EFFECTS OF TEACHING USING ICT ON SECONDARY SCHOOL STUDENTS' PERFORMANCE IN BIOLOGY IN MOLO DIVISION,NAKURU COUNTY,KENYA

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DECLARATION

This Thesis is my original work and has not been presented for examinations in any other University and or institution. No part of this Thesis may be reproduced or photocopied without the permission of the author and/or University of Eldoret.

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Declaration by the Supervisors

This Thesis has been submitted to the school of Education for examination with our approval as university supervisors.

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DEDICATION

This thesis is dedicated to my wife, Olive and our children; for their support and understanding during my studies. To my parents, for their encouragement and laying down the foundation of my education and to my brothers and sisters who motivated me and gave me encouragement.

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ABSTRACT

We are living in a constantly evolving digital world. ICT has an impact on nearly every aspect of our lives from working to socializing, to learning and to playing. The digital age has transformed the way young people communicate, network, seek help, access information and learn. This study aimed at identifying the effects of information and communication Technology (ICT) use in teaching and learning on the achievement of secondary school students in Biology. Quasi-experimental design was adopted. Simple random sampling was used to assign intact classes to experimental and control groups, while purposive sampling was used to select secondary schools that have ICT gadgets in Molo division, Molo sub-county. The sample comprised 240 students (120 males and 120 females) selected amongst form three students in Molo division, Molo sub-county. The objectives of the study were; to investigate the effect of ICT use on students' achievement scores in biology in secondary schools and to establish whether there is any gender differences in achievement scores among boys and girls taught with the use of ICT. ICT approach was used in experimental groups while the regular traditional teaching method was used in control groups. Pre-test was administered before treatment and a posttest after treatment. A Biology Achievement Test was used to measure students' performance and the data collected was analyzed through SPSS programme. The findings of the study showed that ICT use in teaching improved performance of students in biology in secondary schools as most students taught using ICT performed better than those taught using traditional methods. The study found out that the use of ICT method produced better scores in girls than in boys. Conclusions are; use of ICT assisted instruction seemed to have had a deep impact on the process of learning in the learners. The usage of ICT during lessons conducted in classes has improved the learning outcomes of students and therefore its contribution should be recognized by all teachers in order to enhance students' achievement in biology and other sciences in general. Based on the findings, several recommendations have been made to provide some insights into the application of ICT in Biology subjects. The researcher has made recommendations that government and proprietors of public and private schools, respectively, should equip their schools with the necessary ICT gadgets. ICT facilities should be used more in teaching. Teachers should integrate traditional teaching approach with attractive learning styles by involving ICT in their lessons in order to increase students' achievements. Since the findings concluded that using ICT in Biology lessons has positive impacts on students' achievements; schools must strive to increase usage of ICT amongst teachers. On the other hand, teachers should put more effort to use ICT in conducting their biology lessons.

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LIST OF ACRONYMS

ASEI	Activity based, Student centered, Experiment and Improvise
CAI	Computer Assisted Instruction
CBI	Computer Based Instruction
CBIS	Computer-Based Instruction Simulation
CD-ROM	Compact Disc Read Only Memory
DNA	Deoxyribo- Nucleic Acid
E-mail	Electronic Mail
EU	European Union
ICT	Information Communications and Technology
INSET	In-Service Training
KEPSHA	Kenya Primary School Head Teachers' Association
KCSE	Kenya Certificate of Secondary Education
KIE	Kenya Institute of Education
KNEC	Kenya National Examination Council
KNUT	Kenya National Teachers' Union
MoEST	Ministry of Education, Science and Technology

NCST	National Council Science and Technology
OECD	Organization for Economic Cooperation and Development
PDSI	Plan Do See and Improve
SMASSE	Strengthening of Mathematics and Science in Secondary Education
SPSS	Statistical Package for Social Sciences (SPSS)
TSC	Teachers' Service Commission
UK	United Kingdom
UNESCO	United Nations Educational, Scientific, and Cultural Organization

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CHAPTER ONE

INTRODUCTION

1.1 Introduction

This chapter looks at the background of the study, statement of the problem, purpose of the study, objectives, justification and significance of the study, limitations and scope of the study, assumptions, conceptual framework and definition of operational terms.

1.2 Background to the Study

Information and communication technology (ICT) has become commonplace entities in all aspects of life. Across the past twenty years, the use of ICT has fundamentally changed the practices and procedures of nearly all forms of endeavor within business and governance. Education is a very socially oriented activity and quality education has traditionally been associated with strong teachers having high degrees of personal contact with learners. The use of ICT in education lends itself to more student-oriented learning settings. But with the world moving rapidly into digital media and information, the influence of ICT on both education and students' learning behavior is becoming more and more important and this importance will continue to grow in the 21st century.

The government of Kenya in its economic blue print that is popularly referred to as vision 2030 has set out a long term development policy of transforming the country into an industrialized, middle income economy by the year 2030. One of the key pillars identified to drive this transformation is quality and accessible education to its citizens

that is globally competitive (GOK, 2007). The Government of Kenya has particularly felt the need to improve the science education it offers so as to build up a knowledgeable manpower required for its industrial and technological transformation (Republic of Kenya, 1999; SMASSE Project, 2000). Biology is one of the key subjects that would make a contribution towards the realization of this objective because its knowledge is applied in many sectors of the economy including agriculture, Industry and medicine (Juma and Yee-Cheong, 2005). These sectors are the movers of the economy. In agriculture for example, it has been applied in plant breeding to produce high yielding and disease resistant crops to ensure improved food production for the ever growing population (Huang, Pray and Rozelle 2002). In medicine, it has made it possible for organ transplants and disease control to ensure a healthy and productive population. In Industry, it has been applied in beer brewing, bread making and milk processing (Langlois, Rutland and Wald,2006). Biological knowledge has also enabled humanity to appreciate the essence of biodiversity and environmental conservation and sustainable utilization of natural resources (UNESCO, 2004).

Biology has a lot of relevancy in everyday life because it helps man to understand himself and the environment around him (Udovic, Morris, Dickman, Postlethwait and Wetherwax 2002). Biology naturally leads to career and employment opportunities. It is continuously opening up various professions to men and women in medicine, agriculture, conservation, research, home science and industry.

According to the Kenya Institute of Education (2005) currently Kenya Institute of Curriculum Development (KICD), the importance of biology to humanity can be outlined

as follows: The learning of biology helps us to know how to use natural resources more efficiently in industry e.g. in bio-technology, food production, building and textile and paper industries. Biology helps us to understand changes in the environment and the factors affecting these changes, in order to know how human needs are influenced.

Biology is important in helping mankind to find effective ways of preventing, treating and curing diseases and home management techniques e.g. better methods of food preservation, efficient food preparation and care of the family. The learning of biology is important in helping the improvement of agricultural yields through scientific research.

Performance of students in Biology in Kenya certificate of secondary examinations (KCSE) has been low (KNEC,2014, 2013, 2012,2011,as shown in table 2.3). Girls have been recording even a lower achievement in biology as compared to boys. In the pursuit of gender equality, this trend in performance should not be allowed to continue.

In Kenya, the inclusion of biology in the secondary school curriculum is aimed at enabling the learner to understand and deal with personal problems, the environment, and the future (Republic of Kenya, 2002).The establishment of whether the objectives of teaching biology have been achieved is done through tests and examinations. Examinations are an inevitable part and parcel of the education process. They are used among others to; measure the level of the candidates' achievement and certify the candidates' levels of education, training and employment. They also provide the basis for evaluating the cost effectiveness of the curriculum both at school and national levels. However, just like other sciences and in addition to mathematics, performance by

secondary school students in biology examinations is generally poor. This implies that the objectives of including biology in the curriculum are not being achieved. The national biology performance in Kenya Certificate of Secondary Education (KCSE) is shown in Table 1.1 below.

Table 1.1: National percentage scores in biology by year

Year	National percentages mean score
2005	29.63
2006	27.45
2007	41.95
2008	30.32
2009	27.43
2010	29.19
2011	34.44
2012	26.21
2013	31.63
2014	31.83
2015	34.80

Source: Abungu,Okere and Wachanga (2014)

This performance has caused a lot of public outcry and concern about the performance in science subjects and mathematics (KNEC, 2000) as it would militate against the country's aspiration to achieve the 'Vision 2030' and the Millennium Development Goals (MDGs) (Kinuthia, 2009). This is because biology is one of the key science subjects that contribute towards industrialization, environmental conservation, medical research, food management and improved agricultural production (Juma and Yee-Cheong, 2005).

