbooni-East Sub-county. At this point, it would be important to find out from research the influence of integration of ICT in teaching Biology on students' performance in Biology. The section below is about what other research has found in order to establish the influence of the use of ICT in teaching Biology on students' performance in Biology.

2.6 Influence of the use of ICT in teaching Biology on students' performance in Biology

Research shows that the use of ICT in teaching Biology has a positive influence on students' performance in Biology. Based on the findings of Volman and Van Eck (2001), the use of ICT creates a powerful learning environment and transforms the teaching and learning process in which students deal with knowledge in a more active, self-directed and constructive way. Use of ICT therefore translates to improved learning outcomes which are reflected in improved students' performance in examinations. (Omollo (2013) concurred with this by saying that the use of ICT in teaching facilitates learning more effectively and enhances students' understanding of concepts. This is expected to translate into expansion of knowledge and improved examination outcomes resulting to good performance. Drent (2005) supported this by stating that the innovative use of ICT in teaching can facilitate student centered learning which can again result to good learning outcomes and hence good performance in examinations.

Mbugua, Gori and Tanui (2015) observed that the objective of global investment in ICT has been to improve teaching and learning in schools since ICT integration in teaching makes the lessons more interesting which again results to improved students' performance in examinations. In addition to this, Abichandani (2012) indicated that there are particular types of simulations in form of virtual experiments through online laboratories which enhances students' understanding of concepts, resulting to good performance in examinations. Through ICT, ideas will be shared globally and support schools in Kenya to improve learning and academic

performance. Manyindo and Muthini (2014) observed that upon adoption of ICT integrated learning, most schools registered good performance. The schools that are already using modern technology in learning through an initiative that seeks to test the viability of using tablets in teaching and learning have recorded improved performance (Merab, 2014). Some schools are transforming learning to deliver more personalized experience to students using mobile and cloud technology to prepare the students towards good examination results.

Inevitably, technology is rapidly penetrating classrooms, with teachers in more developed learning institutions taking innovative use of ICT to facilitate learning (Wamari, 2014) for good performance in examinations. Kenya's master plan on ICT project which covered the period between 2013 and 2018, envisaged deeper integration of ICT in the country's education system and business processes (Kamunyu, 2014). Ouma (2015) noted that as public schools continue to wait for rolling out of computer for schools programme promised by the government three years ago which to date(2020) is eight years ago, the use of technology in some schools makes learning exciting and thus improves school attendance and academic performance.

In particular, teachers use ICT to teach challenging Biological concepts like genetics despite limited computer hardware and software availability for teaching and learning Biology (Van Rooy and Wilhemina, 2012). Therefore, when ICT is used in the teaching process the students are able to understand such difficult concepts which were also a problem in examinations and they are likely to record good performance. Integration of ICT in teaching sciences is expected to ease

understanding of some abstract concepts in science and make learning and understanding easy (Gakime, 2016) resulting to good performance. Mbugua, Gori and Tanui (2015) observed that Kenya's e-government strategy and the National ICT policy gave considerable attention to education and schools to integrate ICT in order to improve students' academic performance.

Oyebola (2018) observed that the use of multimedia improves learning and positively influenced students' academic performance and therefore there is need for integration of ICT in teaching Biology. Basri, Alandejani and Almadani (2018) also found that there exists a relationship between ICT integration and academic performance since ICT integration in teaching results to improved academic performance and hence good performance. This is also supported by Ishtiaq, Qaiser, Naseer ud Din and Farhan (2017) where in their research findings they established that ICT integration positively affects students' academic performance and retention which in turn results to good performance in their examinations. In addition to this, Mbugua, Kiboss and Tanui (2015) in their research also concluded that integration of ICT in teaching is a vital component in improvement of students' academic performance.

This section dealt with the question: Does the use of ICT in teaching Biology influence students' performance in Biology? The findings from other studies show that use of ICT in teaching Biology has a great influence on students' performance since it results to good performance in examinations. It was therefore necessary to conduct research in Mbooni-East Sub-county to establish whether the use of ICT in teaching Biology influences the students' performance in Biology.

2.7 Summary and the Existing gaps of the study in Literature

In conclusion of this chapter it is imperative to present the summary of the major findings and comments of the research that have been reviewed and also to highlight the major gaps that which this study endeavored to bridge.

To begin with, research on available ICT resources reveals that there are some ICT resources available which are already in use but it's not specific on the ICT resources available for use in teaching Biology. Most of the ICT available like charts and photographs may deny the learner hands-on-experience since the learner is not actively involved in the operation of the ICT, making it difficult for the students to acquire knowledge and experience. Research was therefore important to find out the ICT resources available in schools for use in teaching Biology.

Research also reveals the use of ICT in teaching but it's not specific on the type of instructional methods used when using ICT in teaching Biology based on the different concepts in teaching Biology. In addition, research doesn't reveal the frequency of the use of ICT in teaching Biology. Thus, research was necessary to examine extent of the use of ICT in teaching Biology.

Research shows the existence of some challenges faced by teachers in integrating ICT in teaching Biology. These challenges affect the integration of ICT in teaching Biology. Therefore, there was need to find out the possible challenges in ICT integration specifically in teaching Biology.

From the literature review it is also evident that the attitude of teachers towards the use of ICT is of paramount importance in integrating ICT in teaching Biology. Teachers may have either positive or negative attitude towards integration of ICT in teaching. Positive attitude in teachers promotes integration of ICT in teaching Biology. Therefore, research was necessary to determine the teacher's attitude towards ICT integration in teaching Biology.

Finally, research shows that the use of ICT in teaching Biology generally results to improved students' performance and thus good performance in examinations. Research was thus important in order to establish the influence of the use of ICT in teaching Biology on students' performance in Biology.

It should be noted that there is still no research which has so far been conducted in Mbooni-East Sub-county on the influence of integration of ICT in teaching Biology on students' performance and so this study was considered relevant to the Sub-county.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the procedures and methodology employed in this study. The sections of this chapter include the research design, variables, location of study, target population, sampling techniques and sample size, research instruments, piloting procedure, validity and reliability of the instruments, data collection procedures, data analysis and logistical and ethical considerations.

3.2 Research Design

This study was designed to investigate the influence of integration of ICT in teaching Biology on students' performance in Biology in secondary schools in Mbooni-East Sub-county, Makueni County. The study used descriptive survey design. Descriptive survey design is vital in attempting to collect data from members of a population in order to determine the current status of that population with respect to one or more variables of interest (Mugenda and Mugenda, 1999). Orodho (2003) defined descriptive survey as a method of collecting information by interviewing or administering a questionnaire to a sample of individuals. Kombo and Tromp (2006) indicated that the major purpose of descriptive research is description of the state of affairs as it exists. A survey research is also defined as a research design for the examination of variation across cases, usually in terms of a range of variables of interest to the researcher (Henn, Weinstein, and Foard, 2009). Orodho (2009) observed that descriptive survey allows the researcher to gather information,

summarize, present and interpret for the purpose of clarification. Kothari (2004) indicated that the design requires piloting and revising the instruments before the researcher goes into the field. Descriptive survey was found appropriate since it collected data from respondents, assessed their attitudes, opinions and made conclusions based on the findings.

3.3 Variables

The independent variables for this study are the teacher factors which affect the teacher's use of ICT in teaching Biology. They include teachers' use of ICT in teaching Biology, teachers' knowledge and skills in the use of ICT and the teachers' attitude on the use of ICT in teaching Biology. The intervening variables are the Government ICT policies and the school factors which may include the school's ICT policy, time allocation for teaching Biology, access to ICT and the administrative support on the use of ICT in teaching. These influence the adoption of ICT by the teachers and the school and hence affecting integration of ICT in teaching Biology. The dependent variable is the students' performance in Biology examinations.

3.4 Location of Study

The study was conducted in Mbooni-East Sub-county in Makueni County. The study was interested with Mbooni-East Sub-county since it had recorded poor performance in Biology although the study could also have been done in any other Sub-county. The ideal setting for any study is the one that is related to the researcher's interest and which is easily accessible to the researcher for purpose of collection of accurate and in-depth data (Singleton, 1993). The performance in KCSE Biology

examinations in the Sub-county has been poor from the year 2013 posting percentage mean scores of 37.8, 38.2, 36.9, 23.6, 22.7 and 22.8 in the years 2013, 2014, 2015, 2016, 2017 and 2018 respectively. Although nationally, the performance is still poor (refer to Table 1.1), there was need for the research to be conducted in the Sub-county. Mbooni-East Sub-county was also chosen because it's a new Sub-county and no research of this nature has been conducted. Mbooni-East Sub-county is at the southern side of Machakos County. The neighbouring Sub-counties are Mbooni-West, Mwala, Kitui and Makueni. The main economic activities are small-scale dairy farming, livestock keeping, and crop farming. There are transport and communication problems with a network of murram roads and poor electricity supply with frequent blackouts.

3.5 Target Population

Target population is a set of elements that the researcher focuses upon and to which the results obtained by testing the sample should be generalized (Orodho, 2009). Mugenda and Mugenda (2012) concurred with this by defining target population as the particular entity of people, objects or units to which a researcher can reasonably generalize his or her research findings. The target population for the study comprised all the 44 public secondary schools in the Sub-county with a total of 99 Biology teachers, 3840 Form 3 students taking Biology and 44 school administrators. The school administrators were targeted because they are the key managers of the schools and so provided useful information, while the Biology teachers are the ones involved in the implementation of the curriculum. In addition

to this, the students were the main beneficiaries of the curriculum policy and so they too provided crucial information.

3.6 Sampling Techniques and Sample Size

Mbooni-East Sub-county has 44 public secondary schools and so 44 school administrators, 99 Biology teachers and 3840 Form 3 Biology students. According to Mugenda and Mugenda (2012), sampling is a process of selecting a group of units, items or subjects from the population to be included in the study. Henn, Weinstein, and Foard (2009), indicated that a sample is a selected group of people from which the researcher wishes to gather information. David and Sutton (2012), defined sample size as the total number of sampling units, or cases selected from the sampling frame (database of all members of a target population).

3.6.1 Sampling Techniques

Sampling techniques are the methods used when selecting the cases for study. The research first used convenience sampling to categorize the schools according to their respective administrative divisions for convenience of the study. There are four administrative divisions in the Sub-county namely; Kisau, Kiteta, Kalawa and Waia. The research then used purposive sampling to select schools based on gender in order to select one boys' school, one girls' school and one mixed school from each of the four divisions thereby obtaining a total of 12 schools (27.27% of the 44 public secondary schools in the Sub-county). This is shown in table 3.1.

Table 3.1: Sampling Grid for Schools in Mbooni-East Sub-county based on Administrative Divisions

Division	Total number of schools	Sampled (N) Schools	Percentage (%)
Kisau	8	3	37.5
Kiteta	8	3	37.5
Kalawa	14	3	21.43
Waia	14	3	21.43
Total	**44**	**12**	**27.27**

Source; SCDE's Office (2016)

According to Gay (1996), a sample of 10% of the population is considered minimum for a descriptive study but for a small population, 20% of the population may be required. Kothari (1985) concurred with this by stating that a sample of 10% to 30% is appropriate for descriptive studies. The research then used simple random sampling technique by lottery method to select the Biology teachers and the Form 3 Biology students in the sampled schools. This was done by writing small pieces of papers "Yes or No" depending on the number of teachers or students and then folded them to be picked by the respondents. The number of "Yes" papers was equal to the sample size in the respective school. Those who picked "Yes" papers qualified for the study but those who picked "No" papers didn't qualify for the study. However, only one of the school administrators in the respective study school was selected based on availability since they are always busy.

3.6.2 Sample Size

A sample is large enough to serve as an adequate representation of the population about which the researcher wishes to generalize and small enough to be economically selected (Best and Kahn, 2010).The sample size for the schools was

12 making a percentage of 27.27% of the 44 public secondary schools in Mbooni-East Sub-county which were selected for the study. The study involved the Form 3 Biology students in the sampled schools because the Form 3 students had already selected Biology and had already settled in the school. The Form 3 students were also conversant with the Biology syllabus. Form 4 students were busy preparing for the KCSE examination and hence couldn't participate in the study. Gorard (2000) observed that a sampling fraction of between 10% and 20% of the total population in descriptive research is acceptable. The sample size in this study for the respondents was 93 students (10% of the students taking Biology), 25 Biology teachers (average of 2 Biology teachers from each sampled school) and 12 school administrators (1 from each sampled school) as shown in table 3.2. Thus a sample of 130 (13.6%) was taken from the 12 sampled schools.

Table 3.2: Sampling Grid for Respondents in Mbooni-East Sub-county

Division	**School**	**Form 3 Students of Biology**		**Biology Teachers**		**Administrators**	
		Total	Sample(10% Total) (N)	Total	Sample (N)	Total	Sample(N)
Kisau	A	205	21	5	3	1	1
	B	140	14	5	2	1	1
	C	55	6	3	2	1	1
Kiteta	A	35	4	2	2	1	1
	B	131	13	3	2	1	1
	C	35	4	2	2	1	1
Kalawa	A	27	3	3	2	1	1
	B	48	5	2	2	1	1
	C	45	5	3	2	1	1
Waia	A	90	9	3	2	1	1
	B	37	4	2	2	1	1
	C	48	5	2	2	1	1
Total	**12**	**896**	**93**	**35**	**25**	**12**	**12**

Source; SCDE's Office (2016)

3.7 Research Instruments

Research instruments are the tools with which the researcher used to collect data. The study used questionnaires for the students and teachers, interview schedules for the school administrators and Biology teachers and observation checklist to ascertain the ICT resources available in the sampled schools.

3.7.1 Questionnaires for Form 3 Biology Students

The research used questionnaires for the Form 3 Biology students. The students are the main beneficiaries of the use of ICT in teaching and learning Biology. The questionnaires had an introductory note of the researcher that indicated the aim and confidentiality of the information required. They contained both closed-ended and open-ended questions. They were used to gather information from the students concerning the influence of integration of ICT in teaching Biology on students' performance. Onen and Yuko (2005) observed that questionnaires are used for variables that could not be directly observed such as opinions, views and feelings.

3.7.2 Questionnaires for Biology Teachers

The research also used questionnaires for the Biology teachers since they are the ones who are directly involved in the implementation of integration of ICT in teaching and learning Biology. The questionnaires had an introduction of the researcher on the purpose of the research and on the confidentiality of the information provided. The first part included the teacher's personal data followed by open-ended and closed-ended questions on the extent of the use of ICT in teaching and learning of Biology. These questionnaires were used to gather information from

the teachers concerning the use of ICT in teaching and learning of Biology in their respective secondary schools.

3.7.3 Interview Schedules for the School Administrators

The study used interview schedules for the school administrators since they are the school managers and so involved in the monitoring of the implementation of the use of ICT in teaching and learning of Biology. The interview schedules for school administrators were used to collect data from them. They may not be willing to commit themselves in writing and so the researcher wrote down the responses from them as the interview proceeded. According to Kerlinger (1973), more people are willing to communicate orally than in writing and so data is obtained more readily in an interview.

3.7.4 Interview Schedules for Biology teachers

The research study also used interview schedules for the teachers of Biology to collect more data from them. This is because they are the ones who are directly involved in the implementation of the use of ICT in teaching and learning of Biology. Therefore the interview schedules for the Biology teachers were used to collect data to supplement the data collected using their questionnaires on the integration of ICT in teaching Biology. The teachers interviewed were 12 out of the 25 sampled which included 4 from Boys' schools, 4 from Girls' schools and 4 from mixed schools.

3.7.5 Observation Checklist

The study also used observation checklist. It was a list containing the basic ICT resources that can be used in teaching and learning Biology. They helped the researcher to collect data on the availability, adequacy and the state of the ICT resources in the selected secondary schools and be used to compare this with what the respondents said they were aware of, was available and accessible in the classroom.

3.8 Piloting Procedures

Before the actual research, the researcher conducted a pilot study in a selected secondary school in the Sub-county that was not selected for the actual study. From the school 10% of the students (randomly selected), any two Biology teachers and an administrator were considered in the pilot study. The importance of the pilot study was to determine the validity and reliability of the research instruments. It was used to determine the ease of use of the instruments, to detect any weakness like ambiguous statements, to determine whether the respondents can understand the questions, language, any errors or flaws etc. This helped the researcher to make corrections in order to make some improvements on the questions in the research instruments.

3.8.1 Validity

Content validity was done to determine whether the content of the research instruments measured what they were expected to measure. Validity was first ensured through the use of opinions from experts. Here, the researcher consulted

with his supervisors in order to evaluate and include their recommendations in the new research instruments. Secondly, it was done by multiple research instruments, a method called triangulation. Third, it was done by conducting pilot interviews and fourth, it was done by seeking consent of the subject experts. Interviews were also recorded for effective analysis. The questions that were found ambiguous were then reframed and those that were irrelevant to the study were also restructured. This ensured that the evaluation and improvement of the research instruments was done thoroughly. Kumar (2005) observed that in research study, the concept of validity ensures that correct procedures are applied to find answers to questions. Vogt and Johnson (2005) also argued that validity is the trustworthiness of the statements used and the findings provided by the research study.