Studies focusing on the impact of different factors on performance in biology at secondary school level are not well conceptualized but it could partly be due to the unsuitable teaching methods employed by teachers (CEMASTEA, 2012; Republic of Kenya, 2012). The main goal of teaching and learning is to bring about the desired behavioral change in learner. Given the high value placed on biology in the Kenyan secondary school curriculum, the need to teach it effectively through an effective method is indispensable. Many reasons have been advanced for the poor retention of learning materials by students. For instance, students' poor understanding of the basic concepts in biology (Sinatra, Southerland, McCounaghy and Demastes, 2003), use of inappropriate method of teaching by biology teachers and students (Orokpo, 2006) were found to influence students' retention in science and consequently their performance. In addition, Biodun (2002) identified that the use of student centered approach to teaching and learning enhances achievement and consequently high retention in school subjects.

To improve on pedagogical teaching of difficult topics, biology teachers need exposure to powerful conceptual frameworks to help them organize instructions and analyze classroom events otherwise they may fail to grasp new concepts about teaching and learning or they may learn them for the purpose of test, but revert to their perceptions later (Darling-Harmond and Bransford 2005).According to Fawe, Abou-Zaid, Menzies and Belanger (1998), approaches used in teaching science subjects such as Biology have been identified as some of the factors contributing to this poor performance. Most of the teaching approaches practiced in Kenyan schools are mainly expository and fact oriented, assigning a passive role to learners (Kiboss, 1997). Teachers usually act as the dispensers of knowledge while learners listen and try to understand and remember (Rutledge and Mitchell, 2002). Expository approaches cannot stand up to the challenges of the new demands and objectives of Biology education because they do not actively engage learners in authentic and meaningful learning activities. UNESCO (1996) argues that a fresh look at new teaching approaches should be taken. Wango (2009) suggested that the quality of teaching and learning can be enhanced through improved teaching practices. The increasing changes in teaching practices and the need for creative, divergent and

unexpected solutions to improve teaching and learning situations,require a challenging and approach to the field of instructional practices (Steyn & Kamper, 2001).

The quality of learning outcomes depends on the interaction between the teaching styles and methods used by the teacher to create suitable learning environment (Rutledge and Mitchell, 2002).Research has shown that the use of a wide variety of resources and approaches improves students' interests in biology and facilitates the learning of difficult concepts such as those encountered in genetics (Entwistle, 1998).Hennessy, Wishart, Whitelock, Deaney, Brawn, Velle and Winterbottom, 2007) suggest that allowing pupils to make use of ICT can develop their power of observation and open new perspectives for their understanding of scientific concepts. It is expected that ICT use would promote deeper learning, enable schools to respond to the needs of pupils with different scholastic achievements, and foster the development of pupils' cognitive and personal skills, such as independent learning, problem-solving abilities and teamwork (Barak, 2007).

ICT changes the role of the teacher in class in such a way as to make her/him a partner and a facilitator of learning rather than the main source of knowledge and authority (Newton and Rogers, 2001). Kesidou and Roseman (2002) observed that curriculum instructional materials have a major role in teaching and learning, and many teachers rely on them to improve their pedagogical skills in the delivery of their content. The methods used by the teacher should be student- centered and ICT can be used as one of the tools in classroom instruction (Mumtaz, 2000). This is because ICT can help to improve teaching and reinforce learning of some topics in Biology for example genetics, protein synthesis, opening and closing of stomata etc. that would otherwise be abstract (Wang, 2008).

The fact that computers can provide more information to learners is corroborated by Jonassen, Carr and Yueh, 2011) and Tekbiyik and Akdeniz (2010) who argue that computers can provide more information to learners than any other teaching aid. In addition, those who pointed out that computer provide illustrations corroborate earlier findings by Serin (2011) and Tekbiyik and Akdeniz (2010) who argue that computers can provide illustrations to what would be difficult to illustrate using other teaching aids.

According to research studies in literature, the use of computer-based education increases students' attitudes and achievements significantly (Roschelle, Pea, Hoadley, Gordin, & Means, 2000). Rutherford and Lloyd (2001) conducted a study on the attitudes of the Form Six students during computer-aided activities in Geography classes. It showed that students have positive attitudes towards the use of computer which was considered as an effective technique of teaching and learning pedagogy by students.

Kenya National Examination Council identified grey areas in the performances as description, explanation and "accounting for" questions. These areas according to Blooms taxonomy of instructural objectives borders on analysis, application and evaluation. Questions dealing with processes that describe working of organs are abstract and are poorly done. These sub-topic areas can be taught effectively using computer simulations and animations due to their abstract nature. Practical areas that required" accounting for" presence and absence of certain foods like reducing sugars, non-reducing sugars, proteins, starch, ascorbic acid and lipid were poorly done. These practical aspects require understanding of the concepts behind the activities, doing, observing and making conclusions and inferences (Ong'amo, B.,Ondigi, S.,Maundu, J.,2014).

However, in spite of the rapid growth of the use of ICT for educational purposes, there is

a considerable concern about lack of information on the effectiveness of this educational innovation in developing countries Kenya included (Wilson, 2004). Little is known about the use of computer assisted instructional package in the Kenyan education system particularly in interactive learning setting and its effect on performance. In addition, very few empirical studies exist in Kenya regarding the use of ICT in biology. Thus, much remain to be empirically studied on the effect of ICT in biology education in Kenya. This study therefore sought to fill this gap by investigating the effect of ICT use on students' achievement in Biology.

1.3 Statement of Problem

Performance in Biology at KCSE level has continued to be poor. Equally there is notable difference in performance among boys and girls, with girls' performance being even lower when compared with that of boys. Reports available from KNEC, point to poor teaching methods as one of the major causes. In an effort to change the teaching approaches, the use of ICT has been proposed as a strategy that could help improve teaching and consequently performance. This study therefore sought to investigate effect in performance in Biology when ICT is used.

1.4 Objective of the Study

The study investigated the effect of ICT use on the performance of secondary school students in biology.

1.4.1 Specific Objectives

1. To investigate the effect of ICT use on students achievement scores in biology in secondary schools.
2. To establish whether there is any gender difference in achievement scores among boys and girls taught with the use ICT.

1.5 Research Hypotheses

The following research hypotheses were tested in the study.

$H0_1$ ICT use in teaching does not have any significant impact on the achievement scores of students in biology.

$H0_2$There is no significant difference in achievement scores among boys and girls who are taught biology through ICT instruction.

1.6 Justification of the Study

Efforts are being made to improve the quality of learning particularly in science, in the light of the role of science and technology in the country's development and attainment of the set goal of Vision 2030.Biology education enables the learner to acquire problem-solving and decision-making skills that provide ways of thinking and inquiry that help them to respond to widespread and radical changes in information technology and economic development which form part of the Government's vision. Poor performance particularly in Biology is therefore of concern and the need to integrate ICT use into

classroom teaching has become critical. The effectiveness and impact of ICT integration on students' achievement scores in Biology should then also be assessed.

1.7 Significance of Study

The importance of carrying out this study is to assist various education stakeholders in understanding importance of integration of ICT in students' performance of Biology. The study may be of immediate benefit to the Ministry of Education (MOE) and the National Commission for Science, Technology and Innovation (NACOSTI) in the formulation of future science education policies aimed at enhancing students' achievement through the integration of ICT hence improve the quality of education. It will also assist curriculum developers particularly in their effort to research on more innovative and effective ways to implement the curriculum. To the teachers who are curriculum implementers as they look for better ways of curriculum delivery. The use of ICT in classroom is very important for providing opportunities for students to learn to operate ICT gadgets in an information age and improve on their content learning. This research study also has the potential to contribute to existing research in relation to ICT integration in performance of Biology as a subject. The findings of this study will also have both theoretical and practical benefits to the future of science education in Kenya. The study is expected to contribute to the advancement of knowledge about science education and biology education in particular. In Kenya, it is a stated policy to integrate ICT in curriculum delivery hence the knowledge gained from this study may be used in developing appropriate strategies in ICT use in teaching and learning process. In general, the study may lead to improved strategies in teaching and learning of biology not only in Kenya

but also in other parts of the world.

1.8 Scope of the Study

There are many learner-centered methods of instruction that could improve students' performance in biology but this study only concentrated on ICT gadgets in teaching. This study utilized a limited area by using only three schools. This study was carried within a time scope of one month.The study only targeted form three students in the sampled schools. It is only the teaching of Biology that this study focused on.

1.9 Limitations of the Study

The following limitations can be observed regarding this study. First, the study was designed to focus on learning of biology by secondary students drawn from public secondary schools. Thus, the findings were not meant for other public institutions and other private institutions. Second, the study did not examine other alternative means like Internet for delivering the course content. Third, the curriculum content was limited to only one topic of the entire biology curriculum. Fourth, computer use was limited to the presentation of curriculum contents only, as the groups were exposed to pre-test and post-test using paper and pencil approach. Fifth, other factors besides the use of ICT may influence learning but efforts were put to try and use schools where factors were fairly the same.

1.10 Theoretical Framework

In psychology and education, learning is commonly defined as a process that brings together cognitive, emotional, and environmental influences and experiences for acquiring, enhancing, or making changes in one's knowledge, skills, values, and world views (Illeris, 2004; Ormorod, 1995). Learning as a process focuses on what happens when the learning takes place. Explanations of what happens constitute learning theories. A learning theory is an attempt to describe how people and animals learn; thereby helping us understands the inherently complex process of learning. Learning theories have two chief values according to Schunk (2000). One is in providing us with vocabulary and a conceptual framework for interpreting the examples of learning that we observe. The other is in suggesting where to look for solutions to practical problems. The theories do not give us solutions, but they do direct our attention to those variables that are crucial in finding solutions.

Learning theories provide learning organization necessary skills at creating, acquiring, and transferring knowledge, and at modifying its behavior to reflect new knowledge and insights. That is, learning theories trigger the organizational improvement. This study is based on the theory of constructivism.

Constructivist learning theories have their foundations in Piaget’s works on cognitive and developmental and in Bruner’s and Vygostsky’s interactional and cultural perspectives (Driscoll 2007). Constructivist theories of learning assume that the knowledge we acquire about the world is not just a photocopy of the outside world that was put into our heads by some instructional process. Rather, knowledge is actively constructed by the individual, as part of a process of “meaning-making”, in socially, culturally, historically

and politically situated contexts. In a constructivist learning environment, students construct their own knowledge and apply it to new tasks, contexts and situation, integrating the new knowledge into their already existing knowledge structures.

Constructivism holds that knowledge is not 'about' the world, but rather 'constitutive' of the world. Knowledge is not a fixed object; it is constructed by an individual through her/his own experience of that object. Constructivist approaches to learning stress the importance of authentic, challenging projects that include students, teachers and experts in the learning community. Their goal is to create learning communities that are more closely related to the collaborative practice of the real world. In an authentic environment, learners assume the responsibilities of their own learning, they have to develop metacognitive skills to monitor and direct their own learning and performance. When students work collaboratively in an authentic activity, they bring their own framework and perspectives to the activity. But they can see a problem from different perspectives, and are able to negotiate and generate meanings and solution through shared understanding.

ICT learning programs have been related to constructivism in that students are at the centre of the learning process. Rather than being passive recipients of instruction, they are actively involved in constructing knowledge. Learners learn by experimentation, and not by being told what will happen. They are left to make their own inferences, discoveries and conclusions. It also emphasizes that learning is not a haphazard process but that students learn the new information that is presented to them by building upon knowledge that they already possess. This theory suggests that the teacher's role is not

only to observe and assess but to also engage with the students while they are completing activities, suggesting solutions and posing questions to the students for promotion ofreasoning(DeVries*et al*., 2002).Computer assisted learning programs are interactive and enable students to control the pace and sequence of their learning (Driscoll, 2000; Silverman , 2000)

Constructivism in ICT use promotes a more open-ended learning experience where the methods and results of learning are not easily measured and may not be the same for each learner. Constructivists believe that all humans have the ability to construct knowledge in their own minds through a process of discovery and problem solving. Under the theory of constructivism, teachers can focus on making connections between facts and fostering new understanding in student's; through ICT use in teaching.

Constructivism holds that meaningful learning occurs when students construct and give their own meaning to knowledge based on their prior experiences and background knowledge (Fosnot, 1996). It also recognizes that challenging and helping students to correct their misconceptions is essential to effective learning (Schunk, 2000). Conditions that foster such knowledge construction include an instructional approach that has come to be called "cognitive apprenticeship", the useof authentic learning tasks, and exposure to multiple perspectives (Biehler and Snowman, 1997). It is believed that by use of ICT in teaching, simulations would help the students' to connect biological facts and based on their understanding help them acquireknowledge and learn.

1.11 Conceptual Framework

The conceptual framework in this study adapted the systems theory proposed by the biologist Bertalanffy (Bertalanffy, 1968).The systems view the components of the phenomena, the interaction between the components, and the relation of components to their larger environment. The underlying assumption of Bertalanffy's theory is that there are universal principles of organization across different fields.

The systems approach to the design and analysis of teaching/learning situations is the basis of the great majority of modern educational technology-related developments. In general systems theory, a system is any collection of interrelated parts that together constitute a larger whole. These component parts, or elements of the system are intimately linked with one another, either directly or indirectly, and any change in one or more elements may affect the overall performance of the system, either beneficially or adversely. A simple system is illustrated schematically in Figure 1.1.

Systems theory opposes the reduction of systems and criticizes the mechanistic view that neglects the relationship of the components with the larger systems. It emphasizes the totality, complexity, and dynamics of the system. However, it also argues that, despite the complexity and diversity of the world, models, principles and laws can be generalized across various systems, their components, and the relationships between them. In other words, corresponding abstractions and conceptual models can be applied to different phenomena.

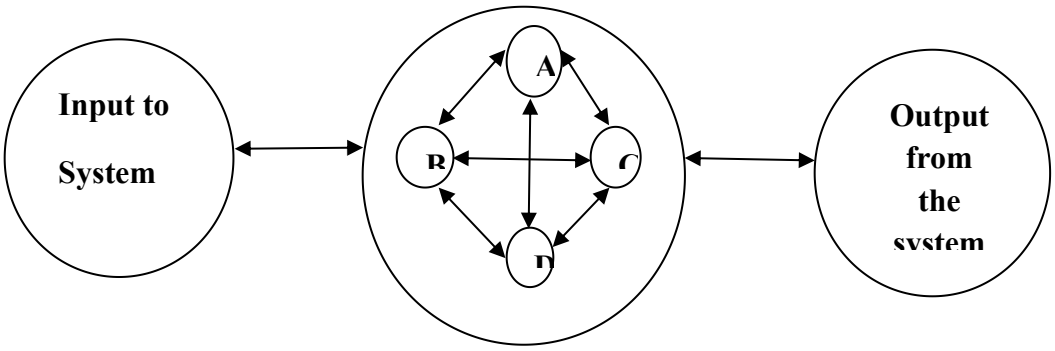
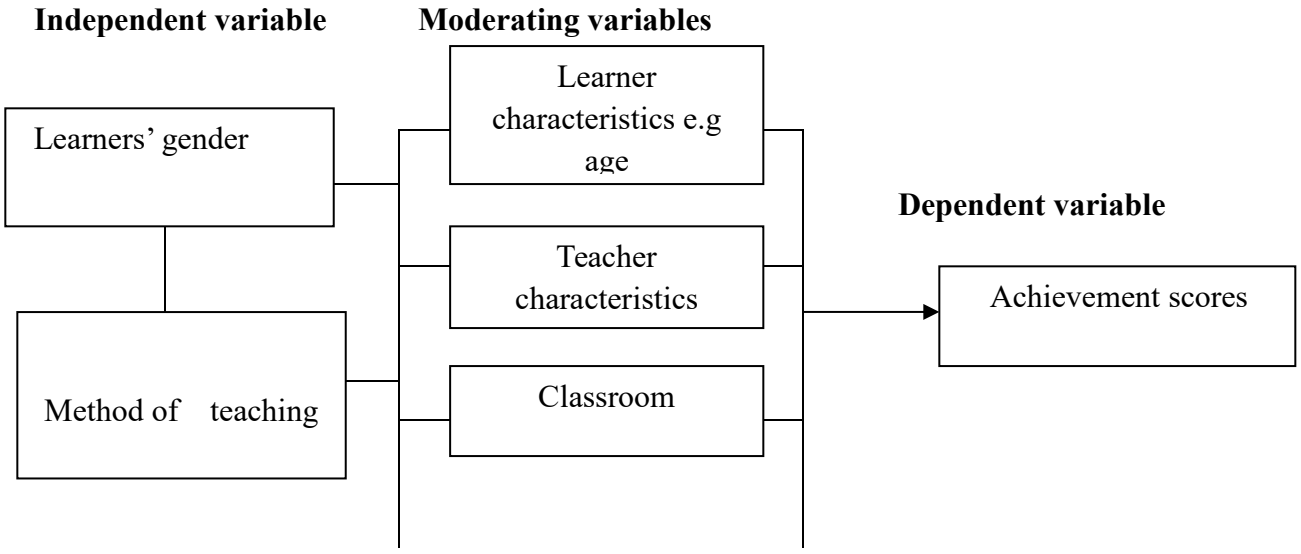


Figure 1.1: A typical system

In Figure 1.1, the system consists of four distinct elements A, B, C, D, which are related to or dependent upon each other as indicated, some interrelationships may be two-way, while others may be one-way only. These elements may themselves be capable of further breakdown into other smaller components, and may thus be regarded as sub-systems of the overall system.