3.8.2 Reliability

Reliability can be defined as a measure of the degree to which a given research instrument produces consistent results after repeated trials. It is the degree to which a particular measuring procedure gives equivalent results over a number of repeated trials (Orodho, 2009). One way to ensure reliability of the instruments was by pre-testing them. Thus, the research conducted a pilot study on the instruments prior to the collection of data. This ensured proper refining of some of the items used. This involved a test-retest technique which involved administering the same instrument twice to the same group of respondents in the two selected schools and the Sub-county QASO within two weeks. Jackson (2009) defined reliability as the consistency or stability of a measuring instrument to measure exactly the same way each time it's used. Mugenda and Mugenda (2012) defined reliability as the

consistency and dependability of data collected through the use of a scientific instrument or data collection procedure under the same conditions. Reliability was also done by triangulation methods where multiple research instruments were used in data collection as supported by Creswell and Miller (2000). These methods were used in collection of similar and different types of data. According to the views of Creswell (2012), different subject informants helped the researcher to gather information by triangulation method and therefore this ensured that the findings were accurate and credible.

3.9 Data Collection Procedure

The researcher had an introductory letter from Kenyatta University, Graduate School to take to the Director General, NACOSTI in order to get the research permit. The researcher then used the research permit to seek permission from Mbooni-East Sub-County Director of Education and then from the respective secondary school administrators (principals) to conduct research in the schools.

The researcher explained the purpose of the study even to the respective teachers. The researcher also made repeated visits to the respective schools to familiarize with the students, teachers and the principal before conducting the actual research. After creating rapport with the respondents, the researcher began the actual research. During the actual research, the researcher issued the research questionnaires to the selected students and teachers when they were in a relaxed way in their usual places in order to provide reliable information. The researcher first took them through the questionnaires to give instructions on how to complete them.

The respondents were given enough time to complete them. The researcher also attended some classes to make observations of the real classroom experiences and requested for the administrative documents related to the school's ICT resources. The researcher also booked an appointment with the school administrator and some Biology teachers for the interviews.

3.10 Data Analysis

The researcher edited the data collected from the field and then carried out data coding process in order to quantify all the data. The data was analyzed quantitatively based on each of the research objectives. The coded data was entered into computer using the SPSS to generate the appropriate descriptive statistics for presentation. Percentiles and percentile ranks were generated on each of the research objectives and the percentages were presented in tables, pie-charts and bar-charts. Data analysis is the process of systematically searching and arranging completed research instruments after fieldwork, with the aim of increasing understanding and hence enabling one to present them to others (Orodho, 2004). Johnson and Christensen (2004) points out that descriptive statistics give a clear view of the situation, allowing the researcher to draw conclusions and give decision makers the means to base their decisions on rational study. The analyzed data was presented in the form of frequency distribution tables, graphs and pie-charts to facilitate description and explanation of the study findings in accordance with the research objectives.

3.11 Logistical and Ethical Considerations

Ethics focuses on the values of the respondents and so need for ethical standards during the planning of the study, data collection and analysis, dissemination and use of the results. Henn, Weinstein, and Foard (2009), observed that ethics in social research involves those issues that concern the behavior of social researchers and the consequences that their research brings to the people they study. The researcher obtained a research permit from the Director General, NACOSTI through Kenyatta University, Graduate School. With the research permit the researcher sought permissions from the local Director of Education and then the respective secondary school administrators to conduct research in the schools.

The researcher had to put into consideration the research time frame and work plan, the packaging of the research instruments and research budget. The researcher obtained informed consent from the respondents and ensured that all respondents participated voluntarily and maintained confidentiality at all times. The researcher accepted individual responsibility to conduct the research and was open and honest when dealing with the respondents. The researcher ensured protection of the respondents physically and psychologically. Finally, the researcher fully explained the research in advance, and "debriefed" the respondents afterwards. The researcher assured the respondents that the data collected was only to be used in writing thesis.

CHAPTER FOUR

FINDINGS, INTERPRETATION AND DISCUSSIONS

4.1 Introduction

The results of the study are presented, analyzed and discussed in this chapter as per the objectives of the study which includes: To find out ICT resources available in the schools, to examine the use of ICT in teaching Biology, to find out the challenges faced by teachers in integrating ICT in teaching Biology, to determine the attitude of teachers towards integration of ICT and to establish the influence of the use of ICT in teaching Biology on students' performance in Biology. The chapter discusses the findings of the study under the following areas: Demographic information of the respondents, ICT resources available in the schools for teaching Biology, the use of ICT in teaching Biology, challenges faced by the teachers in integrating ICT in teaching Biology, the attitude of teachers towards integration of ICT in teaching Biology and influence of the use of ICT in teaching Biology on students' performance in Biology. Finally, a summary of the study findings is provided.

4.2 Demographic Characteristics

The study considered the following demographic characteristics: Age, professional qualifications, professional experience and experience in the current station/school of the Biology teachers and the school administrators; the administrative experience and position of the school administrators.

4.2.1 Demographic characteristics of Biology Teachers

The study was interested with the age, professional qualifications and experience of the Biology teachers including their experience in their current institution. The study sampled 25 (N=25) Biology teachers and the information from them was obtained through questionnaires and interview schedules. Table 4.1 shows the data obtained based on the findings of the study.

Table 4.1: Demographic characteristics of Biology Teachers

		Count	Percentage
Age in years	20-30	11	44.0
	31-40	13	52.0
	41-50	1	4.0
Professional Qualifications	DIP	2	8.0
	BED/PGDE	23	92.0
	Masters	0	0.0
Professional experience in years	0-2	5	20.0
	3-4	6	24.0
	5-6	7	28.0
	7-8	1	4.0
	9 and above	6	24.0
Experience in the current institution in years	0-2	11	44.0
	3-4	7	28.0
	5-6	4	16.0
	7-8	1	4.0
	9 and above	2	8.0

The age of the teachers in the research study was important for the researcher to be sure on the kind of teachers involved in the study since can be used as an indicator of experience and probably has a bearing on performance of students.The study revealed that most of the teachers (56% of the 25 teachers) were in the age brackets of 31 years to 50 years. Therefore most of the teachers who participated in the study

were experienced and were in a better position to decide on the type of ICT to use in teaching Biology.

Professional qualification of the Biology teachers was also of importance to the researcher because it determines the nature of training as a teacher and hence greatly influenced the choice of ICT and the instructional methods used in integration of ICT in teaching Biology. The study revealed that all the teachers handling Biology were professionally qualified since 23 (92%) of the teachers had either a Post Graduate Diploma in Education or a Bachelor of Education degree. So the researcher was satisfied that the teachers were well trained in teaching Biology and hence their responses were taken to be credible and reliable.

The teaching experience of the teachers was determined by the number of years in the teaching profession. The study showed that the biggest number [14 (56%)] of the teachers involved in the study had a teaching experience of five (5) years and above. Most of the teachers (80%) had a professional experience of more than 2 years and had the ability to decide on the type of ICT to use. In addition, more than half [14 (56%)] of the 25 Biology teachers involved in the study had served in their respective schools for over two (2) years with only 11 (44%) having the shortest duration of stay in the school of 2 years and below. The length of stay in the school was important because the teacher can understand well the individual learner's needs and decide the type of ICT to use in teaching Biology. Thus, majority of the teachers had enough time with their students.

4.2.2 Demographic characteristics of school administrators

The study was interested with the age, professional qualifications and administrative experience of the school administrators including their experience in their current institution and their administrative positions. The study sampled 12 (N=12) school administrators and the information from them was sought through face to face interviews. Table 4.2 shows the data obtained based on the findings of the study.

Table 4.2: Demographic characteristics of school administrators

		Count	Percentage
Age in years	31-40	1	8.5
	41-50	10	83.0
	51-60	1	8.5
Professional Qualifications	DIP	0	0.0
	BED/PGDE	11	92.0
	Masters	1	8.0
Administrative experience in years	0-5	1	8.0
	6-10	9	75.0
	11-15	2	17.0
Experience in the current institution in years	3-4	4	33.5
	5-6	4	33.5
	7-8	3	25.0
	Above 8	1	8.0
Administrative positions	Principal	2	17.0
	Deputy Principal	9	75.0
	Senior Teacher	1	8.0

The age of the school administrators was also important in the research study for the researcher to be sure of the kind of administrators involved in the study since age determines the experience and hence probably may have a bearing on performance of the students. Most of the school administrators (92%) involved in the study were above 40 years old and so seemingly have a higher professional experience in

management of the school and are able to determine the type of ICT needed in the school.

The professional qualification of the school administrators was also important since it may influence the acquisition of the ICT for teaching Biology. All 12 (100%) of the school Administrators in the study had either a Bachelor's degree, Post Graduate Diploma in Education or a masters' degree. Thus, all the school administrators were professionally qualified. The researcher was therefore satisfied that the school administrators understood the need for integration of ICT in teaching Biology. Their administrative experience was also important in the administration of schools because it may have a linkage with the type of ICT the school acquires for teaching Biology. The study revealed that the biggest number [11 (92%)] of the school administrators involved in the study have over five (5) years administrative experience with only 1 (8%) having 5 years and below. This means that majority of the school administrators had more than 5 years professional experience in administration and were able to decide on which ICT needed.

The study also sought to find out the length of stay of the school administrators in their respective schools. From the study, 66.5% (8) of the school administrators had been in their respective schools for over four (4) years. Therefore, majority of them had enough time with their students and understood very well their learning needs. Their administrative position in terms of whether a Principal, Deputy Principal or a Senior Teacher was also necessary for the study because they are the ones who facilitate learning in the school and were involved in the requisition of learning resources. Most of the school administrators involved in the study were Deputy

Principals [9 (75%)]. Deputy Principals are involved with curriculum implementation and were directly involved in the requisition of the ICT and so seemingly important to the study.

4.2.3 Type of School

The study was also interested with the type of school. The students' respondents were required to indicate in their questionnaires the type of school in terms of Mixed Day, Girls' Boarding and Boys' Boarding since it determines the learning environment. The results are as indicated in figure 4.1.

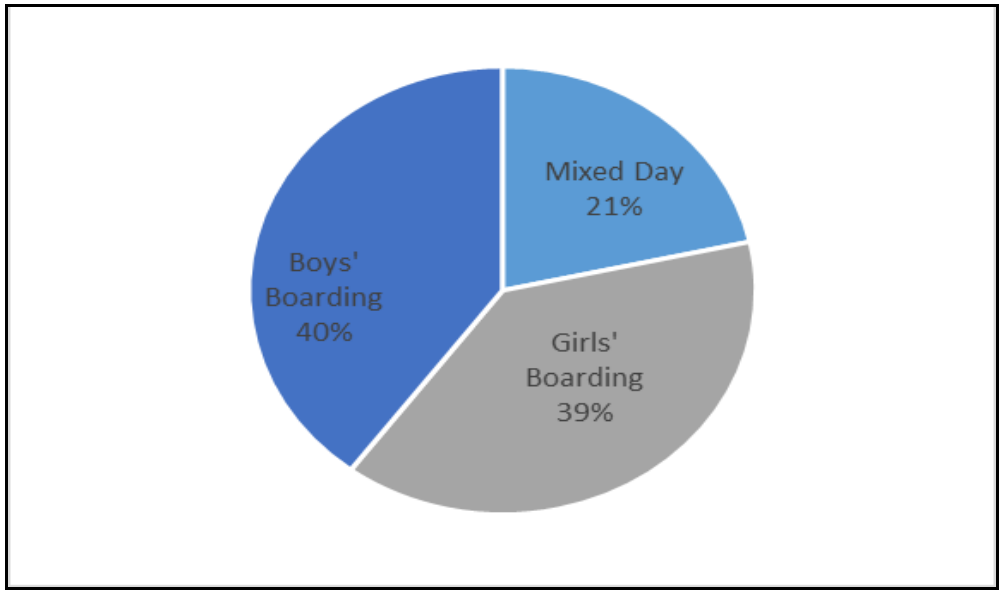


Figure 4.1: Type of School

Most of the 93 student respondents were in Girls' Boarding school and Boys' Boarding School. The study shows that 79% (73) of the 93 students involved in the study were in a Girls' Boarding school and Boys' Boarding School and minority [21% (19)] of the respondents were in a Mixed Day School. Thus, most of the student respondents were from Boarding Schools.

4.3 Schools with Equipped ICT Resource Centre

The research study was also interested to know the schools with equipped ICT Resource Center because this determines the availability of the ICT for teaching Biology. This was established through students' questionnaires. The study had sampled 12 schools with 20 students from mixed day schools, 36 students from Girls' Boarding and 37 students from Boys' boarding schools. Table 4.3 represents the schools with or without ICT Resource Center.

Table 4.3: Type of School and Equipped ICT Resource Centre: Cross tabulation

			Equipped ICT Resource Centre		Total
			No	Yes	
Type of School	Mixed Day	Count	13	7	20
		% within Mixed day Schools	65.0%	35.0%	100.0%
		% within all 12 schools	44.8%	10.9%	21.5%
		% of Total	14.0%	7.5%	21.5%
	Girls' Boarding	Count	5	31	36
		% within Girls' School	13.9%	86.1%	100.0%
		% within all 12 schools	17.2%	48.4%	38.7%
		% of Total	5.4%	33.3%	38.7%
	Boys' Boarding	Count	11	26	37
		% within Boys' Schools	29.7%	70.3%	100.0%
		% within all 12 schools	37.9%	40.6%	39.8%
		% of Total	11.8%	28.0%	39.8%
Total		Count	29	64	93
		% within Type of School	31.2%	68.8%	100.0%
		% within Equipped ICT Resource Centre	100.0 %	100.0%	100.0%
		% of Total	31.2%	68.8%	100.0%

On comparison, the study established that out of the 20 students in the Mixed schools only 7 (35.0%) indicated to have equipped ICT Resource Center making a percentage of 7.5% of all the 93students. The rest 13 (65.0%) which is 14.0% of all the 93 students indicated the absence of equipped ICT Resource Center. In the Girls' Boarding Schools, 31 (86.1%) of the 36 girls who participated in the study (33.3% of the sampled 93 students) indicated to have equipped ICT Resource Centre in their

schools and 5 (13.9%) which makes 5.4% of all the students indicated absence of equipped ICT Resource Center. The study also established that in the Boys' Boarding Schools, 26 (70.3%) of the 37 boys who participated in the study (28.0% of the 93 students sampled) indicated to have an equipped ICT Resource Center while 11 (29.7%) of the 37 boys (11.8% of the 93 students) indicated the absence of the ICT Resource Centre. Therefore out of all the 64 students who indicated presence of equipped ICT Resource Center 10.9% (7) were from mixed schools and 48.4% (31) and 40.6% (26) were from Girls' Boarding and Boys' boarding schools respectively.

A total of 64 (68.8%) of all student respondents indicated the presence of equipped ICT Resource Centre. However, 29 students indicated the absence of equipped ICT Resource Center where 44.8 % (13) were from mixed schools while in Girls' Boarding schools and Boys' Boarding schools were 17.2% and 37.9% respectively. A total of 29 (31.2%) in all the schools indicated absence of equipped ICT Resource Centre. This is an indication that not all schools had equipped ICT Resource Centre. The presence of an equipped ICT Resource Center is an indication of the availability of ICT for teaching Biology but the absence of the ICT Centre means that there are fewer or no ICT in the school for teaching Biology.

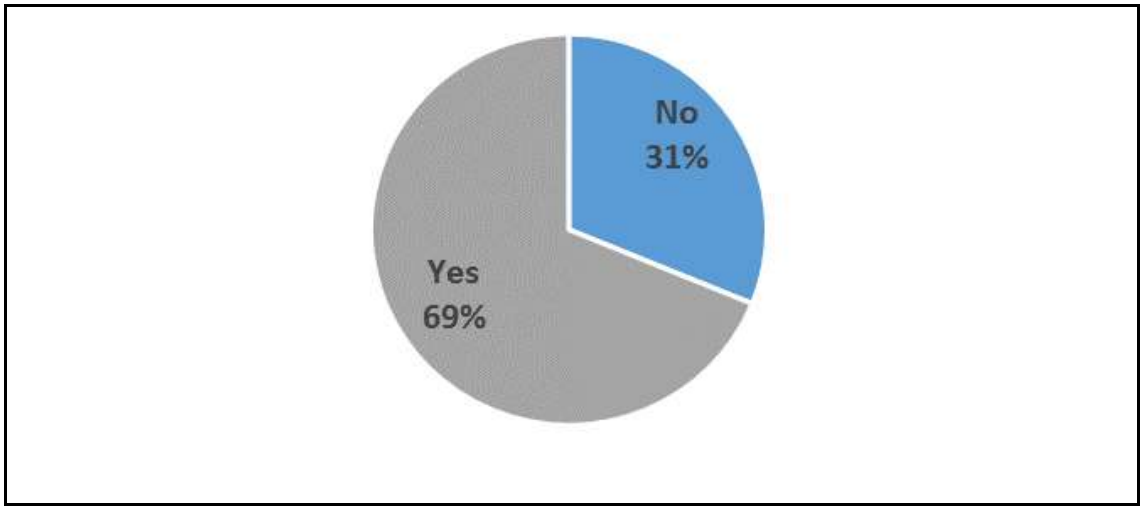
4.4 ICT resources available in the schools for use in teaching Biology

The first objective of the study sought to find out the ICT resources available in the schools for use in teaching Biology. The study used students' and teachers' questionnaires, interview schedules for administrators and teachers and checklists to

determine the ICT resources available in the study schools for teaching Biology. The researcher was interested in finding out the presence of equiped ICT Resource Center, access to the ICT resources and the ICT resources available in the schools for teaching Biology. Table 4.4 and figures 4.2, 4.3(a) and 4.3(b) represents the findings of the study.

4.4.1 Presence of an Equiped ICT Resource Center

The presence of an ICT Resource Center determines the availability and accessibility of the ICT to the teacher and the learner. Figure 4.2 shows the responses in terms of percentages of the 93 students involved in the study.