The processes of teaching and learning can be considered to be very complex systems indeed. The input to a given teaching/learning system consists of people, resources and information, and the output consists of people whose performance or ideas have improved in some desired way. A schematic representation of systems of this type is shown in Figure 1.2:



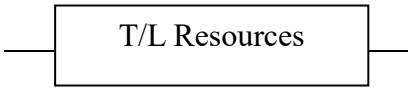


Figure 1.2: The 'systems' model of the educational process

This system has enabled educational technologists to structure the input to systems of this type in such a way as to try to improve the output through increasing the efficiency and effectiveness of the learning process, thus leading to a systems approach to course and curriculum design based on current knowledge of how people learn. Such a systems approach attempts to mold the input to a course in such a way as to enable the optimal assimilation of knowledge and skills to take place during the learning process, and hence maximize the quality of the output.

This theory in education depicts the teaching and learning process as having inputs that interact to produce outputs (Figure 1.2). According to Systems theory, all systems have common characteristics which include: Well defined goals; more than one element which work in harmony; and provides feedback. In education, these conditions are satisfied in that there are inputs which include learners, teachers and learning resources among others; the process is the transformation of learners' behavior through the teaching-learning process and the output are adults who are well adjusted to fit in the society. In the context of teaching and learning, the learner is the input and through the teaching-learning process, the learner undergoes desirable changes. The performance of the learner is the output which provides feedback about the teaching- learning process. Therefore, through manipulation of the teaching-learning process by adopting ICT approach, it is possible to produce desirable outputs in the form of higher achievement scores in Biology. The

extraneous variables in this study are learner characteristics; teacher characteristics; classroom environment; and teaching and learning resources. To control for the teacher characteristics, only trained teachers of more than two years of teaching experience were used. This was to control for training and experience of the teacher. To control for classroom environment, only co-classes were used in this study. To control for the teaching and learning resources and facilities, the schools selected for the study were visited to ascertain that they had ICT resources which are adequate for teaching and learning of Biology and that the learners at form three had adequate Biology course textbooks. For the learner characteristics, the variable of gender was built into the study as the second independent variable to answer the question of whether there are gender differences in Biology mean achievement scores as a result of ICT learning approach. The classes that were selected had comparable performance index to control for initial differences in students' academic abilities.

1.12 Definitions of Operational Terms

i. **Computer Assisted Learning (CAL)** - covers subject-specific software which provides students with instruction in the form of a tutorial-style program on the material being covered.

ii. **Effective learning**- learning approaches actively engage the learner in the learning process for effective mastery of the subject content matter and promote a positive attitude towards the subject i.e. student-centered methods.

iii. **Integrated Learning Systems (ILS)** - covers programs which provide students with individualized instruction in the form of an interactive tutorial system.

iv. **ICT**–it involves the integration of ICT tools i.e. Computer components, audio, video presentations, projectors and display boards in teaching.

v. **Integration**–this is the process of making ICT part of instructional presentation.

vi. **Traditional methods**- these are teacher-centered methods that mainly focus on rote learning and memorization. It is where the teacher presents information to students in a lecture and students complete assignments out of class and later take an examination to demonstrate their degree of understanding and retention of the subject matter. Mainly used by teachers in Kenya.

vii. **Science** - has been taken to include one or several of the school science subjects, i.e. integrated/general science, science, biology, chemistry, physics and earth science.

viii. **Science subjects**- this include Biology, Chemistry and Physics

ix. **Multimedia** - The term is used in contrast to media, which use only rudimentary computer display such as text-only or traditional forms of printed or hand-

produced material. Multimedia includes a combination of text, audio, still images, animation, video, or interactivity content forms.

x. **Vision 2030**- Kenya's development program towards creating a globally competitive and prosperous nation with a quality of life by 2030.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter aims to bring together key points from a review of a significant part of the available literature associated with teachers' integration of ICT into teaching of science in general and biology in particular. This literature includes; Performance of secondary school students in Biology in Kenya, teaching methods and their influence on student performance in Biology in Kenya, teaching and learning approaches, effective science teaching and learning approaches in science, challenges to effective science teaching and learning approaches in science, review of computer use in Kenya, meaning of ICT integration and benefits of ICT integration in Biology teaching.

2.2 Main Review

The following sub-topics will discuss: performance of Biology in Kenya, factors leading to Poor Performance in Biology in Kenya, students' difficulties in learning biology, teaching and learning approaches, effective teaching and learning approaches in science, effect of teaching approaches on performance, and teaching methods mostly used by teachers in teaching biology in Kenya.

2.1.1 Performance in Biology in Kenya

According to the Kenya Institute of Education (2002), the study of biology aims at equipping the learner with knowledge, skills and attitudes that are necessary for controlling and preserving the environment; enables the learner to appreciate humans as part of the broader community of living organisms; is a foundation for careers in health, agriculture, environment and education; and is the precursor of biotechnology which is a tool for industrial and technological development. Through the knowledge of Biology,

researchers have been able to develop high yielding, disease resistant and fast maturing food crops and animals to meet the food requirements of an ever increasing world population (Graham *et al.,* 2001; Borlaug, 2000). Biology is a prerequisite subject for admission into courses in the health profession such as Human and Veterinary Medicine, Pharmacy and Dentistry among others(Salvatori, 2001).Despite the importance of the knowledge of biology for socio-economic development of a country, performance in Biology at KCSE which is offered by KNEC has been poor over the years (MoE, 2012). Table 2.1 shows the national overall performance of students in Biology at KCSE in the period 2010-2014

Table 2.1: The National Performance of Candidates in KCSE Biology Examination for 2009-2014

YEAR	CANDIDATURE	MEAN SCORE
2010	317,135	29.20
2011	363,817	32.44
2012	389,523	26.21
2013	397,319	31.63
2014	432,977	31.83
2015	463,564	34.80

SOURCE: KNEC REPORTS (2009-2014)

From the data in the table above, it is evident that the national performance of students in KCSE Biology has been relatively low in the whole country for many years. The table 2.3 below shows the national percentage passes in biology.

Learning achievement was adopted as a key indicator of education during world conference of education for all (EFA) in Jomtien,Thailand (UNESCO, 2000).Since achievement in Biology at KCSE in Kenya has been consistently low over the years, this could be an indication of low quality Biology teaching/learning. The performance in Biology at KCSE for the years under review, clearly indicates that a large proportion of students who leave secondary school education cycle at form four in Kenya do not attain the basic mastery level of the secondary Biology course. Unless this trend is reversed, the prospects of attaining the goal of Kenya vision 2030 may not be achieved. By this year, Kenya envisions itself to have attained a reasonable economic achievement. Table 2.3 shows KCSE performance in Biology by gender in the period 2011-2015.

Table 2.3: The KCSE Biology National overall Performance by Gender (2011-2015) Percentage Mean Score

YEAR	ALL	FEMALE	MALE
2011	32.44	30.07	34.53
2012	26.2	24.4	27.9
2013	31.63	30.15	32.99
2014	31.83	29.84	33.71
2015	34.80	32.87	36.64

Source: compiled from KNEC reports (2011 -2015)

From the data displayed in Table 2.4, females are performing poorly in Biology in

comparison to boys; it therefore calls for adoption of teaching strategies that stimulate girls' interests in Biology to alleviate this gender imbalance in performance.

2.1.2 Factors Leading to Poor Performance in Biology in Kenya

Many factors contribute to poor performance of science subjects at KCSE. These factors include: Student attitude towards the subjects which they perceive as difficult; inappropriate teaching approaches that are teacher centered rather than student centered; inadequate mastery of teaching subject content by some teachers; inadequate teaching and learning resources such as text books and laboratory equipment and apparatus; poor terms and conditions of service for teachers; and heavy teaching loads among others (SMASSE) (Yara and Catherine, 2011; Muraya and Kimamo, 2011; Musasia *et al.,* 2012). It was further noted that the teaching approach employed by a teacher is one of the important explanations of poor performance in science subjects at KCSE (Muraya and Kimamo, 2011). Teacher centered teaching approaches are dominant at the secondary school level where the teacher presents information to students in a lecture and students complete assignments out of class and later take an examination to demonstrate their degree of understanding and retention of the subject matter (Kolawole, 2008). The lecture method which is predominant in our classrooms does not stimulate students' innovations, inquiry and scientific thinking but rather encourages students to cram facts which are easily forgotten (Adeyemi, 2008). In Kenya, secondary school teacher training combines teaching methodology and teaching subject content mastery and under this system both academic and methodology suffer from an overburdened program (MoE, 2005). This may imply that the teachers are not adequately prepared on teaching

approaches which may in turn explain the low achievement in Biology at KCSE. In order to address the low achievement in Biology at KCSE in Kenya, Biology teachers need to be exposed to appropriate teaching and learning approaches that are learner centered rather than teacher centered. The learner centered teaching and learning approaches actively engage the learner in the learning process for effective mastery of the subject content matter and promotes a positive attitude towards the subject (Darling-Hammond, 2008). To improve academic achievement, the teaching approaches adopted by a teacher should make learning more learner-centered so as to promote imaginative, critical and creative skills in the learners resulting in better achievement of instructional objectives (Weimer, 2013).

2.2 Students' Difficulties in Learning Biology

Students' difficulties in learning biology have been studied by various researchers across the world (Muraya and Kimamo, 2011; Bahar, 1999; Shihusa and Keraro, 2009). Many concepts or topics in biology, including water transport in plants, protein synthesis, respiration and photosynthesis, gaseous exchange, energy, cells, mitosis and meiosis, organs, physiological processes, hormonal regulation, oxygen transport, genetics, Mendelian genetics, genetic engineering, and the central nervous system can be perceived as difficult to learn by secondary school students (Bahar, 1999; Sinatra *et al.,* 2003). Tekkaya *et al.* (2001) also found that hormones, genes and chromosomes, mitosis and meiosis, the nervous system, and mendelian genetics were considered difficult concepts

by secondary school students. Experiencing difficulties in so many topics in biology negatively affects students' motivation and achievement (Çimer, 2012). Students' difficulties with many topics in biology have stimulated researchers to investigate why students experience such difficulties and how to overcome these difficulties (Bahar *et al.,* 1999).

There are many reasons why students have difficulties in learning biological concepts (Çimer, 2012). The nature of science itself and its teaching methods are among the reasons for the difficulties in learning science, while according to Anderson (2002) the biological level of organization and the abstract level of the concepts make learning biology difficult. Overloaded biology curricula, the abstract and interdisciplinary nature of biological concepts, and difficulties with the textbooks are the other factors preventing students from learning biology effectively (Cimer, 2012; Klein, 2000). Chiepetta and Fillman (2007) state that overloaded biology curricula may not contribute to students' achievement and lead them to learn the material through memorization. This prevents meaningful learning. These difficulties can be overcome by use of teaching methods that constructively engage learners in learning and offer an atmosphere that make learners find concepts applicable to their day to day lives and hence easy to understand relate to. The use of ICT can help overcome some of these difficulties.

2.3 Teaching and Learning Approaches

Hammerless*,* Darling-Hammond, Branford, Berliner, Cochran, McDonald & Zeichner (2005) define teaching and learning as an attempt to help someone acquire or change

some knowledge, skill or attitude. Wong and Wong (2001) further define teaching and learning as a process where one person, the teacher intentionally passes information to another person, the learner. Therefore the goal of teaching is to bring about desirable learning in students (Putnam and Borko, 2000). In this process, the learner is expected to receive information, understand it and use it later when the need arises. For effective teaching and learning to occur, the teacher must use an effective approach of conveying the information to the learner (Baker *et al.,* 2010). He further notes that the way a teacher teaches is important in that with the right methods and techniques, students can grasp concepts and ideas while poor methods and techniques frustrate students and minimize their chances of success. It emerges from the fore-going discussion that for effective teaching and learning the approach adopted by a teacher is paramount and teachers should therefore have a choice of effective teaching and learning approaches for effective learning to occur (Çimer, 2012).

Arends (2004) notes that many teaching and learning approaches have been created and studied by educational researchers, classroom teachers, psychologists, industrial trainers and philosophers. He further notes that a teaching and learning approach has four defining attributes: a coherent theoretical rationale made explicit by its creators or developers; a point of view about what and how students learn; specific teaching behaviors that make the approach to work; and required classroom structures for bringing about intended outcomes. Arising out of this, teaching and learning approaches are classified according to their instructional goals, their syntaxes (sequential patterns) and the nature of their learning environments. Arends and Kilcher (2010) further note that a

teaching and learning approach syntax refers to the overall flow or sequence of steps that a lesson usually follows and it specifies what kinds of teacher and student actions are required, the order in which these actions normally occur, and the particular task demands placed on students. Each teaching and learning approach employs different learning environment and management system and places different demands on the learner, on the physical space, and on the classroom social system. He further classifies teaching and learning approaches into four types: direct instruction, problem-based instruction, cooperative learning and discussion. Direct instruction is based on ideas from behavioral psychology and social learning theory. It is designed to promote student learning of well-structured procedural and declarative knowledge that can be taught in a step-by-step fashion and requires a tightly structured learning environment. Problem-based instruction is based on cognitive psychology and constructivist perspectives about learning and is an effective approach for teaching higher-level thinking processes and helping students construct their own knowledge about the social and physical world around them i.e. ICT. Discussion as a teaching and learning approach cuts across the other teaching approaches and therefore it is used in conjunction with another teaching and learning approach. For example, discussion can occur in small groups during cooperative learning or between a teacher and students during a problem-based lesson. It is therefore possible to distinguish and select different teaching and learning approaches that are appropriate for attaining particular objectives in a teaching and learning situation. This researcher has picked the use of ICT in teaching and learning approach in order to determine its effect on students' understanding of concepts in animal reproduction. Concepts in this topic that include: structure of gametes, process of fertilization, gestation

period and parturition cannot be demonstrated practically in the lab. According to Hmelo-Silver (2004), student-centered promotes more learning in that learning is more likely to be effective where a student plays a proactive role in the learning process

2.3.1 Effective Teaching and Learning Approaches in Science

The knowledge of how teaching and learning approaches affect students' learning may help science teachers to select teaching and learning approaches that improve teaching quality, effectiveness, and accountability to learners and the public (Wachanga and Mwangi, 2004). According to McDowell (2001), learning no longer supports a transmissive style of lecturing as it has been found that learning through memorization and reproduction does not result in knowledge that can be used to reason and to solve problems in new situations. He further notes that what the student does is more important in determining what is learned than what the teacher does. Thus, the teacher's role is not to lecture in an exclusively transmissive way, but to encourage active participation, dialogue and interaction by students with course materials and with each other as ICT is believed to offer (Wallace, 2003).

Students learn by interacting with and transforming received information so as to own it and make it personally meaningful,which leads to powerful understanding and useful knowledge (McDowell, 2001). Putnam and Borko (2000) have noted that teachers should have the knowledge of how students learn science and how best to teach and that effort should be taken now to direct the presentation of science lessons away from the traditional methods to a more student centered approach. Similarly Wambugu and

Changeiywo, (2008), note that the teaching approach that a teacher adopts is one factor that may affect student's achievement and therefore use of an appropriate teaching approach is critical to the successful teaching and learning of science. Learning is facilitated by a range of tasks that involve students in active processing, such as questioning, explaining and discussion.

According to Wilson and Berne (1999), effective teaching is at the heart of science education and good teachers of science create environments in which they and their students work together as active learners. The need for effective teaching and learning of science at secondary school level in Kenya as a means of achieving industrial and technological advancement is a widely recognized and accepted fact but despite this recognition, performance in science subjects at KCSE has consistently remained poor over the years (Wachanga and Mwangi, 2004). There is a relationship between the teaching and learning approach and achievement in science subjects. Given the possible link between science achievement and teaching and learning approaches, biology teachers should adopt teaching and learning approaches that can improve student achievement as the focal point of reversing the current trend of low achievement in biology at KCSE (Muraya and Kimamo, 2011).

ICT in education has undoubted potential, to be influential in changing teaching methodologies. Studies have also demonstrated that computer use can result in effective literacy gains. There is empirical evidence that students can be motivated and engaged using ICT (Lynch *et al.,* 2005; Segers and Verhoeven, 2009).

2.3.2Effect of Teaching Approaches on Performance

Studies carried out by International Evaluation of Educational Achievement (IEA) from a cross cultural survey revealed that gender differences have been found in every subject area in the written test, and that boys outperformed girls in Biology at all levels (Amunga *et al.,* 2013). In Kenya similar results are evident as shown by a study carried out by the Njeru and Orodho(2003) that boys performed better than girls in Chemistry, Physics and Biology in KCSE.

However, studies carried out by Salta and Tzougraki(2004); Jones *et al.* (2000) showed no significant difference on the achievement of boys and girls in chemistry. The outcome of Wachanga (2002) investigation on the effect of cooperative class experiment on the achievement of boys and girls in chemistry disagree with the findings of this study. It showed that there was no significant difference between the achievement of boys and girls who were taught chemistry through CCE methods. Other studies carried out by Wambugu and Changeiywo (2008) in Kenya, Nwagbo and Chukelu(2011) in Nigeria with secondary school students showed similar results in Physics and Biology subjects respectively. Oludipe (2012) carried out a study to investigate the influence of gender on junior secondary school students' academic achievement in basic sciences using cooperative learning-teaching strategy. His findings revealed that there was no significant difference in academic achievement of male and female students.

Most of the studies generally indicate that there are disparities in boys and girls achievement in biology in secondary schools. The information obtained from this study

reinforces the notion of male dominance in science learning and the view that science careers being predominantly male preserve. This study aims to examine whether ICT use in Biology instruction has any effect on achievement scores on students, especially on girls.