(KEY: **Yes**-ICT resource center present, **No**-ICT resource center absent)

Figure 4.2: Presence of Equipped ICT resource center

The study revealed that 64 (69%) of all the 93 students from all the study schools agreed that there was an equipped ICT Resource Center in their respective schools where as reflected by the findings in **table 4.3**, 10.9% (7) were from mixed schools and 48.4% (31) and 40.6% (26) were from Girls' Boarding and Boys' boarding

schools respectively. However, 29 students indicated the absence of equipped ICT Resource Center where 44.8 % (13) of them were from mixed schools while in Girls' Boarding schools and Boys' Boarding schools were 17.2% and 37.9% respectively. A total of 29 (31.2%) in all the schools indicated absence of equipped ICT Resource Center. According to the research study by Ishtiaq, Qaiser, Naseer ud Din and Farhan (2017), the infrastructure of the schools should be designed in such a way that ICT is available and easily accessible in order to be successfully used in teaching. Thus, absence of an ICT Resource Center shows that there are fewer or no ICT available but its presence indicates that there are available ICT for use in teaching Biology.

4.4.2 Access to the various ICT resources available

The ease at which the students access the ICT is important in teaching and learning Biology. The findings are reflected in Table 4.4**.**

Table 4.4: Equipped ICT Resource Center and access to various ICT; Cross tabulation

			Students can easily access the various ICT in this school					Total
			Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	
Equipped ICT Resource Centre	No	Count	1	3	5	10	10	29
		% within Equipped ICT Resource Centre	3.4%	10.3%	17.2%	34.5%	34.5%	100.0%
		% within Students can easily access the various ICT in this school	25.0%	11.1%	22.7%	38.5%	71.4%	31.2%
		% of Total	1.1%	3.2%	5.4%	10.8%	10.8%	31.2%
	Yes	Count	3	24	17	16	4	64
		% within Equipped ICT Resource Centre:	4.7%	37.5%	26.6%	25.0%	6.3%	100.0%
		% within Students can easily access the various ICT in this school	75.0%	88.9%	77.3%	61.5%	28.6%	68.8%
		% of Total	3.2%	25.8%	18.3%	17.2%	4.3%	68.8%
Total		Count	4	27	22	26	14	93
		% within Equipped ICT Resource Centre:	4.3%	29.0%	23.7%	28.0%	15.1%	100.0%
		% within Students can easily access the various ICT in this school	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	4.3%	29.0%	23.7%	28.0%	15.1%	100.0%

From table 4.4, despite the fact that 64 (69%) of the students indicated that they had equipped ICT Resource Center as in figure 4.2**,** only 31 (33.3 %) agreed to the fact that they can easily access ICT in the school, while a larger 43.1% disagreed to this. From the research study of Mwanda, Midigo and Maundu (2017), they recommended that there should be increased accessibility of ICT resources like computers, adequate training on the use of ICT and development of policy framework to guide on the path to effective ICT integration into instruction process.

In addition to this, availability and accessibility of the ICT determines the frequency of its use in teaching Biology.

4.4.3 The main ICT resources available in the school for teaching and learning Biology

When questioned on the availability of ICT resources the Biology teachers stated the availability of printers, TV screen, laptops, projectors, computers, the audio-visual/animated DVDs and CDs, DVD player, white board and smart phones. This is represented in figure 4.3 (a).

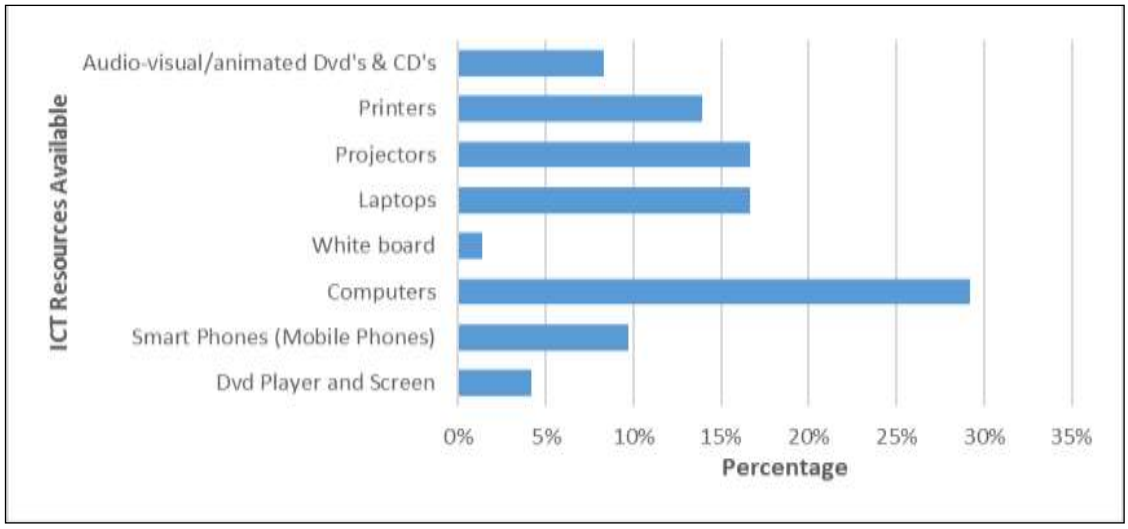


Figure 4.3(a): Main ICT resources available in the school in teaching Biology as stated by Biology teachers

The results of the study showed that there were some ICT resources available for teaching and learning Biology in all the study schools. Majority of the 25 teachers sampled [7 (28%)] indicated desk top computers while 4 (16%) indicated projectors and laptops. Others include audio-visual DVDs and CDs, printers, projector, laptops, white boards, smartphones and television screens with DVD players. However,

when the students were requested to indicate the main ICT used in teaching and learning Biology the results are presented in figure 4.3(b).

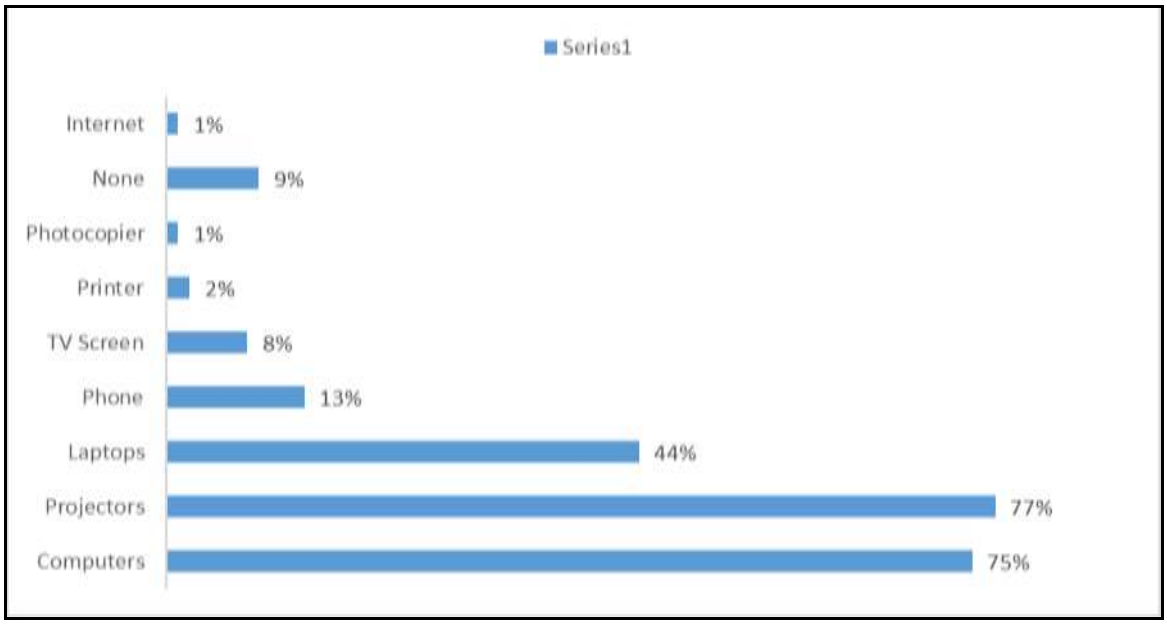


Figure 4.3(b): Main ICT resources in teaching and learning Biology as stated by students

Majority of the students indicated desktop computers, laptops and projectors as the most commonly used ICT since of all the 93 students involved in the study 70 (75%) indicated that they use computers, 72 (77%) projectors and 41 (44%) laptops. However, 8 (9%) of the students indicated that they did not have any ICT for teaching and learning of Biology in their respective schools. Desktop computers, laptops and projectors were listed as the most common ICT. The study findings showed that there were some ICT available in the schools and majority were desktop computers. Osama (2008) stated that there were a variety of ICT tools available for teaching and learning which include computer laboratory networks, digital microscopes with sensors for science subjects like Chemistry and Biology, data show/projectors, electronic whiteboards, digital cameras, audio visual devices and

soft-wares that allow for distributed teaching amongst networked computers. In addition to this, Sorgo (2010) indicated that computers were available for use in teaching if they were strategically located in a Biology classroom (or Biology laboratory). Therefore, for effective ICT integration, the available ICT should be easily accessible to the teachers and to the students for use in teaching and learning Biology.

4.5 Use of ICT in teaching Biology

The second objective of the study examined the use of ICT in teaching Biology. This determined the effectiveness of content delivery using ICT. The efficiency of ICT integration in teaching is determined by how the ICT is used in teaching. The information was obtained through students' and teachers' questionnaires and interview schedules for administrators and teachers. The researcher was interested in finding out lessons per week in which ICT is used in teaching Biology, the students' use of ICT in Biology lessons, the students' involvement in the use of ICT to perform tasks and finally the benefits of using ICT in teaching and learning Biology. Figures 4.4, 4.5, 4.6 and 4.7 show the results of the study.

4.5.1 Lessons per week in which ICT is used in teaching Biology

The researcher was keen to find out the number of lessons per week where ICT is used. This is because for effective integration of ICT in teaching and learning Biology, ICT should be used in almost every lesson. This helped the researcher to find out how regularly ICT is used in class. The information was collected using students' questionnaires and the findings represented in figure 4.4.

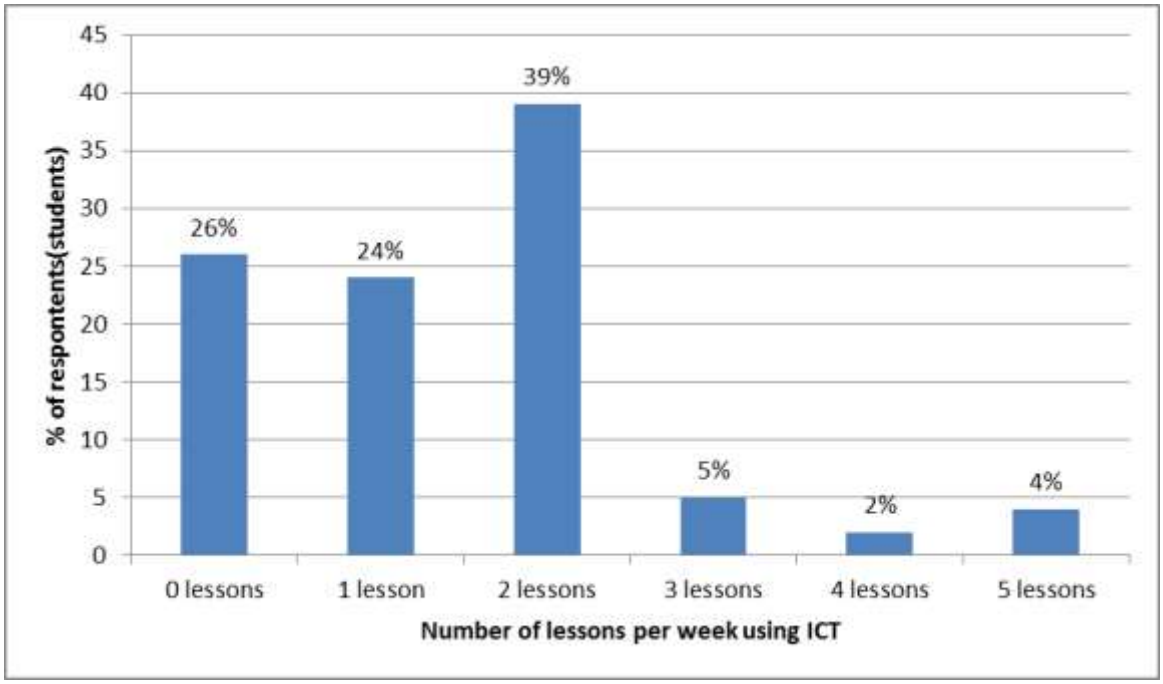


Figure 4.4: Lessons per week in which ICT is used in teaching Biology

According to figure 4.4, 24 (26%) of the students from the study schools indicated that they did not use ICT in learning Biology in any Biology lesson but 74% (69 students) indicated that ICT is used in teaching and learning Biology for at least one Biology lesson in a week. Gakime (2017) in his research study noted that learning in classroom depends on the teaching methods used in content delivery which influences the learning outcome. Therefore for effective integration of ICT in teaching Biology, ICT should be regularly used in almost all Biology lessons.

4.5.2 Students' use of ICT in Biology lessons

The researcher wanted to find out how the students were actively involved in the use of ICT in teaching and learning Biology. Students' questionnaires were used to find

out whether the students were actively involved in the use of ICT in teaching and learning Biology. Their responses are represented in figure 4.5.

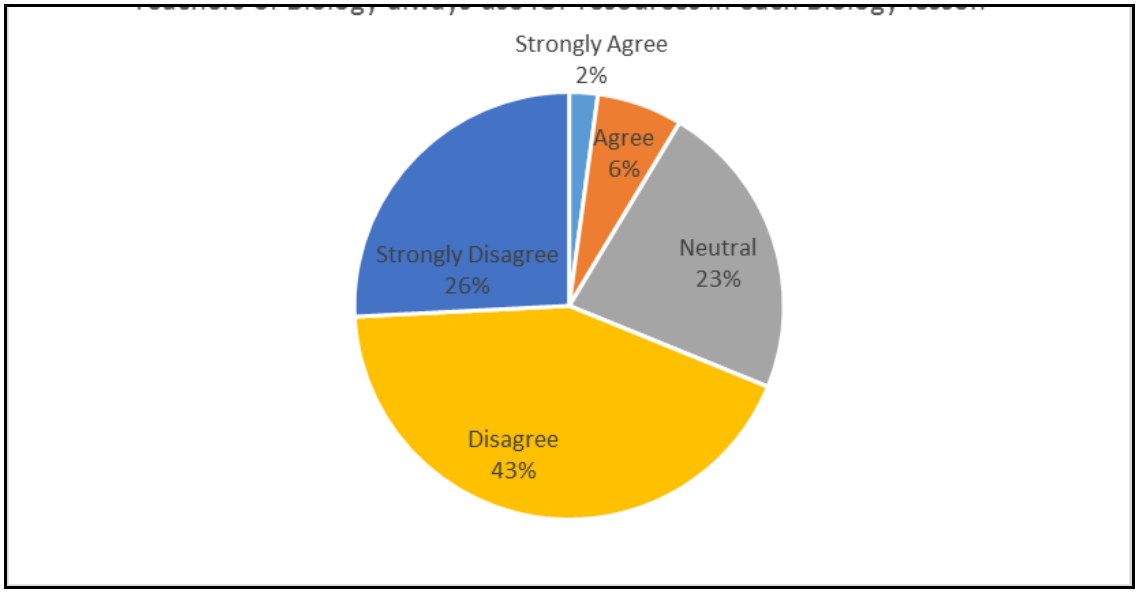


Figure 4.5: Students' use of ICT in Biology lessons

The information from the students on how they were activelly involved in the use of ICT showed that despite most of the students agreeing and indicating that most teachers use ICT in teaching Biology, only 8% of the 93 students sampled agreed to be actively involved in the use of ICT, while 69% disagreed that teachers involved them in the use of ICT in each Biology lesson. However, 23% of the students were not sure. This showed that most of the teachers do much of the work since they do not allow the students to use ICT when in class. The study findings by Mbugua, Kiboss and Tanui (2015) noted that ICT can be described as a catalyst in learning processes since it provides tools which teachers use to improve teaching and giving learners access to electronic media that make concepts clearer and more accessible to them. Therefore, learners should be actively involved in the use of the ICT in order to make the learning process more learners centered. This makes them to

easily understand the Biological concepts. However Sorgo (2010) pointed out that the presence of computers outside Biology classroom in a computer laboratory is not a guarantee that they are used in Biology instruction unless they are put into use. The availability of an ICT doesn't guarantee its use and hence teachers should ensure that the ICT is used in teaching Biology.

4.5.3 Students' involvement in the use of ICT to perform tasks

Teachers were also required to confirm whether they engaged their students in the use of ICT to perform learning activities and tasks when teaching and learning Biology. Teachers' questionnaires and interview schedules were used to gather the information. Their responses are summarized in figure 4.6.