2.3.3Teaching Methods most Frequently used by Teachers in Biology in Kenya

According to Kavulya (2007), biology as a science subject requires an integration of both theoretical and practical work to make it easily understood by the students. This, therefore, calls for application of a myriad of teaching aids to enable learners to concretize biological principles, concepts and facts. Traditional instructional practices that centre on teacher dominated pedagogy predominates our schools (Changeiywo *et al.,* 2001). The author observes that learning activities in most secondary schools centre on the textbook and past examination papers. Research on teaching behavior indicates that there are teaching methods that influence students' achievement more positively than others (Wenglinsky, 2002). The author further argues that there was a correlation between high academic achievements of students and classroom practices of the teachers. Yilmaz-Tuzun (2008) indicates that the majority of elementary teachers rely heavily on the use of lecture and textbooks. The author posits that it is essential that teachers learn to use instructional practices that positively affect science learning instead of relying solely upon the use of textbooks and lectures.

Biology,as a science subject, requires an integration of both theoretical and practical work to make it easily understood by the students (SMASSE Project, 2000). Table 2.5 carries

information on the teaching methods most frequently used by the teachers while teaching biology. Information from Table 2.5 shows that the largest proportion of teachers (40%) still used the conventional lecture method while teaching biology. This is contrary to the recommendations of curriculum developers and the Quality Assurance and Standards directives (Shiholo and Ocholla, 2003). It is expected that through field trips the learners would acquire attitudinal skills; however none of the teachers (0.0%) frequently used field trips to teach biology. This could be attributed to financial constraints and many schools could not afford to take students for frequent field trips.

Table 2.4: Teaching Methods Most Frequently Used by Teachers in Biology

Teaching methods	**F**	**%**
Experiment method	7	20.0
Demonstration method	4	11.4
Project work	2	5.7
Lecture method	14	40.0
Field trips	0	0.0
SMASSE(ASEI / PDSI) Approach	8	22.9
Total	**35**	**100.0**

Source: SMASSE

Only (22.9%) of teachers had embraced the ASEI / PDSI approach as advanced by the SMASSE Project (2000). This implies that the Ministry of Education in conjunction with other stakeholders should organize for more in-service seminars for teachers on this

teaching approach. This approach has been recommended by the Ministry of Education and most teachers had been in-serviced. This approach emphasizes a learner centered teaching methodology that integrates hands-on activities, eyes-on activities and experimentation with one of its main objective being to change the attitude of the learners by their teachers through this new teaching approach (Minner *et al.,* 2010).

Although the government of Kenya has made efforts to in-service biology teachers through initiatives such as SMASSE, no marked improvement in the students' performance in biology has been observed. The traditional pedagogical practices used by the teachers in the teaching and learning of the biological concepts underscore the students' poor understanding resulting into poor performance and loss of interest in Biology. The Strengthening of Mathematics and Science in Secondary School Education (SMASSE) report (2000) reveals that inappropriate teaching methods led to poor understanding and performance in biology and in other science subjects at selected secondary schools. The report, specifically, pointed out that poor understanding of biology content and a lack of innovative skills lead to poor performance in practical tasks by the students. Questions testing experimental design were performed poorly indicating lack of practical approach to teaching. Teachers rush over to cover topics thus stifling students' ability to critically analyze situations and sustain their interest in biology, teacher-centered approaches defeat the key goal of biology teaching: to develop more effective and scientifically aligned strategies to assist high school students understand the key concepts in the biology curriculum.

2.4. Use of ICT in Teaching

ICT refers to the use of computer-based communications technology that serves as a network to find information. This includes computer hardware and software that can be used for teaching and learning and information resources (Mumtaz, 2000).Teaching at School as well as Higher Education, mostly, concentrate on giving information, which is not the sole objective of Teaching. Along with giving information, the other objectives are: To develop understanding and application of the concepts, developing expression power, developing reasoning and thinking power, development of judgment and decision making ability, improving comprehension, speed and vocabulary, developing self-concept and value clarification, developing proper study habit and finally development of tolerance and ambiguity, risk taking capacity, scientific temper.

With the present infrastructure, class size, availability of teachers, quality of teachers, training of teachers, etc., it is difficult to achieve all the objectives. Further, most of the teachers use Lecture Method, which does not have potentiality of achieving majority of above mentioned objectives (Wenglinsky, 2002). The objectives are multi-dimensional in nature, so for their achievement, multiple methods should be used in an integrated fashion. At present ICT may be of some use. It is a well-known fact that not a single teacher is capable of giving up to date and complete information in his own subject (No and Colony, 2014). The ICT can fill this gap because it can provide access to different sources of information. It will provide correct information as comprehensive as possible in different formats with different examples. ICT provides online interaction facility. Students and teachers can exchange their ideas and views, and get clarification on any

topic from different experts, practitioners, etc (Sansanwal, 2009). It helps learners to broaden the information base. ICT provides variety in the presentation of content,which helps learners in concentration, better understanding, and long retention of information, which is not possible otherwise (Shiholo and Ocholla, 2003). ICT provides flexibility to a learner, which is denied by the traditional process and method (No and Colony, 2014). Flexibility is a must for mastery learning and quality learning. On internet many websites are available freely, which may be utilized by teachers and students for understanding different concepts, improving vocabulary, developing reasoning and thinking, etc.

The use of technology in the learning environment has become an unstoppable force in recent years (Collis and Moonen, 2001). ICT affects a large section of education, from record keeping and school websites to the creation of online learning communities (Bishop*et al.,* 2009). Educational institutions can use specialized websites to make learning resources available online at any time.

Some educational institutions do not even require students to be physically present. Virtual classrooms have flourished in tandem with improved internet accessibility. The significant barriers of time and distance are rendered almost obsolete in such virtual classrooms (Stennes, 2011).

However, the benefits of ICT use in the classroom depend on the success with which it has been integrated (Condie and Munro, 2007). Dawes (2001) asserts that new technologies could support education across the entire curriculum, providing innovative opportunities for effective communication.

ICT in education has undoubted potential, to be influential in changing teaching methodologies. Studies have also demonstrated that computer use can result in effective literacy gains. There is empirical evidence that students, who are having difficulties with reading, can be motivated and engaged using ICT (Segers andVerhoeven, 2009).

Condie and Munro (2007) conclude that the use of ICT has had positive effects in a number of subjects, as well as being constructive in assisting students that are marginalized as a result of personal or familial issues. Glewwe and Kremer (2006), concluded that using Computer Aided Instruction (CAI) considerably diverts the teacher's focus to weaker students.

Research has shown that many students benefit from the use of ICT (Bingimlas, 2009). Wishart and Blease (1999) claim that students get immediate feedback or rewards. Korte and Husing (2006) refer to its ability to motivate learning. Forrester and Jantzie (1998) assert that the computer has enormous potential in developing the various multiple intelligences. Kozma (2008) suggests that ICT can be used to improve delivery of and access to education. In learning ICT skills, the student becomes better equipped for the world of work, which increasingly demands such competency. Furthermore, Kozma and Anderson (2002) claim that ICT is transforming education by introducing new curricula based on real life problems, providing different tools to enhance learning, providing students and teachers with more opportunities for feedback and reflection. Social Constructivism places emphasis on this type of student centered learning, viewing the teacher as a guide or facilitator, motivating students to discover things for themselves (Woo and Reeves, 2007).

Schoepp (2005) claims that constructivist approaches must dominate the learning environment for technology to have a significant impact on learning. However, it must be remembered that the use of ICT in classrooms is a relatively new phenomenon when compared to traditional teaching methods. While there have been notable critics (Cuban *et al.,* 2001; Palak *et al.,* 2006) most research strongly supports the premise that ICT enhances the teaching and learning process.

2.4.2 ICT use in biology

ICT has many applications in biology ;including data logging tools and digital video for data capture, spreadsheets for data handling, simulation and modeling, creation of virtual environments and provision of resources through the internet or on CD-ROM or DVD (Voogt, 2003). As well as making science more interesting, authentic and relevant for pupils, ICT use has been found to allow more time for post-experiment analysis and to foster discussion, communication and collaboration (Ally, 2009).

Simulations have been shown to help students gain a greater depth of understanding of scientific principles and relationships (Roschelle *et al.,* 2000) and permit experiments to be shown that would pose practical difficulties in a school environment. McFarlane and Sakellariou (2002) found that difficult-to-grasp concepts could be considered more readily and that ICT could take over many of the mechanical aspects of practical investigations, allowing pupils to concentrate on interpreting and analyzing data.

They also noted that data-logging tools, which record and store measurements electronically, can help, improve the quality and quantity of results in investigations. In

exploring the weather, for example, they could be used to record measurements outside the classroom as well as overnight or periodic data. Combined with analytical software, relationships can be discerned more readily due to the accuracy of the data. Students can also access authentic data on the internet and use its facilities to collaborate with professional scientists. The use of simulation software offers opportunities to investigate problem or difficult areas which are impossible to create in classrooms – or are often too dangerous (Cox and Hopkins, 2006).

Simulations and animations allowed pupils to see events that would otherwise be invisible because they happened too quickly, too slowly or were not readily observable (McFarlane and Sakellariou, 2002). Examples included the flap of a humming bird's wing, the life cycle of a redwood tree, fertilization,foetal development, the pulsing of a human heart and a bee collecting pollen on its legs. Similarly, dangerous materials or expensive apparatus could be simulated, such as the processes inside a nuclear reactor or a mass spectrometer, or the dissection of small animals (Voogt, 2003; Roschelle *et al.,* 2000).

Although simulations can eliminate experimental error and provide visual stimuli that help understanding, Steinmetz (2001) warns that accurate data may lead to pupil misconceptions, portraying measurement as contentious. Cox *et al.* (2004) showed that the use of ICT and animations in science could be used to challenge pupils' thinking and conceptual understanding (or misconceptions) through providing experiences which resulted in cognitive dissonance or conflict. This provided a focus for discussion and reflection on their understanding. In addition, they found that experience with computer

micro-worlds resulted in improvement in thinking skills and strategic planning as well as the use of more complex scientific language. Papert (2002) defined a micro-world as a computer-based interactive learning environment where the pre-requisites are built into the system and where learners can become the active, constructing architects of their own learning. Essentially, they are explorative (usually closed) learning environments with rules of their own – a virtual library, a virtual museum, an invented landscape – within which students can explore concepts and relationships

2.4.3 ICT approaches in education

There appear to be three main approaches to ICT taken by teachers according to (UNESCO, 2004). Integrated approach which involves planning the use of ICT within the subject to enhance particular concepts and skills and improve students' attainment. This approach involves a careful and considered review of the curriculum area, selecting the appropriate ICT resource which will contribute to the aims and objectives of the curriculum and scheme of work, and then integrating that use in relevant lessons. This study would mostly make use of this approach in its treatment group.

Enhancement approach is planning the use of an ICT resource which will enhance the existing topic through some aspect of the lessons and tasks. For example, using an electronic whiteboard for presenting theory about a topic. In this approach, the teacher plans to complement the lesson with an innovative presentation method to promote class discussion and the visualization of problems. Complementary approach is using an ICT resource to empower the pupils' learning, for example by enabling them to improve their

class work by taking notes on the computer, or by sending homework by email to the teacher from home, or by word processing their homework.

All three approaches can enhance attainment, but the effects may be different. In the integrated approach, students' learning is enhanced because they are confronted with challenges to their existing knowledge and given deeper insights into the subject being studied. The enhancement approach could improve students' learning through presenting knowledge in new ways, promoting debates among students, and encouraging them to formulate their own explanations. The complementary approach draws on the approach that suggests that learning can be enhanced by reducing the mundane and repetitive aspects of tasks such as writing essays and homework by hand, freeing the learner to focus on more challenging and subject-focused tasks (UNESCO, 2004). These different types of use require the teacher to have an extensive knowledge of ICT and to be able to fit its use either into their existing pedagogy or to extend their pedagogical knowledge so they can accommodate ICT effectively in their teaching

2.4.4 Review of impact of ICT use in teaching of biology

Many researchers have carried out research on the implication of ICT for science teaching. Among these Smeets (2005), who did research on ICT contributions to quality learning in science at key stage 3. This research was conducted in United Kingdom (U.K.) Also, Huppert (2002) investigated the impact of a biology simulation "the growth curve of micro- organism' on high school students' academic achievement and their science process skills. The study focused on the relations between academic achievement,

mastery of process skills, gender and cognitive stages. The research however, shows that the achievement of students using the stimulation was higher than those not using the stimulation, with girls achieving equally with boys. The stimulation was found to benefit students with low reasoning abilities in particular, enabling them to cope with learning scientific concepts and a principle which requires high cognitive skill. Osborne and Dillon (2010) in his paper reviewed the current state of science education, the impact of ICT use on the curriculum, pedagogy and learning, and the implications. He stated that there are diverse ways of linking ICT use to exiting classroom teaching, including supporting or replacing it.

The use of ICT in education and training has been a key priority in most EU and OECD countries in the last decade, although progress has been uneven. ICT has had a major impact on the education sector, on organization and on teaching and learning methods (Martin and Matlay, 2001; Papert, 2002). Yet there are considerably different ICT expenditure levels within and between countries, as well as between institutions within countries. In some countries schools have embedded ICT into the curriculum, and demonstrate high levels of effective and appropriate ICT use to support teaching and learning across a wide range of subject areas. However, in other countries schools are in the early phase of adopting ICT, characterized by important enhancements of the learning process, some developments of ICT-enabled learning, but without any profound improvements in learning and teaching (Balanskat *et al.,* 2006).One puzzling question concerns the effective impact of these technologies on educational outputs and outcomes. There is also a need to show that education should be seen as using technology not only

as an end in itself, but as a means to promote creativity, empowerment and equality and produce efficient learners and problem solvers (McFarlane and Sakellariou, 2002). Many academic researchers have tried to answer this question at theoretical and empirical levels. They have faced two main difficulties. On one hand, student performance is hard to observe and there is still confusion about its definition. On the other, ICT entails evolving technologies and their effects are difficult to isolate from their environment (Balanskat *et al.,* 2006; Martin and Matlay, 2001).

At national and institutional levels, educational policies and regulations have been established to support the educational use of ICT. In school and classroom settings, teachers and school administrators are attempting to find the best ways to harness ICT technology to support their teaching and students' success. However, accomplishments that are convincingly the result of the direct causal impact of ICT use are not always easily identifiable (Kang *et al.,* 2008). Currently, there is a significant number of initiatives to assess and monitor the efficiency of ICT use and its impact on education. SITES (the second information technology in educational study), sponsored by the International Association for the Evaluation of Educational Achievement (IEA), is an exemplary study which identifies and describes the educational use of ICT across 26 countries in the world. The study explores the use of computers in teaching through sampling teachers, principals and ICT responsibility in schools. While it does not look into student achievement, it does look at the perceived impact of ICT on students from the teacher's perspective (Kozma, 2008;Kozma and Anderson, 2002).

Bayraktar (2001) carried out a comparative study to evaluate the effectiveness of CAI on the Science achievement of American students following two different teaching methods. The assessment covered four subject areas, general science, physics, chemistry and biology. The participants were drawn from urban, suburban and rural secondary schools. The sample included a total of 2343 students. The purpose of the study was to establish the differences that existed between the academic achievement levels of science students who used computer assisted instruction, and those who used traditional approaches to learn biology, general science, chemistry and physics. The experimental group that used systematically designed traditional instruction supplemented with CAI obtained significantly better academic achievement compared to the control group that adopted a conventional teaching approach.

Moreover, Balanskat et *al.* (2006) reviewed several studies on the impact of ICT on schools in Europe. They conclude that the evidence is scarce and comparability is limited. Each study employs a different methodology and approach, and comparisons between countries must be made cautiously. In addition, in several other studies (Yusuf and Afolabi, 2010; Shaikh, 2009; Shaheeda and Laura, 2007) it is argued that ICT helps to improve the quality of learning and educational outcomes. Some other surveys (e.g., Iqbal, and Ahmed, 2010; Khan and Shah, 2004) argue that, in order to be successful, a country should improve its education system by implementing effective and robust ICT policies. In contrast, Trucano (2005) reviews a series of studies on ICT's impact on schools and concludes that the impact of ICT use on learning outcomes is unclear. Moreover, Cox *et al.* (2004) point out that ICT studies and indicators do not demonstrate

solid effects. Korte and Hüsing (2006) also explores the access and use of ICT in European schools in 2006. It presents information for 25 EU member states, Norway and Iceland, but does not look into student results so it is impossible to study this important aspect of ICT impact. Machin*et al.* (2007) state that, while there is a clear case for using ICT to enhance the computer skills of students, the role of technology enhanced learning (TEL) is more controversial. There is neither a strong and well developed theoretical case nor much empirical evidence supporting the expected benefits accruing from the use of ICT in schools since different studies find mixed results (Aristovnik, 2012). However, very few recent studies have examined the efficiency of countries in utilizing their ICT resources for educational outputs and outcomes and the impact of ICT on education in a particular country, for instance in Turkey (Tondeur *et al.,* 2008) and Belgium (Gülbahar and Güven, 2008).

It is expected that ICT use would promote deeper learning, enable schools to respond to the needs of pupils with different scholastic achievements, and foster the development of pupils' cognitive and personal skills, such as independent learning, problem-solving abilities and teamwork (Barak, 2007).ICT changes the role of teacher in class in such a way as to make her/him a partner and a facilitator of learning rather than the main source of knowledge and authority (Newton and Rogers, 2001).