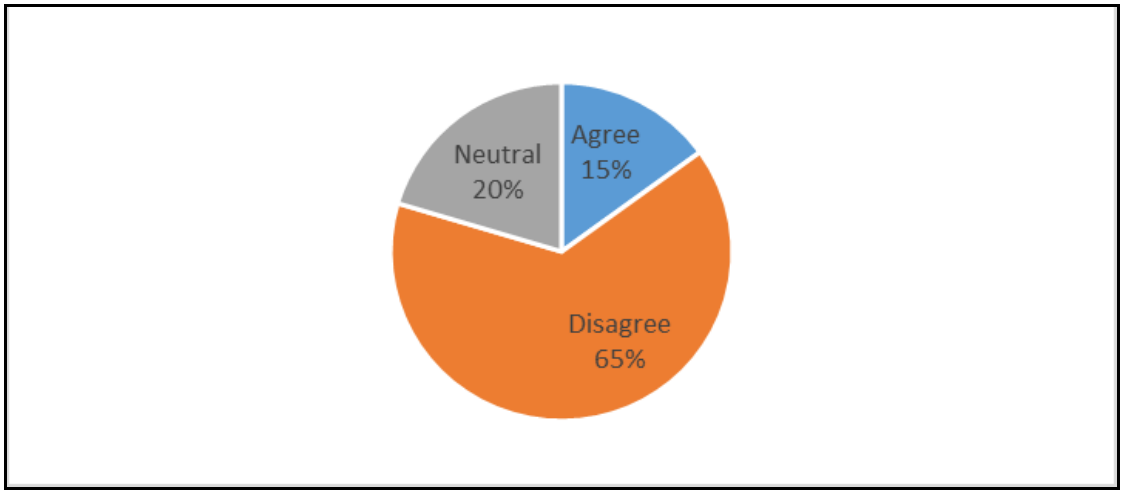


Figure 4.6: Teachers allowing students in using ICT in learning Biology

The study revealed that most teachers were not keen in allowing students to use ICT in performing tasks in Biology lessons. Only few teachers (15%) were willing to engage their students in using and operating ICT during the Biology lessons. The

results were in agreement with responses of some of the teachers interviewed. One of the Biology teachers commented;

> In fact I do not allow my students to handle ICT during my Biology lessons because I feel that this may result to breakdown of some of the ICT. In addition to this, most of my students lack the ICT skills to operate them and it becomes a challenge to use them in the teaching process. Therefore, I prefer doing much of the work as my students observe. Mostly, I just use demonstration method when using ICT in teaching Biology.

Teachers should let their students to be actively involved in handling ICT during the Biology lessons for ease in conceptual understanding in Biology. Based on the findings of Aina (2013), computers help the students to visualize objects that are difficult or impossible to view; for example, computers can be used to display human anatomy, internal structure of human and animal cells. Therefore, teachers should allow the students to do much of the work using ICT. This is because when the students operate the ICT, they become more engaged and active throughout the lesson, making understanding and hence learning of Biological concepts easier.

4.5.4 Benefits of use of ICT in teaching and learning Biology

The researcher also wanted to know the benefits associated with the use of ICT in teaching and learning Biology. This helps the teachers in deciding on the use of ICT in their teaching processes. The information was collected from students using students' questionnaires. This is as indicated in figure 4.7.

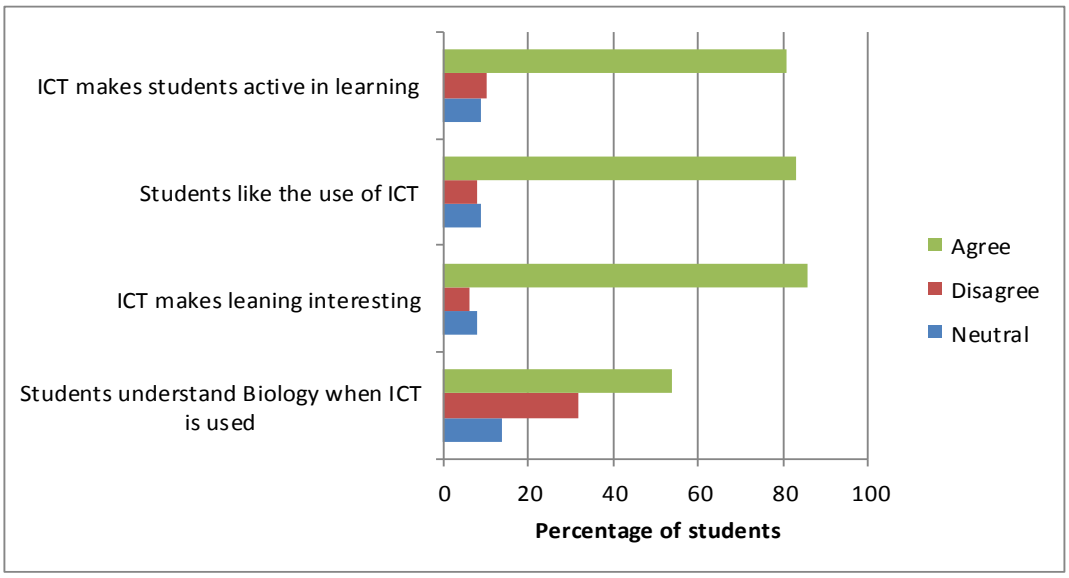


Figure 4.7: Benefits of use of ICT in teaching Biology

The study findings show that a big percentage [81 % (76 students)] of the 93 students involved in the study overwhelmingly supported the use of ICT in teaching and learning Biology. The students indicated that use of ICT in teaching and learning Biology makes them to be active in the lessons. However, a smaller percentage (18%) of the students thought otherwise. In addition to this, a bigger percentage of the students [83 % (78 students)] unanimously agreed that they liked the use of ICT in Biology lessons, while 86 % (80 students) concurred that the use of ICT makes learning interesting to them. Based on the fact that some schools do not have ICT resource facilities in their schools though, only a good number (50) of the students (54%) agreed to the fact that they easily understand Biology when ICT is used.

According to Abichandani (2012), Biological systems, Industrial chemical plants and concepts such as interactions within ecosystems, populations and food chains

can be explained using CD ROMS which are available with interactivity. This makes the students to easily understand such concepts which may seem difficult when ICT is not used in teaching them. Deany, Ruthven and Hennesy (2003) observed that while the quality and level of ICT continue to improve in many schools, provision of equipment alone is likely to be of limited value unless more is understood about the interactions and processes engendered by using technology in different settings, and how pedagogical strategies to enhance students' learning might be developed effectively through them.

4.6 Challenges faced by teachers in integrating ICT in teaching Biology

In the third objective, the study sought to find out the challenges faced by the teachers in integrating ICT in teaching Biology. The research used students' and teachers' questionnaires and interview schedules for the school administrators and teachers to gather the information on the challenges teachers faced in integration of ICT in teaching Biology. The researcher was interested in finding out the ratio of computers to the Form 3 Biology students, availability and accessibility of the ICT, electricity supply in the school. The respondents were required to list the challenges teachers encounter when integrating ICT in teaching and learning Biology. The study findings are represented in Figures 4.8, 4.9, 4.10, 4.11(a) and (b) and 4.12.

4.6.1 Ratio of Computers to Form Three Biology Students in the School

Computers are the commonly used ICT and therefore they should be sufficient enough to the learners for effective integration of ICT. The ratio of computers to

students was important. Teachers had to confirm whether the ratio of computers to the students in their Biology class was 1:2 since only a maximum of two students can comfortably use one computer. This was done using questionnaires. The state of affairs in the schools is represented in figure 4.8.

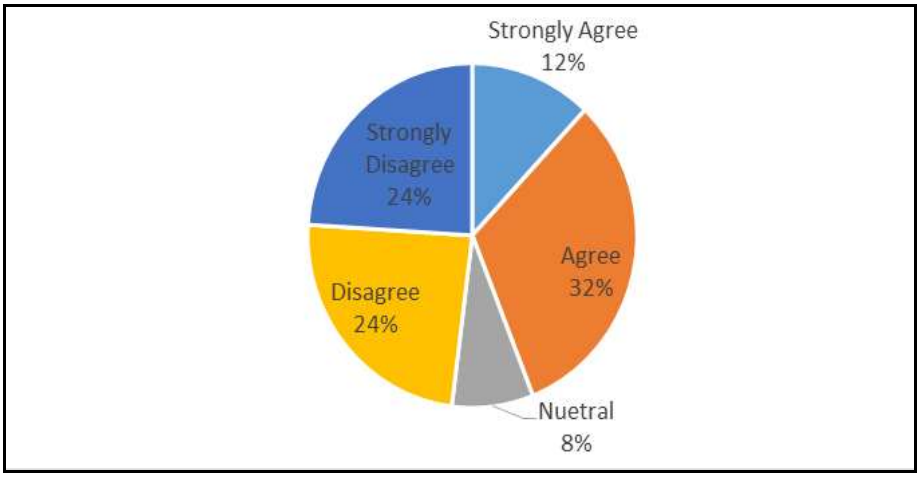


Figure 4.8: Ratio of computers to students in the school is 1:2

The research revealed that almost half (11) of the teachers (44%) agreed that the computers in the school were adequate for use in teaching Biology. Each computer can be comfortably used by a maximum of 2 students in every Biology lesson, but almost half (12) of the teachers (48%) disagreed with this. This therefore meant that the Biology classes in which ICT is used are likely to be congested with more than three students sharing access to one computer and hence posing a greater challenge to the teachers in terms of class control and effective learning by the students. A research study done by Abanikanndah (2018) observed that when fewer students make use of a technology in learning Biology in high schools, the technology influences students' interest in learning Biology. Therefore, the students should not be allowed to congest on a computer. There should be enough ICT for all the

students for use in teaching and learning Biology to ensure effective integration of ICT in teaching Biology.

4.6.2 Availability and accessibility of ICT in the School

Biology teachers were required to indicate through questionnaires and interview schedules the challenges they experience in terms of availability and accessibility of ICT. Some of the challenges they listed included limited ICT for teaching Biology, lack of internet connectivity, accessibility of the available ICT by teachers and students. These findings are as indicated in figure 4.9.

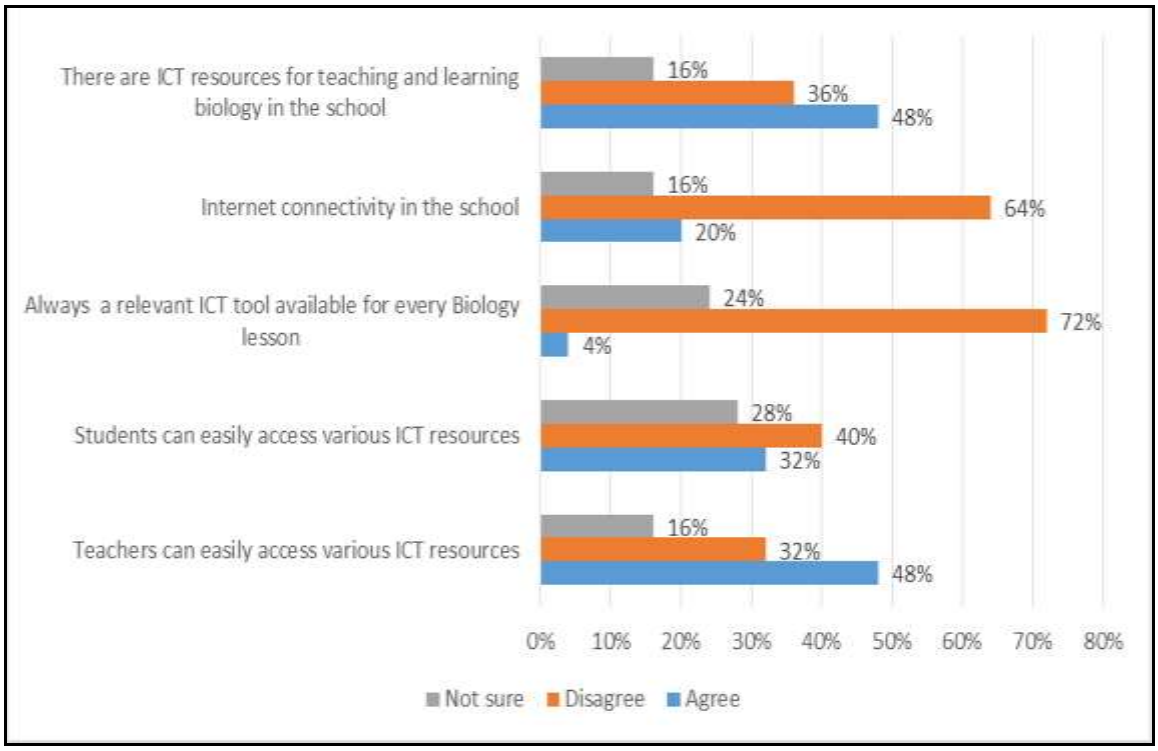


Figure 4.9: ICT status in various schools

The research observed absence of internet connectivity in most schools since a bigger percentage (64%) of the 25 teachers involved in the study indicated that there was no internet connectivity in the school. In addition to this, most of the teachers

(72%) involved in the study noted that there was hardly a relevant ICT tool for use in teaching Biology. This makes it difficult to integrate ICT in teaching Biology in the school. Further, 10 (40%) of the teachers in the study noted that the students couldn't easily access the various ICT while 12 (48%) of the teachers agreed that they had easy access to the various ICT in their respective schools. This posed a great challenge since according to Sorgo (2010), Biology teachers should have access to fully equipped computer laboratories with sufficient and different types of ICT in order to access and utilize them in teaching Biology and hence for effective ICT integration.

4.6.3 Electricity supply in the School

Lack of electricity supply in the schools may not be a key challenge to most of the schools though some schools still lack electricity supply. Electricity supply is important since it's used in running most of the ICT. Teachers were required to indicate whether electricity was available or not. The teachers' responses are as represented in figure 4.10.

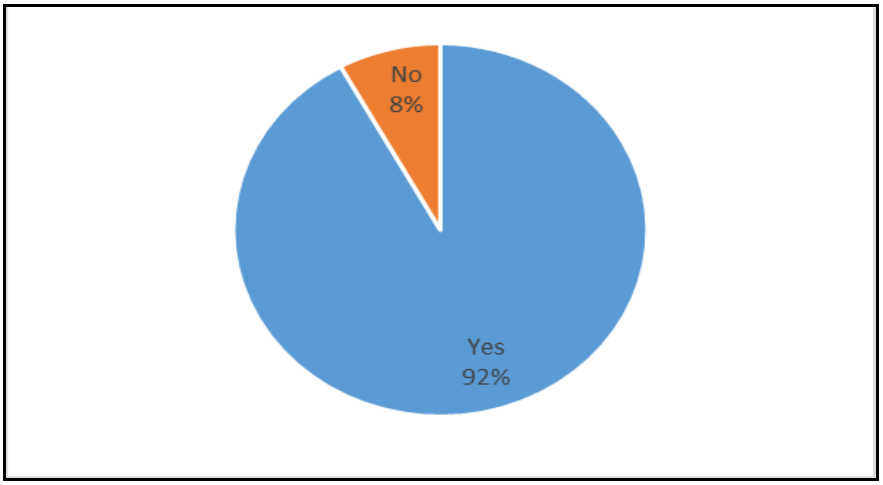


Figure 4.10: Electricity supply in the school

Majority of the teachers involved in the study [92 % (23 teachers)] indicated that there was electricity supply in the school while only 2 (8%) disagreed to the fact that there was electricity supply in their school. This meant that there were some schools without electricity supply and therefore had a great challenge in the use of ICT in teaching Biology.

4.6.4 Students', Teachers' and Administrators' responses on the Challenges experienced in integration of ICT in teaching Biology

The students through questionnaires were required to state the challenges experienced when using ICT in learning Biology. They noted that the key challenges to the use of ICT in learning Biology are lack of or insufficient ICT due to a high student and low resource ratio; poor electricity supply to the school or none at all; limited space or no laboratories present in the school and broken down computers. This is revealed in figure 4.11(a).

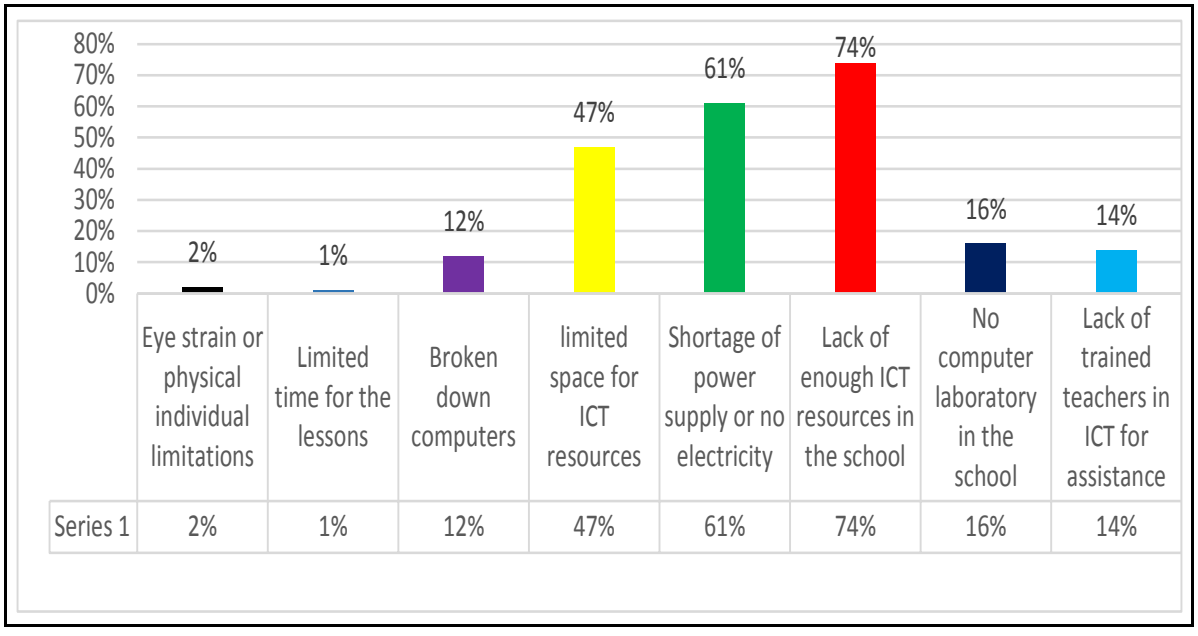


Figure 4.11(a): Challenges experienced by teachers in integration of ICT in teaching Biology as stated by the Form 3 Biology students

From the information in figure 4.11(a), the main challenges noted were lack of enough ICT (74% of the 93 students sampled indicated that there were no enough ICT in their school), shortage of power supply or even absence of electricity (61% stated that there was shortage of electricity supply) and limited space for ICT (47% stated that there was no enough room for the ICT in the school). The other challenges listed were insufficient time allocated for the Biology lessons, computer outbreaks, absence of computer laboratories, lack of teachers trained in ICT and straining a lot during learning processes. All these greatly affect the use of ICT in teaching and learning Biology.

Through Biology teachers' questionnaires and interview schedules, the teachers also highlighted the main challenges they face when integrating ICT in teaching Biology as inadequate skills by students in ICT, lack of properly trained personel in ICT, time wastage in connecting ICT, inadequate computer laboratory space for the students, lack of an equiped ICT Resource Centre, inadequate computers for the learners and unreliable electricity supply or frequent black outs. The information is represented in fiqure 4.11(b).

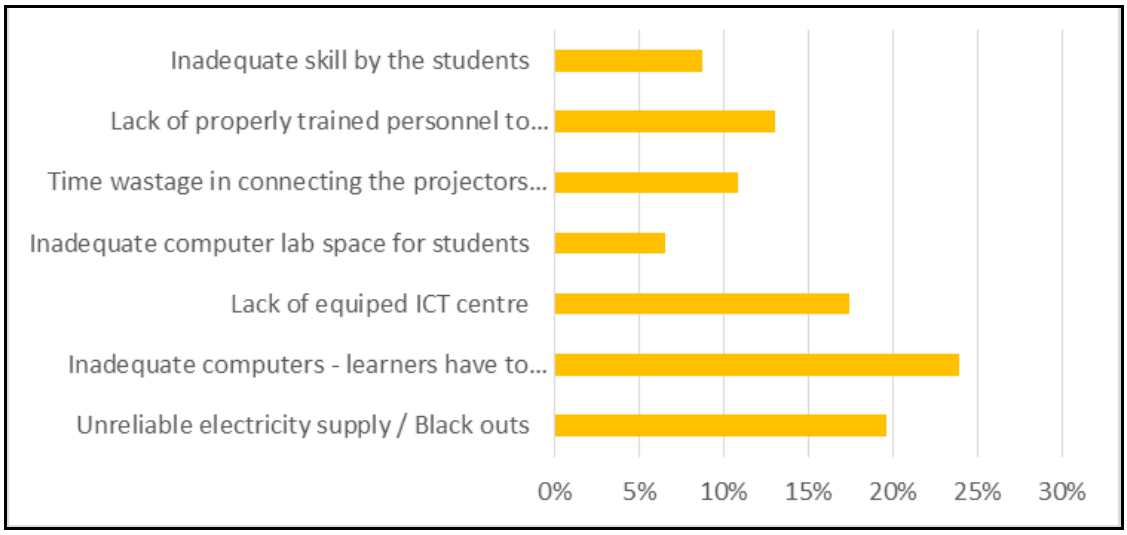


Figure 4.11(b): Challenges experienced by teachers in integration of ICT in teaching Biology as stated by Biology the teachers

Teachers stated the challenges they experience in the use of ICT in teaching Biology. The biggest percentage (24%) of the 25 teachers indicated inadequate computers, followed by unreliable electricity supply or blackouts(19.5% of the teachers) and then lack of equiped ICT Resource Centre (as indicated by 17.5 % of the teachers). Other challenges listed by the teachers include inadequate computer laboratory space, time wastage especialy in connecting computers, lack of properly trained personel to assist in ICT and inadequate skill by the students. These results are in agreement with the results from the interview schedules for the Biology teachers. One of the Biology teachers stated:

> We have a graet challenge in the use of ICT in teaching Biology in our school because there are very few computers in our school and are only in the computer laboratory. The computer laboratory is a small room that is not well equiped, with few computers resulting to congestion of students in a computer. In addition, we are not trained in ICT, electricity supply is a problem since there are usually frequent black outs and there is no any stand-by generator or any other alternative source of electricity to run the ICT. Our students do not even have the ICT skills to handle the ICT if any. The school's policy

is to complete syllabus as early as possible in order to have more time for revision and preparation for the National Examinations. We also work with targets and so we also faced by time challenges for completion of syllabus and revision for examinations.

The school administrators were also interviewed on the challenges that were experienced by the Biology teachers in the use of ICT in the school. They stated lack of skill or knowledge in the use of ICT; power or electricity shortage (blackouts); financial constraints in acquisition of ICT; insufficient time; inadequate ICT and few computers compared to the number of students. The information is represented in figure 4.12.

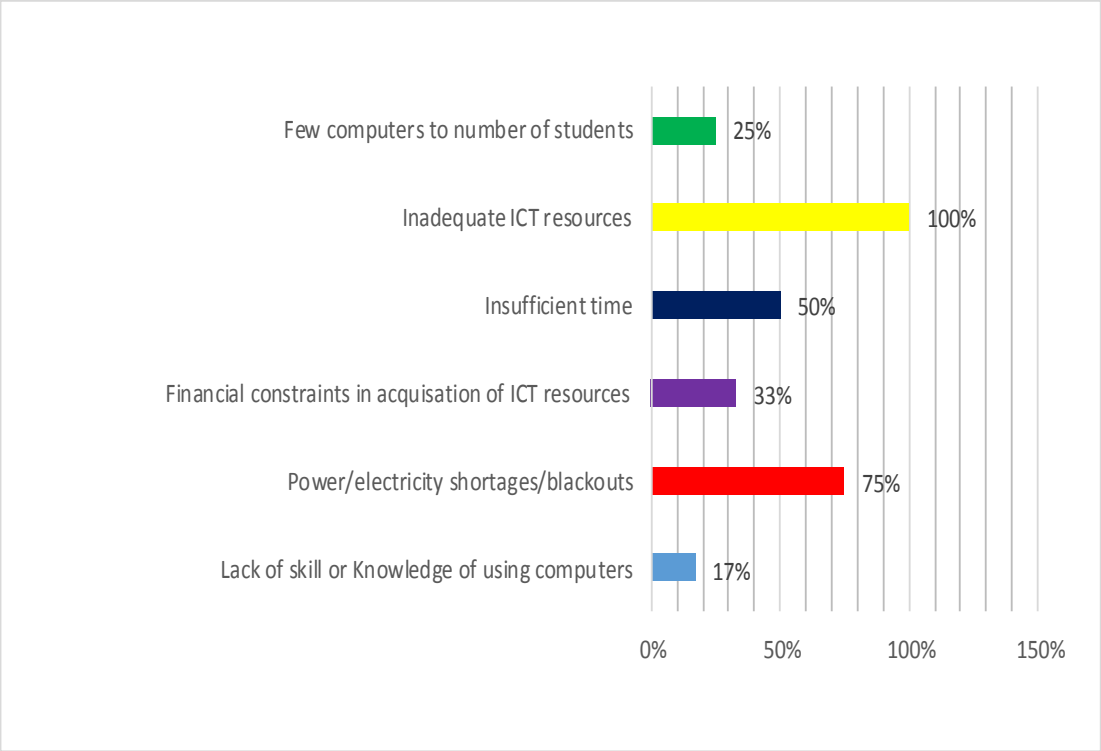


Figure 4.12: Challenges faced by teachers in the integration of ICT in teaching Biology as stated by the school administrators

All the 12 (100%) school administrators involved in the study noted the major challenge in the use of ICT in teaching and learning Biology lies in having inadequate ICT in the schools, followed by power outages and insufficient time for teaching using ICT as stated by 75% and 50% of the school administrators

respectively. Notably, 33% of the 12 administrators stated that there were financial constraints in the acquisition of ICT and 25% said that there were few computers in relation to the number of students. This therefore meant that there were fewer ICT for use in teaching and learning Biology. One of the school administrators interviewed pointed:

> Biology teachers in this school do not really integrate ICT in teaching Biology as expected. This is because the school is faced by financial constraints and it's unable to acquire the expected ICT and therefore we have fewer ICT. In addition, the school is unable to sponsor the teachers for ICT training making the teachers to lack the skills to operate the ICT. We are also faced with electricity challenges due to frequent blackouts and so the few computers in our small computer laboratory are not fully put into use. Lastly the school's policy is to complete syllabus early enough for the students to be given enough revision time in preparation for the National examinations. This means that all the teachers are in a hurry to complete syllabus, leaving a shorter or even no time for the use of ICT.

There was, however, some concern raised in lack of knowledge on how to use ICT in teaching Biology since 17% said that there was lack of skill in the use of computers. This can be well addressed by having capacity building for the teachers in which they would be trained on ICT. This is supported by the study of Bitok (2014) who recommended on the need for training of teachers who are not ICT competent to acquire ICT skills in order to be able to use the various ICT tools used in teaching Biology.

Generally, the study reveals the common challenges in the use of ICT in teaching Biology as lack of skill or knowledge in the use or handling of ICT in students and teachers; power or electricity shortage like frequent blackouts; insufficient time in the use of ICT in Biology lessons; inadequate ICT and few computers compared to the number of students. Most of the challenges cited are in line with the findings of Aladejana (2008) who stated that the various barriers to use of ICT in African

schools are poor infrastructure; epileptic power supply; lack of electricity; lack of trained personnel; poverty; inadequate funding and limited or no internet access. These challenges should therefore be addressed to enhance effective integration of ICT in teaching Biology.

4.7 Teachers' attitude towards integration of ICT in teaching Biology

The fourth objective of the study sought to determine the attitude of teachers towards integration of ICT in teaching Biology. Attitude is of importance because unless teachers have a positive attitude towards the integration of ICT in teaching Biology they may not use ICT in teaching Biology. The study was concerned with how teachers used the ICT, teachers' computer literacy and equipped ICT Resource Centre and teachers' interest in the use of ICT. The information was collected through the use of students' and teachers' questionnaires and also interview schedules for the school administrators and teachers. The results of the study are represented in figure 4.13 and tables 4.5 and 4.6.

4.7.1 Teachers' use of ICT in teaching Biology

Teachers' use of ICT in teaching Biology involves how they allow students to perform tasks using the ICT; whether they always use the ICT in every Biology lesson and whether they insist on use of the ICT when teaching Biology. The information was gathered through the use of Biology teachers' questionnaires and interview schedules. Figure 4.13 shows teachers' view on the use of ICT in teaching and learning Biology.

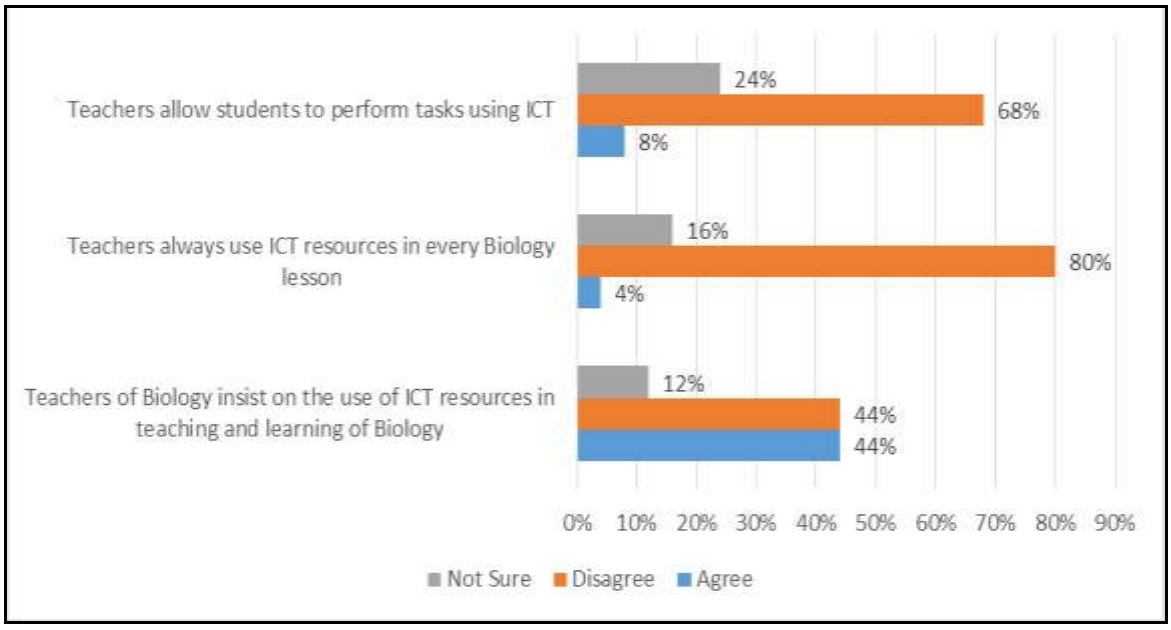


Figure 4.13: Teachers view on Integration of ICT in teaching and learning Biology

From the figure 4.13, the study deduced that only some few teachers (8%) allowed students to perform tasks using ICT in their respective schools, while 68% of them do not do so; 80% of the teachers never used ICT in their Biology lessons while only 16% use this. On whether the teachers insist on use of ICT however, 44% insisted on using ICT in teaching and learning, while 44% never insisted on the use of ICT. These results were in line with those from the teachers' interview schedules. In fact one of the Biology teachers was categorical and indicated:

> We do not actually allow the students to perform tasks using any of the available ICT because the ICT resources in this school are few and there are several classes that need them. We don't even regularly use the ICT and if one happens to use them, it's only done through demonstration. Personally I don't like using them because they are tedious and time consuming when assembling them and this will waste my time. This is because I would wish to complete my syllabus early enough and begin revision and preparation for the National Examinations. We have set KCSE targets and would wish to give more time to revision work by early completion of the syllabus. Therefore, we don't see the need for using ICT in teaching.

The use of ICT in teaching and learning Biology should be part of the Biology lesson and students need to be engaged in the use of ICT in the learning process. Bitok (2014) indicated that there should be continuous follow-up on teachers on efficient integration of ICT in teaching. In addition to this Mwunda and Ogutu (2018) observed that teachers need to be offered incentives like lower workload in order to embrace the use of ICT in their lesson delivery. This will give them enough time to prepare their ICT integrated Biology lessons.

4.7.2 Teachers' computer literacy and its effect on the use of ICT

Computer literacy enables teachers to be able to operate and use the various ICT. Through Biology teacher's questionnaires and interview schedules, teachers were required to indicate whether they were computer literate and whether ICT makes teaching of Biology interesting. The findings are recorded in table 4.5.

Table 4.5: Computer literacy in teachers and effect of use of ICT in teaching Biology; Cross tabulation

			ICT makes teaching and learning interesting			Total
			Strongly Agree	Agree	Strongly Disagree	
Are you computer literate?	Yes	Count	12	10	3	25
		% within Are you computer literate?	48.0%	40.0%	12.0%	100.0%
		% within ICT makes teaching and learning interesting	100.0%	100.0%	100.0%	100.0%
		% of Total	48.0%	40.0%	12.0%	100.0%

From the study, 88% of the teachers indicated that they were computer literate. In addition, 88% of the teachers agreed that ICT makes teaching and learning of Biology interesting but 12% of the teachers strongly disagreed, meaning that some teachers were not willing to use ICT in teaching Biology.The study findings of Bitok

(2014) recommended that there should be ongoing support for teachers so that they utilize their skills on Information Communication Technology in their teaching processes. Mwunda and Ogutu (2018) recommended that teacher's readiness to integrate ICT in teaching and learning processes need to be addressed by availing funds that could be used to organise in-service training of teachers and also to acquire the necessary infrastructure.

4.7.3 Equipped ICT Resource Centre and Teachers' interest in use of ICT in teaching and learning Biology

Teachers' interest in the use of ICT is based on their willingness to use the ICT in teaching Biology. The information was gathered in comparison with whether there was an equipped ICT Resource Centre or not. The information was collected using students' questionnaires where they were required to indicate whether their teachers liked using ICT in teaching Biology. The data was analyzed and presented as shown in table 4.6.

Table 4.6: Equipped ICT Resource Centre and Teachers interest in use of ICT in teaching and learning Biology; Cross tabulation

			Teachers of Biology in this school like using ICT when teaching Biology					Total
			Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	
Equipped ICT Resource Centre	No	Count	2	3	1	10	13	29
		% within Equipped ICT Resource Centre	6.9%	10.3%	3.4%	34.5%	44.8%	100.0%
		% within Teachers of Biology in this school like using ICT when teaching Biology	40.0%	27.3%	3.6%	45.5%	48.1%	31.2%
		% of Total	2.2%	3.2%	1.1%	10.8%	14.0%	31.2%
	Yes	Count	3	8	27	12	14	64
		% within Equipped ICT Resource Centre	4.7%	12.5%	42.2%	18.8%	21.9%	100.0%
		% within Teachers of Biology in this school like using ICT when teaching Biology	60.0%	72.7%	96.4%	54.5%	51.9%	68.8%
		% of Total	3.2%	8.6%	29.0%	12.9%	15.1%	68.8%
Total		Count	5	11	28	22	27	93
		% within Equipped ICT resource center	5.4%	11.8%	30.1%	23.7%	29.0%	100.0%
		% within Teachers of Biology in this school like using ICT when teaching Biology.	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	5.4%	11.8%	30.1%	23.7%	29.0%	100.0%

Notably, as shown in table 4.6, in the schools without ICT Resource Centre only 5.4 % (5) of the 93 students agreed that their teachers liked using ICT in teaching Biology while 24.8% (23) disagreed. In the schools with an equipped ICT Resource Centre, only 11.8% (11) of the 93 students agreed that their teachers liked using ICT in teaching Biology, while 28% (26) of the 93 students disagreed, despite their schools having an equipped ICT Resource Centre. Generally, 17.2 % (16) of the 93 students agreed that their teachers liked using ICT in teaching Biology but 52.7 % (49) of the students disagreed. This therefore was an indication that most of the

Biology teachers didn't have positive attitude towards the use of ICT in teaching Biology. This negatively affected ICT integration in teaching Biology. According to Buabeng-Andoh (2012), if teachers' attitudes towards the use of educational technology are positive, then they can easily provide useful insight about adoption and integration of ICT into teaching and learning processes. Bitok (2014) recommended that Biology teachers need to be trained on the value of ICT because many teachers tend to perceive themselves as technologically incompetent. Acikalin (2014) supported this by pointing out that there is need to increase teacher's knowledge and skills about how to use Instructional Technology and help them develop positive attitudes towards the use of ICT in teaching and learning. This is because when teachers have the ICT skills, they can readily and comfortably use ICT in teaching.

4.8 How the use of ICT in teaching Biology influences students' performance in Biology

The last objective of the study sought to establish whether the use of ICT in teaching Biology influences students' performance in Biology. The information was gathered using students' questionnaires, teachers' questionnaires and interview schedules for school administrators and Biology teachers, observation schedules and checklists. The research was interested in the commonly used ICT, the frequency of the use of ICT in Biology lessons, the rating of the use of ICT and the influence of the use of ICT in teaching on students' performance. The respondents were required to indicate whether the use the ICT in teaching Biology affects students' performance in

Biology. The study findings are as shown in tables 4.7 and 4.8 and figures 4.14, 4.15, 4.16 and 4.17

4.8.1 The Commonly used ICT in the School

Teachers identified the commonly used ICT in teaching and learning Biology as printers, laptops, cell phones/smart phones, projectors, computers, DVDs/CDs and TV screens as shown in figure 4.14.

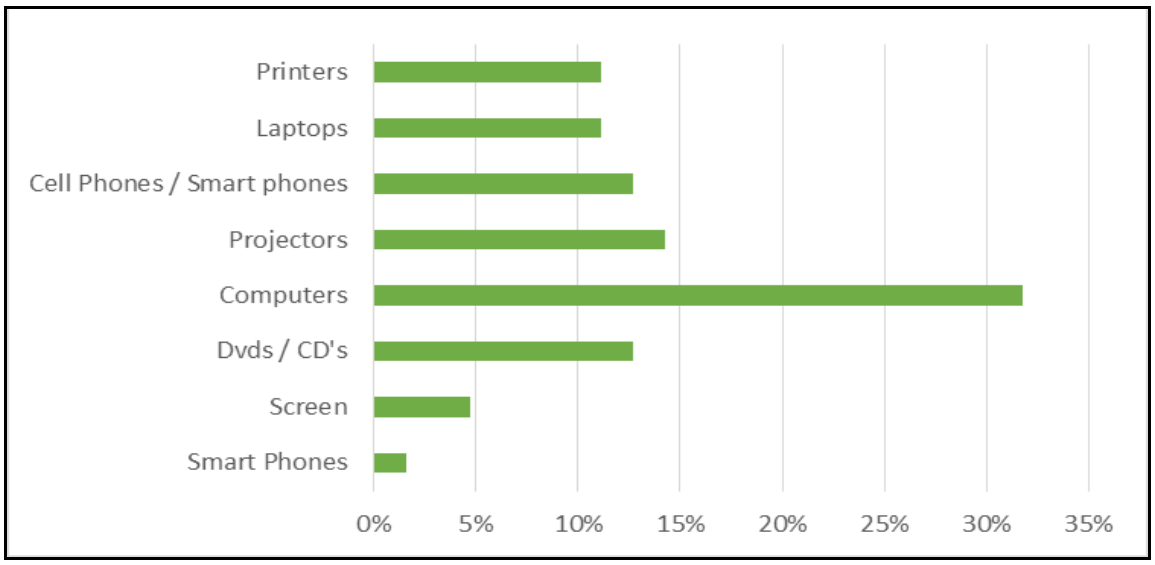


Figure 4.14: Commonly used ICT in teaching Biology

The commonly used ICT in teaching Biology in all the study schools as revealed by the study were printers, laptops, cell phone and smartphones, projectors, computers and TV screens. Most of the teachers also listed desktop computers, laptops and projectors as the most commonly used ICT in teaching Biology although 15% of the teachers also listed smartphones as being in use.

4.8.2 Frequency of use of ICT in Biology Lessons

In order to find out the frequency of the use of ICT, the student respondents had to indicate in their questionnaires how frequently ICT is used in teaching Biology. This was determined by indicating the number of Biology lessons per week ICT is used. This is because for effective integration of ICT in teaching Biology, ICT should be more frequently used in almost all the Biology lessons in a week. The students were required to indicate the frequency of the use of ICT in their schools depending on the number of Biology lessons in which ICT is used in a week as; Not really (where ICT was never used in any lesson), Less Frequently (for 1 lesson), Average (for 2 lessons), Frequently (for 3 lessons) and Most Frequently (for 4-5 lessons). Figure 4.15 clearly shows the frequency of the use of ICT in teaching and learning Biology.

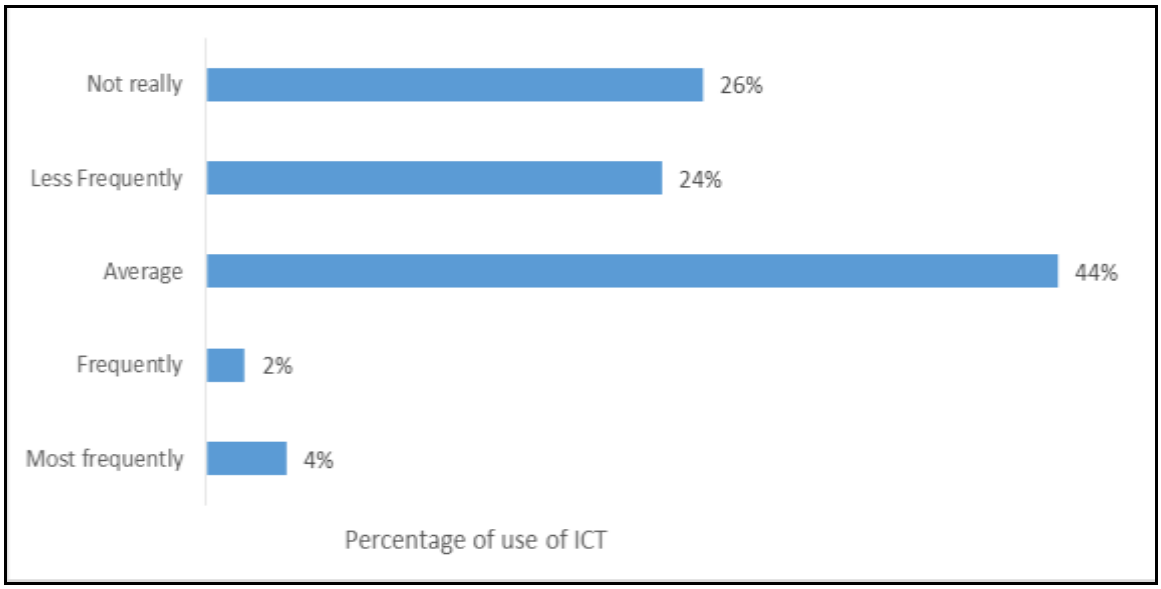


Figure 4.15: Frequency of use of ICT in Biology lessons per week

From the study, 26% (24) of the students indicated that they didn't even use any ICT in any of the Biology lessons, while 24% (22) of the 93 students noted that they less

frequently used ICT meaning that they used ICT in only one Biology lesson. But 44% (41) of the students said that the use of ICT in their schools in teaching and learning Biology is average (for about two Biology lessons in a week) and another 2% (2) indicated that they frequently used ICT (for three Biology lessons). Notably, 4% (4) of the students indicated to have used ICT more frequently (for four to five Biology lessons in a week). Basri, Alandejani and Almadani (2018) in their research concluded that there is a relationship between ICT adoption in teaching and academic performance since when ICT is used in teaching, there will be good academic performance. Therefore, there is need for use of ICT in almost all Biology lessons in order to have good performance. In addition to this Bitok (2014) states that teacher's preparedness in integrating ICT has a significant effect on teaching and learning Biology. Therefore, teachers should always be ready to use ICT when teaching Biology.

4.8.3 Rating of use of ICT in teaching and learning Biology

The students were told to rate how ICT is used in teaching and learning Biology per week. This is also a measure of how ICT is used in teaching Biology. The rating was also done based on the number of Biology lessons ICT is used in every week. The rating was done by indicating; Very Good (for 4-5 lessons), Good (for 3 lessons), Average (for 2 lessons), Poor (for only 1 lesson) and Very Poor (if ICT is never used in any lesson). Figure 4.16 shows how the students rated the use of ICT in teaching and learning Biology in the study schools.

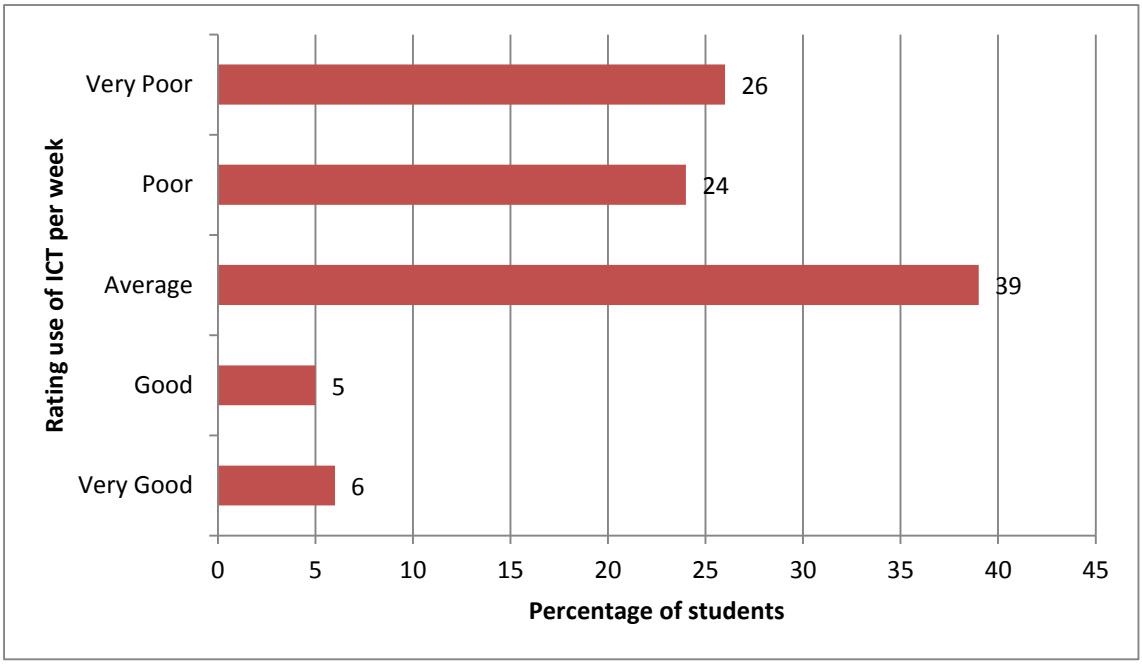


Figure 4.16: Rating use of ICT in teaching and learning Biology per week

From the student's remarks, 11% indicated that the use of ICT is above average while 39% stated that its average, but 50% indicated that it's below average.

Data was also collected from the school administrators using interview schedules. The information collected from the school administrators showed that despite the presence of internet connectivity in their schools they rated the use of ICT according to the results represented in table 4.7.

Table 4.7: School Administrators' rating on use of ICT in teaching Biology and presence of internet connectivity; Cross tabulation

			Rate the use of ICT in learning Biology in your school		Total
			Average	Poor	
Is there internet connectivity and services in your school?	No	Count	2	4	6
		% within Is there internet connectivity and services in your school?	33.3%	66.7%	100.0%
		% within Rate the use of ICT in learning Biology in your school	28.6%	80.0%	50.0%
		% of the 12 school administrators	16.7%	33.3%	50.0%
	Yes	Count	5	1	6
		% within Is there internet connectivity and services in your school?	83.3%	16.7%	100.0%
		% within Rate the use of ICT in learning Biology in your school	71.4%	20.0%	50.0%
		% of the 12 school administrators	41.7%	8.3%	50.0%
Total		Count	7	5	12
		% within Is there internet connectivity and services in your school?	58.3%	41.7%	100.0%
		% within Rate the use of ICT in learning Biology in your school	100.0%	100.0%	100.0%
		% of the 12 school administrators	58.3%	41.7%	100.0%

The school administrators who rated the use of ICT in teaching Biology as average were 7 (58.3%) out of the 12 school administrators involved in the study while 5 (41.7%) rated the use of ICT as poor. The use of ICT in teaching and learning Biology should be emphasized in Biology teachers. This is supported by Aina (2013) who emphasised that there are soft-wares that are already developed which show actions of viruses and bacteria. Therefore, if the teacher was to teach about these micro-organisms they cannot be learnt well without seeing them in action using ICT. This is also supported by Abichandani (2012) who pointed out that the teacher of the future must not only be accomplished in the use of ICT resources but also integration of ICT in teaching and learning. A research study by Mwunda and

Ogutu (2018) observed that there is need to develop a curriculum that encourages integration of ICT rather than leaving the decision to use ICT in teaching to the individual teacher. Thus, emphasis should be put in the use of ICT in teaching Biology.

4.8.4 Influence of use of ICT on students' Performance in Biology

The influence of the use of ICT in teaching Biology on performance in Biology examinations was of great significance to the study. The information was gathered from the school administrators using interview schedules and also from the Biology teachers using questionnaires and interview schedules where they had to state how the use of ICT in teaching Biology influences students' performance in Biology examinations. Figure 4.17 represents the results obtained from the responses of the school administrators.

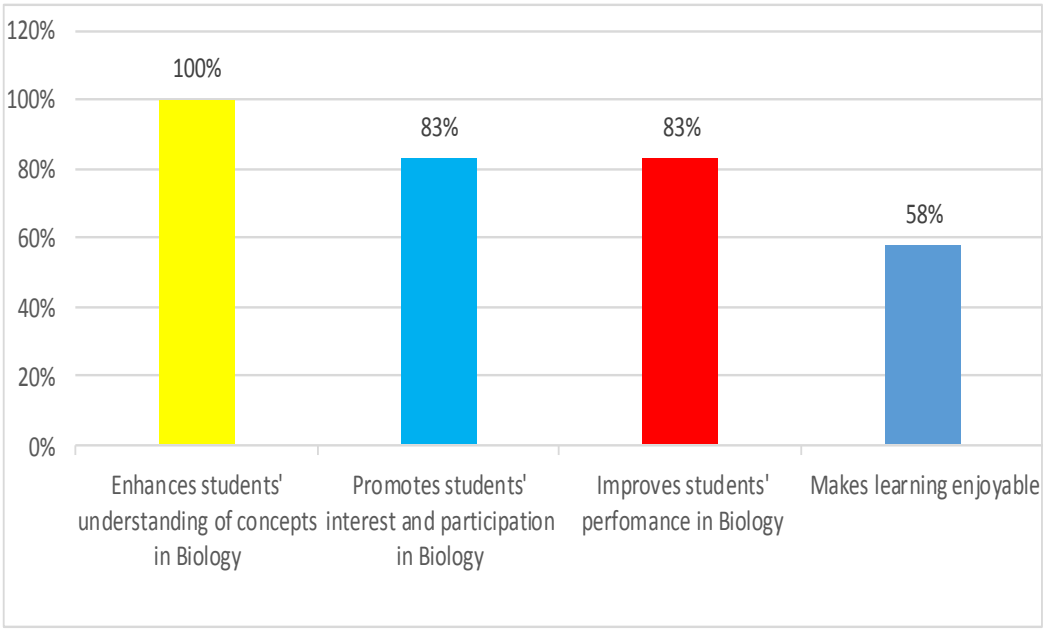


Figure 4.17: Influence of use of ICT on performance in Biology as stated by the school administrators

The study showed that all the school administrators were convinced that the use of ICT in teaching and learning Biology definitely enhances the students understanding of concepts taught in Biology. A good number (10) of the school administrators (83%) stated that the use of ICT promotes the students interest and participation in Biology lessons and also improves students' performance in Biology. The study also reveals that most of the school administrators had the feeling that the use of ICT makes learning enjoyable. As a matter of fact, one of the school administrators interviewed said:

> Personally, I do support the use of ICT in teaching and learning Biology because from the time the teachers began using ICT, we have recorded a remarkable improvement in performance in Biology. Our Biology teachers began using ICT in teaching Biology from the year 2014 and this made our performance in Biology to improve from a percentage mean score of 32.5 in the year 2013 to 44.2, 56.8, 54.4, 52.5, 55.3 in the years 2014, 2015,2016, 2017 and 2018 respectively. From the time we began using ICT in teaching Biology, we have never recorded a mean grade of E as before. In fact my students told me that when ICT is used, they easily understand what is taught, they develop a better interest in the lesson, fully participate in the class and enjoy the learning process resulting to good performance. Use of ICT in teaching is good for better understanding and good performance and should be emphasised.

These findings suggest that the use of ICT in teaching Biology enhances students' understanding and hence resulting to good performance. However, effective integration of ICT in teaching Biology occurs when ICT is used in teaching in all the Biology lessons. It was therefore important to collect data from the Biology teachers on how regularly they use ICT when teaching Biology and the students' performance.

The Biology teachers were required to indicate the number of Biology lessons per week they used ICT in teaching Biology and the performance of their students in

Biology especially from the year 2014. This would assist in establishing the influence of ICT integration in teaching Biology on students' performance. Therefore, the Biology teachers were required to state the number of lessons per week in which they were using ICT in teaching and the performance in Biology from the year 2014 to 2018. The data was used to determine the influence of ICT integration on students' performance in Biology. The teachers' responses on frequency of ICT use and performance in Biology are as in table 4.8.

Table 4.8: Number of Lessons per week ICT is used and Students' performance in Biology when ICT is used

Number of lessons using ICT per Week	Biology teachers' Count	Percentage Biology teachers' count (%)	Average percentage (%) KCSE mean score in Biology from the year 2014 to the year 2018					Students' performance [Average (%) mean]
			2014	2015	2016	2017	2018	
5	1	4.0	44.4	56.8	54.6	52.8	53.6	52.4
4	2	8.0	40.8	42.5	40.4	39.3	41.2	40.8
3	2	8.0	35.9	38.1	36.5	35.8	36.8	36.6
2	9	36.0	30.9	32.3	30.6	30.8	31.3	31.2
1	5	20.0	29.8	30.1	29.2	28.9	29.4	29.5
0	6	24.0	22.9	24.7	22.6	22.5	22.8	23.1

The research findings showed that 56% (14) of the 25 sampled teachers used ICT for at least two (2) Biology lessons per week and the performance in Biology was seemingly better (recording a mean score of above 30%) than for those who used ICT in only one Biology lesson per week or didn't even use ICT in any of the lessons since they had a mean score of below 30%. This is an indication that when

ICT is used, performance in Biology is likely to improve and students are likely to post better results. But the performance in Biology depends on the frequency of the use of ICT in teaching Biology. The more the number of Biology lessons ICT integration is done in a week, the better the performance of the students in the Biology examinations. Table 4.8 can therefore be summarized by figure 4.18.

Relationship between the numbers of lessons using ICT per Week versus Students' performance [Average percentage (%) mean] in Biology from the year 2014 to 2018

Number of lessons using ICT per Week	Students' performance[Average percentage (%) mean]
5	52.4
4	40.8
3	36.6
2	31.2
1	29.5
0	23.1

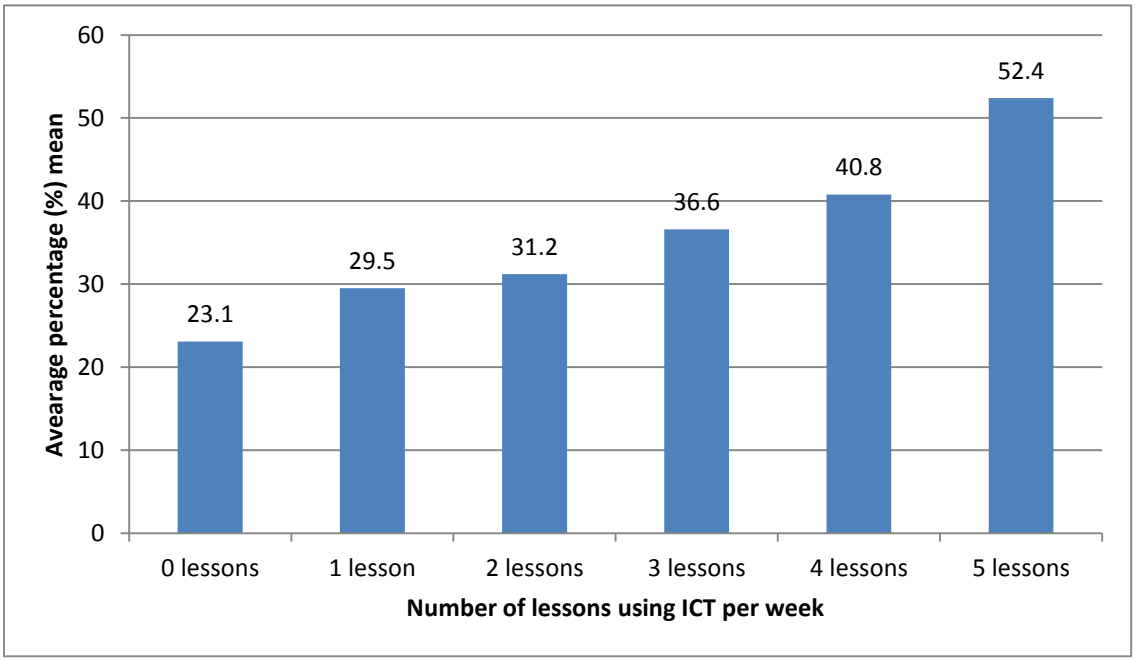


Figure 4.18: Relationship between the number of Lessons per week ICT is used and the average Students' performance (average percentage mean scores) in Biology when ICT is used from the year 2014 to the year 2018.

From the study findings, it's now clear that teachers who used ICT in all their Biology lessons recorded better performance than those who didn't regularly use ICT or never used ICT in any of the Biology lessons. The teachers who used ICT in all the 5 lessons recorded an average mean score of 52.4% while those who didn't use ICT at all had an average mean score of 23.1%. Therefore the more the number of Biology lessons ICT was used the better the performance of the students in Biology examinations. These results are in agreement with the teachers' responses from the interview schedules. One of the Biology teachers indicated:

> The use of ICT in teaching Biology has resulted to a remarkable improvement in performance in Biology in our school. Our school has recorded a positive improvement in academic performance in Biology from a mean of 38.5 in 2016 to a mean of 50.2 in 2018. The reason behind the improved performance in Biology is because from my observations, most of the Biological concepts and processes are well understood when ICT is used. When we were not using ICT in teaching Biology, teaching was abstract and the most challenging concepts and topics were difficult to the teachers and students. They could not easily understand them but now, from the year we began integration of ICT in teaching Biology, the students could now easily understand the Biological concepts and hence performance in Biology has improved. Surely, I really support the use of ICT in learning, for improved academic performance and hence good performance in Biology examinations.

These findings are supported by the research findings of Van Rooy and Wilhemina (2012) who observed that teachers incorporate ICT in teaching, however limited, in order to improve the quality of student learning and to translate to good performance. Omollo, Indshi and Ayere (2013) pinpointed out that the use of ICT like computer technology and internet is intended to enable teachers facilitate learning more effectively and enhance students' understanding of concepts which are expected to translate into expansion of knowledge and improved examination

outcomes which results to good performance. Research findings by Mbugua, Kiboss and Tanui (2015) showed a positive influence on students' performance with the integration of ICT in teaching, meaning that when ICT is used in teaching Biology, the performance of students would be good. Abanikannda (2018) recommended that the government and other stake holders in education should provide support in the use of ICT in teaching and learning process in schools for good performance. Gakime (2016) clarified that integration of ICT in teaching and learning would not only improve performance but also encourage interest and develop skills of problem solving and life-long learning. In conclusion, integration of ICT in teaching Biology results to good performance. But effective integration of ICT in teaching Biology requires that ICT is used in all Biology lessons.

4.9 Summary

This chapter focused on findings, interpretation and discussions. All the findings of the study on influence of integration of ICT in teaching Biology on students' performance were corroborated in the research. First, the study sought to find out the ICT resources available for use in teaching Biology. Computers, projectors and laptops were the most commonly used ICT resources while some schools used mobile phones, TV screens, printers and the internet. But it was also noted that some schools did not have any ICT resources for teaching Biology. Secondly, the study sought to examine the use of ICT in teaching Biology. The study findings showed that some teachers did not use ICT in teaching Biology in any of the Biology lessons while others used ICT in only one or two Biology lessons per week and others used ICT in three to five lessons in a week. Effective integration of ICT in teaching Biology requires the use of ICT in every Biology lesson. Third, the study sought to

find out the challenges faced by teachers in integration of ICT in teaching Biology. The key challenges faced include lack of or insufficient ICT resources due to a high student and low resource ratio, followed by poor electricity supply and frequent blackouts to the school or none at all, limited space or no ICT laboratories present in the school and broken down computers, lack of skill or knowledge in the use of ICT, financial constraints in acquisition of ICT resources, insufficient time for teaching using ICT, inadequate ICT resources in the schools and few computers compared to the number of students. Fourth, the study sought to determine the attitude of teachers towards integration of ICT in teaching Biology. The study established that most of the teachers do not have a positive attitude towards the use of ICT in teaching Biology. This affects integration of ICT in teaching Biology since such teachers are not willing to integrate ICT in teaching Biology. Lastly, the study sought to establish whether the use of ICT in teaching Biology influences students' performance. The study established that when ICT is used in teaching Biology, performance in Biology is likely to improve and students are likely to post better results. The study concludes that integration of ICT in teaching Biology results to good performance in Biology examinations.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of the study findings, conclusion, recommendations and suggestions for further study. The summary is organized around the ICT resources available in the schools for teaching Biology, the use of ICT in teaching Biology, the challenges faced by teachers in integrating ICT in teaching Biology, the attitude of teachers towards integration of ICT in teaching Biology and whether the use of ICT in teaching Biology influences students' performance in Biology. The final section is on the conclusion on the study findings and recommendations for further research based on the findings of the research study.

5.2 Summary of findings

The research study sought to investigate the influence of integration of ICT in teaching Biology on students' performance in secondary schools in Mbooni-East Sub-county in Makueni County, Kenya. The respondents of the study were Form 3 students, Biology teachers and School administrators. Questionnaires for the students and teachers, interview schedules for the school administrators and teachers and observation checklists were used in data collection to increase reliability. The summary presented here is based on the findings of the study and it is done as per the study objectives.

5.2.1 ICT resources available for teaching Biology

The first objective of the study sought to find out the ICT resources available in the schools for teaching Biology. The findings revealed that there were some ICT resources used by teachers in teaching Biology. The study noted that the main ICT resources used in teaching and learning of Biology are computers, laptops and projectors, while in some schools they have access to use of mobile phones, TV screens, printers and internet. Desktop computers, laptops and projectors were listed as the most commonly used ICT resources since 75% of the students indicated the use of desktop computers, 44% indicated the use of laptops while 77% indicated the use of projectors. At average the study found out that desk top computers were 51%, projectors 46%, laptops 30%, smart phones 11%, TV and DVD players 6%, CD and DVDs 8% and printers 7%. But the study also noted that some schools did not have any ICT for teaching Biology.

5.2.2 Use of ICT in teaching Biology

The second objective of the study examined the use of ICT in the teaching Biology. From the study, 26% of the students indicated that teachers did not use ICT in teaching Biology in any of the Biology lessons, while 63% noted that teachers use the ICT in only one or two Biology lessons per week while 11% of the students indicated that teachers use ICT in three to five lessons in a week. Therefore the study noted that majority of the teachers did not use ICT in teaching Biology in any of the Biology lessons. Others used the ICT in only one or two Biology lessons per week while only very few used them in three to five lessons in a week. This should not be the case because effective integration of ICT in teaching Biology involves the use of ICT in almost every Biology lesson. Several students indicated that teachers

do not use the ICT in teaching Biology and they didn't even allow their students to use the ICT to perform some tasks when teaching Biology. In addition to this the students overwhelmingly supported the use of ICT in teaching Biology since majority (82%) indicated that the use of ICT in teaching and learning Biology makes them active in the lessons. Most (84%) of the students agreed that they like the use of ICT in Biology lessons. Almost all the students (86%) concurred that the use of ICT in teaching Biology makes learning interesting. Based on the fact that some schools do not have ICT facilities or centers, majority (54%) of the students agreed to the fact that they easily understand Biological concepts when ICT is used.

5.2.3 Challenges faced by teachers in integrating ICT in teaching Biology

The third objective of the study sought to find out the challenges faced by the teachers in integrating ICT in teaching Biology. The research study identified various challenges faced in integrating ICT in teaching Biology. The key challenges include lack of or insufficient ICT resources due to a high student and low resource ratio; poor electricity supply and frequent blackouts or none at all; limited space or no laboratories present in the school; lack of skill or knowledge in the use of ICT; financial constraints in acquisition of ICT resources; insufficient time for teaching using ICT; inadequate ICT resources in the schools and few computers compared to the number of students. The information gathered from the students showed that 74% of the students indicated lack of enough ICT, 61% indicated shortage or lack of electricity, 47% indicated limited space for ICT resources, 16% lack of computer laboratory and 14% indicated lack of trained ICT teachers. In addition, 24% of the teachers indicated in adequate computers, 19.5% stated unreliable electricity, 17.5%

stated lack of equipped ICT Resource Centre, 13% indicated lack of trained ICT personnel, 12% stated wastage of time when connecting the ICT and 7% stated that there is inadequate space. From the school administrators, 100% of them indicated inadequate ICT, 75% stated electricity problems, 50% indicated inadequate time for using ICT, 33% indicated financial constraints, 25% stated few computers and 17% stated lack of ICT skills. There was, however, some concern raised in lack of knowledge in the use ICT in teaching Biology. This can be well addressed by having capacity building for the teachers in which they would be trained on the use of ICT.

5.2.4 Attitude of teachers towards integration of ICT in teaching Biology

The fourth objective of the study sought to determine the attitude of teachers towards integration of ICT in teaching Biology. It was evident that teachers' attitude towards the integration of ICT in teaching Biology was important as it determines the usage of the ICT in every Biology lesson. From the study it was deduced that very few teachers allow students to perform tasks using ICT in their respective schools, while majority of the teachers do not do so. From the study findings, majority of the teachers (80%) never used ICT in their Biology lessons but very few (16%) used the ICT. Notably, 88% of the teachers were computer illiterate. In addition to this, the study findings showed that out of the schools with an equipped ICT Resource Centre, only few teachers liked using ICT while teaching Biology as indicated by 11.8% of the students, but the majority of the teachers did not like using ICT while teaching Biology (as indicated by 28% of the students) despite their schools having an equipped ICT Resource Centre. Generally 17.2% of the students

agreed that their teachers liked using ICT in teaching Biology while 52.7% of the students disagreed. In fact, almost all the teachers (88%) who stated that they were computer literate agreed that use of ICT makes teaching and learning of Biology interesting though they do not frequently use them. The information gathered from the teachers indicated that 44% of the teachers insisted on the use of ICT and hence have a positive attitude towards use of ICT. However, 44% didn't necessarily insist on the use of ICT while 12% were not willing to state on their willingness to use ICT in teaching Biology. This is an indication that most of the teachers do not have a positive attitude towards the use of ICT in teaching Biology and so negatively affecting integration of ICT in teaching Biology.

5.2.5 How the use of ICT in teaching Biology influence students' performance in Biology

The last objective of the study sought to establish whether the use of ICT in teaching Biology influences students' performance in Biology. The study generally found that some teachers rarely or did not use ICT in teaching Biology since 24% of the students noted that they less frequently use ICT in teaching and learning Biology while 26% noted that they did not even use ICT in any of the Biology lessons and 44% said that the use of ICT in teaching and learning Biology was average (for about two Biology lessons in a week). Most of the school administrators indicated that use of ICT in teaching Biology would definitely enhance the students understanding of concepts taught in Biology; it would make learning enjoyable and would promote the students interest and participation as well as improve students' performance in Biology. From the study findings, 83% of the school administrators

said that the use of ICT in teaching Biology improves the students' performance and hence results to good performance. In addition, the study showed that 56% (14) of the 25 sampled teachers used ICT for at least two (2) lessons and recorded a better performance in Biology than for those who used ICT in only one lesson per week or never used ICT in any of the Biology lessons. This showed that when ICT is used, performance in Biology is likely to improve and the students' performance would be good. Table 4.8 presents a summary of the findings based on the number of lessons per week ICT is used. Teachers who used ICT in teaching Biology in all the Biology lessons in a week recorded a better average mean score of 52.4% than those who didn't use ICT in all the lessons or never used ICT in any of the Biology lessons. The findings in table 4.8 can be summarized by table 5.1;

Table 5.1: Number of Lessons per week ICT is used versus Students' performance in Biology

Number of lessons using ICT per Week	Biology teachers' Count	Percentage Biology teachers' count (%)	Students' performance[Average (%) mean]
5	1	4.0	52.4
4	2	8.0	40.8
3	2	8.0	36.6
2	9	36.0	31.2
1	5	20.0	29.5
0	6	24.0	23.1

Effective integration of ICT in teaching Biology is when ICT is used regularly in all the Biology lessons. Teachers who used ICT in teaching in more Biology lessons

recorded better results than those who used ICT in teaching Biology in fewer Biology lessons or didn't even use ICT in any of the Biology lessons. Therefore, the more the number of Biology lessons ICT is used in teaching and learning Biology, the better the students' performance in Biology. Thus, this study concludes that integration of ICT in teaching Biology results to good performance in Biology examinations.

5.3 Conclusion

Based on the findings of the research study it was concluded that integration of ICT in teaching Biology is not done as expected since most teachers rarely use or do not use ICT in teaching Biology. This is mainly due to the unavailability of the ICT resources, the several challenges associated with integration of ICT or even negative attitude of the teachers towards the use of ICT in teaching Biology. This therefore affects integration of ICT in teaching Biology in the secondary schools and hence affecting the performance of students in Biology. Schools where ICT is used for at least two (2) Biology lessons per week recorded a better performance in Biology examinations than those where ICT is used in only one Biology lesson a week or none at all. There is also need for provision of adequate and variety of ICT to meet all the learner's needs. Effective integration of ICT in teaching Biology occurs when there is adequate ICT and is used in all the Biology lessons. The study concludes that integration of ICT in teaching Biology results to good performance in Biology examinations.

5.4 Recommendations

The following recommendations were made based on the findings of the study;

a. School administrators should ensure that there is a variety of ICT for teaching Biology.
b. Teachers should vary the use of ICT in every Biology lesson to create interest in the learner.
c. Teachers should integrate ICT in every lesson for effective conceptual understanding in Biology.
d. Teachers need to be sensitized on the role of ICT integration for effective teaching of Biology.
e. The schools' administration should ensure that they have equipped and spacious ICT Resource Centre or computer laboratories.
f. There is need for regular workshops and seminars for Biology teachers or even in-servicing of teachers on effective integration of ICT in teaching and learning Biology.
g. There is need to come up with ways of improving teachers' attitude towards ICT integration in teaching Biology

5.5 Suggestions for further research

The following suggestions are deemed pertinent to the study:

a. Identify how the curriculum can be restructured to adequately cater for an effective and total integration of ICT in teaching and learning of Biology and other subjects.

b. Find out how best learners can be effectively involved in the use of ICT in learning Biology for effective conceptual understanding in Biology and other subjects.
c. Consider the need for regular assessments to find out the effectiveness of integration of ICT in teaching Biology and other subjects.
d. Establish extent into which integration of ICT has been done in teaching Biology and other subjects in other Sub-counties in Kenya.
e. Identify effective strategies that teachers can use for maximum integration of ICT in teaching of Biology and other subjects.

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APPENDICES

APPENDIX A: Letter to Respondents

SCHOOL OF EDUCATION

DEPARTMENT OF EDUCATIONAL COMMUNICATION & TECHNOLOGY

KENYATTA UNIVERSITY

P.O BOX 30197

NAIROBI.

Dear Sir/Madam;

RE: REQUEST FOR YOUR PARTICIPATION IN THIS STUDY

I am a post graduate student in Kenyatta University in the Department of Educational Communication and Technology currently carrying out Research on integration of ICT in teaching and learning Biology in Mbooni-East sub-county, Makueni County.

You are kindly requested to take part in the study.

All information given will be treated with a lot of confidentiality.

Thanks in advance for your co-operation in the study.

Yours sincerely

NDOLO LEONARD MUSAU

APPENDIX B: Questionnaire for Form 3 Biology students

I am a post-graduate student at Kenyatta University, carrying out Research on integration of Information and Communication Technology (ICT) in teaching and learning of Biology. This questionnaire is designed to gather information on the same from the Form 3 Biology students. You are therefore kindly requested to give responses to all the questions. The information will be treated with a lot of confidentiality and will only be used for this study. Please tick (✓) where appropriate. Thanks in advance

1. Name of School:_____

   Please tick (✓) where appropriate in relation to your school:

2. Sex: Male ☐ Female ☐

3. The type of school:

   Mixed Day ☐ Mixed Day & Boarding ☐ Mixed Boarding ☐

   Girls' Boarding ☐ Boys' Boarding ☐

4. There is an equipped ICT resource center: YES NO

5. How frequently is ICT used in Biology lessons? 4-5 lessons Most frequently

   3 lessons Frequently **2 lessons** Average **1 lesson** Less frequently

   0 lessons Not really

   Please tick (✓) where appropriate in relation to your school:

(**SA**-Strongly Agree, **A**-Agree, **N**-Neutral, **D**-Disagree, **SD**-Strongly Disagree)

		SA	**A**	**N**	**D**	**SD**
6	There are ICT resources for teaching and learning of Biology in the school					
7	Students can easily access the various ICT in this school					
8	Teachers of Biology always the ICT in each Biology lesson					
9	Teachers of Biology allow students to perform tasks using the					

	ICT					
10	Teachers of Biology in this school like using ICT when teaching Biology					
11	Students in this school easily understand Biology when ICT is used					
12	ICT makes learning interesting to students					
13	Students like the use of ICT in Biology lessons					
14	ICT makes the students to be active in the Biology lessons					

15. List down the main ICT used in teaching and learning of Biology in your school.

16. List down the challenges experienced by teachers in the use of ICT in teaching and learning of Biology in your school.

17. Suggest solutions on how to overcome these challenges.

18. How many lessons per week do you use ICT in learning Biology? (Tick (✓) where appropriate)

5 ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ 0 ☐

19. How can you rate the use of ICT in teaching and learning of Biology in terms of the number of Biology lessons per week it is used? (Tick (✓) where appropriate)

Excellent (5lessons) ☐ Very Good (4 lessons) ☐ Good (3 lessons) ☐

Average (2 lessons) ☐ Poor (1 lesson) ☐ Very Poor (0 lessons) ☐

Thank you for your co-operation

APPENDIX C: Questionnaire for Biology teachers

I am a post-graduate student at Kenyatta University, carrying out Research on integration of Information and Communication Technology (ICT) in teaching and learning Biology. This questionnaire is designed to gather information on the same from the Biology teachers. You are therefore humbly requested to give responses to all the questions. The information will be treated with a lot of confidentiality and will only be used for this study. Please tick (✓) where appropriate. Thanks in advance

1. Name of School:_____
2. Number of Form 3 students taking Biology :_____

Please tick (✓) where appropriate in relation to your school:

3. Sex: Male ☐ Female ☐
4. Your age in Years: 20-30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐
5. Your Highest Academic level:

Diploma ☐ Bachelor's Degree/PGDE ☐ Masters ☐ PhD ☐

6. Professional Experience in Years:

0-2 ☐ 3-4 ☐ 5-6 ☐ 7-8 ☐ 9 & above ☐

7. Experience in your current station in Years:

0-2 ☐ 3-4 ☐ 5-6 ☐ 7-8 ☐ 9 & above ☐

8. There is an equipped ICT resource center: YES NO

9.Are you computer literate? YES NO

10. How frequently do you use ICT in Biology lessons?

Most Frequently (4-5 lessons)	Frequently (3 lessons)	Average (2 lessons)	Less Frequently (1 lesson)	Not Really (0 lessons)

Please tick (✓) where appropriate in relation to ICT facilities in your school:

(**SA**-Strongly Agree, **A**-Agree, **N**-Neutral, D-Disagree, **SD**-Strongly Disagree)

		SA	**A**	**N**	**D**	**SD**
11	The ratio of computers to Form 3 Biology students in the school computer Laboratory is less than 1:3					
12	Biology teachers in this School can easily access the various ICT					
13	Students in this School can easily access the various ICT					
14	There is always a relevant ICT available for every Biology lesson					
15	There is internet connectivity & services in the School					
16	There are ICT for teaching and learning Biology in this school					
17	There is electricity supply in the School					
18	Biology teachers insist on the use of ICT in teaching and learning of Biology					
19	All Biology teachers in this school always use the ICT in teaching every Biology lesson					
20	All Biology teachers allow students to perform tasks using the ICT					
21	Biology teachers easily access the internet in teaching and learning Biology					
22	All Biology teachers in this School are computer literate					
23	The school administration facilitates in-servicing of teachers on ICT					
24	Biology teachers in this school use laptops and projectors in teaching					
25	The administration is supportive on the use of ICT in Biology lessons					
26	ICT in this school is well maintained					
27	Biology teachers in this school like using ICT in teaching					
28	Students understand Biology very well when ICT are used					
29	ICT makes teaching and learning interesting					
30	Through the use of ICT, the performance in Biology					

	KCSE examinations has improved to a mean grade of C- and above					
31	Students in this school like the use of ICT in Biology lessons					
32	ICT makes the students to be active in the Biology lessons					
33	Much work/ syllabus is covered within a short time when ICT is used in Biology lessons					
34	The administration in this school advocates for the use of ICT in teaching and learning of Biology					

35. What is the ratio of computers in the computer laboratory to the students of Biology in your class? (Tick (✓) appropriately)

1:1 to 1:2 ☐ 1:3 ☐ 1:4 ☐ 1:5 ☐ 1:6 and above ☐

36. List down the ICT resources available in your school.

37. List down the most commonly used ICT in your school.

38. List down the challenges experienced by Biology teachers in the use of ICT in teaching and learning of Biology in your school.

39. Suggest solutions on how to overcome these challenges.

40. How many lessons per week do you use ICT in teaching and learning of Biology? (Tick (✓) appropriately)

5 ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ 0 ☐

41. How can you rate the use of ICT in teaching and learning of Biology in your school in terms of number of Biology lessons it is used? (Tick (✓) appropriately)

Excellent (5 lessons) ☐ Very Good (4 lessons) ☐ Good (3 lessons) ☐

☐ ☐

Average (2 lessons) Poor (1 lesson) Very Poor (0 lesson) ☐

42. How can you rate the use of ICT in teaching and learning of Biology in terms of the number of Biology lessons per week it is used? (Tick (✓) where appropriate)

Excellent (5lessons) ☐ Very Good (4 lessons) ☐ Good (3 lessons) ☐

Average (2 lessons) ☐ Poor (1 lesson) ☐ Very Poor (0 lessons) ☐

43. Have you been using ICT in teaching Biology from the year 2014?

43. Comment on the performance of your students in KCSE Biology examinations from the year 2014 to the year 2018.

Thank you for your co-operation

APPENDIX D: Interview schedule for School administrators

I am a post-graduate student at Kenyatta University, carrying out Research on integration of Information and Communication Technology (ICT) in teaching and learning of Biology. This interview schedule is designed to gather information on the same from the School Administrators. You are therefore humbly requested to give responses to all the questions. The information will be treated with utmost confidentiality and will only be used for this study. Thanks in advance

1. School:_____
2. Sex: Male ☐ Female ☐
3. Your age in Years: 20-30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐
4. Your Highest Academic level:

   Diploma ☐ Bachelor's Degree /PGDE ☐ Masters ☐ PhD ☐
5. Position in this school: Principal ☐ D/Principal ☐ Senior Teacher ☐

   HOD ☐
6. Professional Experience in your current post in Years:

   0-5 ☐ 6-10 ☐ 11-15 ☐ 16-20 ☐

   above 20 ☐
7. Experience in your current station in Years:

   0-2 ☐ 3-4 ☐ 5-6 ☐ 7-8 ☐ above 8 ☐
8. Are you computer literate:_____
9. How many computers and projectors are in your school?
10. Does your school have a ICT resource center:_____

11. How equipped is the school's ICT resource center if any? _____

12. What is the ratio of computers in the computer laboratory to the students per class? (Tick appropriately).

    1:1 to 1:2 ☐ 1:3 ☐ 1:4 ☐ 1:5 ☐ 1:6 and above ☐

13. Name the type and number of ICT available for use by teachers of Biology in teaching and learning of Biology?

14. How many of each type of ICT are functional in your school?

15. How many of each type of ICT are non-functional in your school?

16. Is there internet connectivity and services in your school? _____

17. How many of the teachers of Biology are computer literate? _____

18. How frequently do the teachers of Biology use ICT in teaching and learning of Biology?

19. Is there electricity supply in your school? _____

20. What challenges face the teachers of Biology in the use of ICT in your school in teaching and learning of Biology?

21. How has the use of ICT in teaching and learning Biology affected the performance in Biology in your school?

22. In your own opinion, what is the effect of the use of ICT in teaching and learning of Biology?

23. How many lessons per week do teachers use ICT in teaching and learning Biology? (Tick (✓) appropriately).

    5 ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ 0 ☐

24. How can you rate the use of ICT in learning Biology in your school? (Tick (✓) appropriately).

Excellent	☐	Very Good	☐	Good	☐
Average	☐	Poor	☐	Very Poor	☐

Thank you for your co-operation

APPENDIX E: Interview schedule for Biology teachers

I am a post-graduate student at Kenyatta University, carrying out Research on integration of Information and Communication Technology (ICT) in teaching and learning of Biology. This interview schedule is designed to gather information on the same from the teachers of Biology. You are therefore humbly requested to give responses to all the questions. The information will be treated with a lot of confidentiality and will only be used for this study. Thanks in advance

1. School:_____
2. Sex: Male ☐ Female ☐
3. Your age in Years: 20-30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐
4. Your Highest Academic level:

   Diploma ☐ Bachelor's Degree /PGDE ☐ Masters ☐ PhD ☐
5. Professional Experience in your current post in Years:

   0-5 ☐ 6-10 ☐ 11-15 ☐ 16-20 ☐ above 20 ☐
6. Experience in your current station in Years:

   0-2 ☐ 3-4 ☐ 5-6 ☐ 7-8 ☐ above 8 ☐
7. Are you computer literate?_____
8. How did you acquire computer literacy?
9. Do you use ICT in teaching Biology?
10. Which topics have you used ICT in teaching Biology?
11. When did you begin using ICT?
12. How did your students begin to perform in Biology from when you began using ICT?
13. How does the use of ICT affect the performance of your students in Biology? Explain.

APPENDIX F: Observation checklist

Some of the ICT resources expected to be found in the secondary schools are listed in this table and more would be added incase those that available in the schools goes beyond the list.

Name of School: _____

NAME OF ICT	NOT AVAILABLE	AVAILABLE	FUNCTIONING	NOT FUNCTIONING	ICT-STUDENT RATIO	ADEQUATE
Desktop Computers						
Projectors						
Laptops						
Radios						
Televisions						
Video players						
DVD players						
DVDs/VCDs						
CDs						
Educational games						
Digital Cameras						
Simulations						
Instructional Animations						
YU-Tube Video clips						
Power point presentations						
Printers						

Photocopiers						
Tablets						
ipads						
Smart phones						

APPENDIX G: Approval of Research Proposal

KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: kubps@yahoo.com
dean-graduate@ku.ac.ke
Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 810901 Ext. 57530

Internal Memo

FROM: Dean, Graduate School

DATE: 9th March, 2016

TO: Mr. Ndolo L. Musau
C/o Educational Comm. & Technology Dept.
Kenyatta University

REF: E55/CE/24232/12

SUBJECT: APPROVAL OF RESEARCH PROPOSAL

We acknowledge the receipt of your revised Research Proposal entitled "Integration of Instructional Communication Technology in Teaching and Learning Biology in Secondary Schools in Makueni County, Kenya" as per recommendations raised by the Graduate School Board of 27th January, 2016.

You may now proceed with your Data collection, subject to clearance with the Director, General, National Commission, Ministry of Education.

As you embark on your data collection, please note that you will be required to submit to Graduate School completed supervision Tracking Forms per semester. The form has been developed to replace the progress Report Forms. The Supervision Tracking Forms are available at the University's Website under Graduate School webpage downloads.

Thank you.

REUBEN MURIUKI
FOR: DEAN, GRADUATE SCHOOL

c.c. Chairman, Educational Communication & Technology Department

Supervisors:

1. Prof. John Maundu
   C/o Educational Comm. & Technology Dept.
   KENYATTA UNIVERSITY
2. Dr. Benard C. Mugo
   C/o Educational Comm. & Technology Dept.
   KENYATTA UNIVERSITY

RM/cao

APPENDIX H: Research Authorization from Kenyatta University

KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: dean-graduate@ku.ac.ke

Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 8710901 Ext. 57530

OUR REF: E55/CE/24232/12

Date: 9th March, 2016

The Director General,
National Commission for Science, Technology & Innovation
P.O. BOX 30623
NAIROBI

Dear Sir/Madam,

RE: RESEARCH AUTHORIZATION FOR MR. NDOLO L. MUSAU REG.NO. E55/CE/24232/12

I write to introduce **Mr. Ndolo** who is a Postgraduate Student of this University. He is registered for M.Ed. Degree programme in the **Department of Educational Communication & Technology in the School of Education.**

Mr. Ndolo intends to conduct research for M.Ed. thesis entitled, **"Integration of Instructional Communication Technology in Teaching and Learning Biology in Secondary Schools in Makueni County, Kenya"**

Any assistance given will be highly appreciated.

Yours faithfully,

MRS. LUCY N. MBAABU
FOR: DEAN, GRADUATE SCHOOL

RM/cao

APPENDIX I: Research authorization from NACOSTI

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone:+254-20-2213471,
2241349,3310571,2219420
Fax:+254-20-318245,318249
Email:dg@nacosti.go.ke
Website: www.nacosti.go.ke
when replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/16/17329/10863**

Date: **11th May, 2016**

Leonard Musau Ndolo
Kenyatta University
P.O. Box 43844-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Integration of instructional communication technology in teaching and learning biology in secondary schools in Makueni County, Kenya,"*** I am pleased to inform you that you have been authorized to undertake research in **Makueni County** for the period ending **10th May, 2017.**

You are advised to report to **the County Commissioner and the County Director of Education, Makueni County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

DR. STEPHEN K. KIBIRU, PhD.
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Makueni County.

The County Director of Education
Makueni County.

National Commission for Science, Technology and Innovation is ISO 9001: 2008 Certified

APPENDIX J: Research Clearance Permit from NACOSTI

THIS IS TO CERTIFY THAT:
MR. LEONARD MUSAU NDOLO
of KENYATTA UNIVERSITY, 1982-90100
MACHAKOS,has been permitted to
conduct research in *Makueni County*

on the topic: *INTEGRATION OF INSTRUCTIONAL COMMUNICATION TECHNOLOGY IN TEACHING AND LEARNING BIOLOGY IN SECONDARY SCHOOLS IN MAKUENI COUNTY, KENYA*

for the period ending:
10th May,2017

Permit No : NACOSTI/P/16/17329/10863
Date Of Issue : 11th May,2016
Fee Recieved :Ksh 1000

.....
Applicant's Signature

.....
for Director General
National Commission for Science, Technology & Innovation

CONDITIONS

1. You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit
2. Government Officers will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2) hard copies and one(1) soft copy of your final report.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

REPUBLIC OF KENYA

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No. A 9117

CONDITIONS: see back page