Kesidou and Roseman (2002) observed that curriculum instructional materials have a major role in teaching and learning, and many teachers rely on them to improve their pedagogical skills in the delivery of their content. The methods used by the teacher should be student- centered and ICT can be used as one of the tools in classroom

instruction. This is because ICT can help to improve teaching and reinforce learning of some topics in Biology for example genetics, protein synthesis, opening and closing of stomata etc that would otherwise be abstract (Heinrich, 2001).This indicated that the achievement of students was increased when teacher used ICT in their teaching and learning. According to Smeet (2005), ICT provided significant contribution to teaching and learning in all subjects and to all ages.

According to Balanskat *et al.* (2006), using ICT in lessons can enhance self-esteem leading to expectations of achieving goals. Becker *et al.* (2009) also suggested that using ICT in lessons may help students in mastering subject skills. ICT used in lessons, especially produced higher quality output of students. Heinrich (2001) suggested that ICT can be used effectively in the science subjects to show video sequences of processes that are hard to explain or visualize. Students would be able to construct knowledge easier with the support of ICT (Osborne and Dillon, 2010).

A research carried out by Akwee *et al*. (2012) to determine the effectiveness of computer based technology in teaching and learning of gene concept found out that the integration of computer-based technology in teaching and learning improved students' achievement scores and understanding of the gene concept.

In a review of empirical studies on CAI, Yusuf and Afolabi (2010) concluded, among others, that the use of CAI as a supplement to conventional instruction produces higher achievement than the use of conventional instruction alone, research is inconclusive regarding the comparative effectiveness of conventional instruction alone and CAI alone,

and that computer-based education (CAI and other computer applications) produce higher achievement than conventional instruction alone.

2.4.5 Review of ICT use in Kenya

In a recent study by Kiptalam and Rodrigues (2010) observed that access to ICT facilities is a major challenge facing most African countries, Kenya included, with a ratio of one computer to 150 students against the ratio of 1:15 students in the developed countries. The adoption and use of ICTs in education institutions in developing countries remains very limited despite a decade of large investment in information and communication technologies. Kenya, like other developing countries struggles with high levels of poverty and this has an effect on the adoption and access to ICT (Aker and Mbiti, 2010). The initial aim to introduce ICTs in education was primarily at developing ICT skills, the focus has over time shifted to leverage ICTs to address issues of quality and to improve teaching and learning, especially at secondary and post-secondary levels (Kort and Hüsing, 2006). However, availability and use of ICTs at various levels is still patchy. About 1,300 secondary schools out of more than 6,000 schools have computers, while most schools with computers use less than 40% of the available infrastructure and very few actually use ICT as an alternative method for curriculum delivery. This shows a very slow integration pace and may lead to all benefits of ICT in schools un-equitably realized or not being realized in the near future. Many teachers perceive that adoption of ICT in school will render them jobless due to it foreseen benefits such as e-learning and efficiency in the mode of delivery (Trucano, 2005).

Currently, in Kenya, the Government is planning on Free Primary schools class one laptops project. In this project, Government plans to introduce laptops as a teaching and learning tool in the public primary school system; and ensures the policy is not only relevant but is on-point and service delivery is effective and efficient. It is also seen in the context of Government policy to integrate Information Communication and Technology in curriculum delivery in our schools. Tech-driven competitiveness requires an educational system that is strongly oriented towards producing citizens who are comfortable and productive in a hi-tech world. This is the major principle underlying the laptop project in schools. The intention is to prepare an entire generation of world-beating scholars, innovators, entrepreneurs and leaders who will take Kenya beyond Vision 2030.

To enable the government provide laptops to all Class One children in public primary schools in three phases beginning,the Government has already set aside Sh15 billion to ensure that at least 12,000 primary schools are connected to the national electricity power grid. Another Sh15.37 billion has been dedicated to the transformation of education by digitising school curricula, training teachers and providing the laptops.

The laptop programme has been considered in the context of a total structural overhaul. What will the laptops do in the short term? They will boost pupil-driven learning and largely free teachers to concentrate on coaching and learner support. The immediate impact of this programme is to make delivery of education services more effective and

empower the teacher and pupil. There will also be computer laboratories in schools to support the system.(Wanjala, A.S.,2013)

The approach, roadmap and governance structure for the National Digital Literacy program is now complete. The program, will be run through a multiplicity of government agencies whose main coordinator is the Ministry of ICT through the ICT Authority.

Other government organs that have defined roles are the Ministry of Education, Science and Technology, who is the project owner, Ministry of Industrialization & Enterprise Development, The National Treasury, the Ministry of Energy and Petroleum and the Office of the Attorney General.

“We want to see the success of the project. That’s why we are adopting a different strategy which focusses on the digital content for learners rather than the purchase of devices. We first have ensured that schools have adequate electrical power.We are also ensuring that teachers are trained in ICT,” said Dr Fred Matiang’i, the Cabinet Secretary, Ministry of ICT.The CS added that, the content will be accessible anywhere irrespective of device or platform. To ensure the success of the programme, the leadership will ensure stakeholder involvement, robust communication and a smooth transition for all parties involved. The strategy puts emphasis on ensuring sustainability in the long-term for the initiative to achieve its vision of creating a knowledge-based economy (Bitok, B.E. ,2014)

The project will be governed through a three tier framework. This consists of an Oversight, inter-ministerial and a technical implementation committee.The oversight committee will consist of the Attorney General and Cabinet Secretaries from the ICT, National treasury; Industrialization and enterprise development; Education, Science and Technology; Energy and Petroleum; and Devolution and planning. The inter-ministerial Committee comprise of Principal Secretaries in the above named ministries. The Technical committee will be chaired by the ICT Authority and will sit technical heads from the implementing agencies and key stakeholders such as TSC, KNUT and KEPSHA.(Wanjala, A.S.,2013)

The program, whose overall objective is to enhance learning in Kenya education system through the use of digital technologies, will have the Ministry of ICT providing leadership and take overall responsibility for the successful coordination of the initiative. The ICT Authority will oversee any technical matters regarding design, co-creation, selection and procurement of the appropriate technology solution as well as develop the partnerships necessary to ensure that the programme is underpinned by the establishment of a robust local capacity initiative to undertake first line assembly of the devices and accessories. Another role will be that of developing adequate device support maintenance and warranty frameworks that ensure adequate local participation and value for money.

The Ministry of Education, science and technology, is tasked with the development of curriculum content for use on the digital platform, identification of beneficiary primary schools, capacity building and training for teachers and other relevant education stakeholders. The ministry will also convert all Kenya Institute of Curriculum Development (KICD) digital content to open source format to allow for delivery across multiple technology platforms.(Wanjala, A.S.,2013)

The Ministry of Industrialization and Enterprise development will develop and implement plans to ensure local assembly of devices and related accessories while the Ministry of Energy and Petroleum will fast track the completion of the electricity to all the identified primary schools.Other government arms responsible are the National Treasury which will reallocate budgetary resources earmarked for the program and prepare budget and taxation consideration to support the establishment of local assembly plants for ICT devices and related accessories.

The office of the Attorney General, is tasked with undertaking all necessary processes and procedures to ensure the proper revocation of all previous public procurement activities related to the purchase of ICT devices for the integrated ICT for Schools program.

Already a strategy critical to the success of the program has been formalized as constituting four main areas which are Policy and Strategy, Digital Content Management, Device and Infrastructure Management and Program sustainability. Among the policies to be formulated are cloud computing strategy and ICT standards.

Other deliverables of the strategy are the establishment of a content framework and its conversion to digital platforms. On devices, the strategy advocates that they should adopt common standards with emphasis laid on content requirements, health and safety measures and environmental friendly equipment.To sustain the program four key issues have been identified namely; financial sustainability, partnering with key manufacturers to set up local IT assembly plan, capacity building and change strategy.

The cost of the first phase of the project is estimated at 17 billion shillings and will deliver 1.2 million devices in the next two years to cover all public primary schools. The pilot phase of 150 schools was planned for September, 2015. The Kenya Institute of Curriculum Development (KICD), formerly the Kenya Institute of Education (KIE), which is mandated to develop curriculum under the Kenya Institute of Curriculum Development Act 2013, has already developed digital content in anticipation of the laptop rollout.(Wanjala, A.S.,2013)

Although there is a significant literature on ICT in science education, much of it takes the form of articles on applications for use in teaching situations: the emphasis is on how to use ICT, rather than exploring its effects. Where effects have been given, none has assessed the effect of ICT on performance of students in 'Animal Reproduction'. There is a sense in which it is taken rather for granted that ICT is a 'good thing', with students being motivated when they use it, and this leads to better learning. Thus a central purpose of this review is to assess the strength of the evidence base to support the notion that the use of ICT activities in Biology enhances students' understanding of Biological concepts.

2.5 Summary

In this chapter, literature associated with integration of ICT into teaching of science in general and biology in particular has been covered in detail. This literature includes; performance of biology in Kenya causes of poor performance in biology, teaching and learning approaches, effective teaching and learning approaches in science, review of ICT use in Kenya, ICT integration and benefits of ICT integration into Biology teaching.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

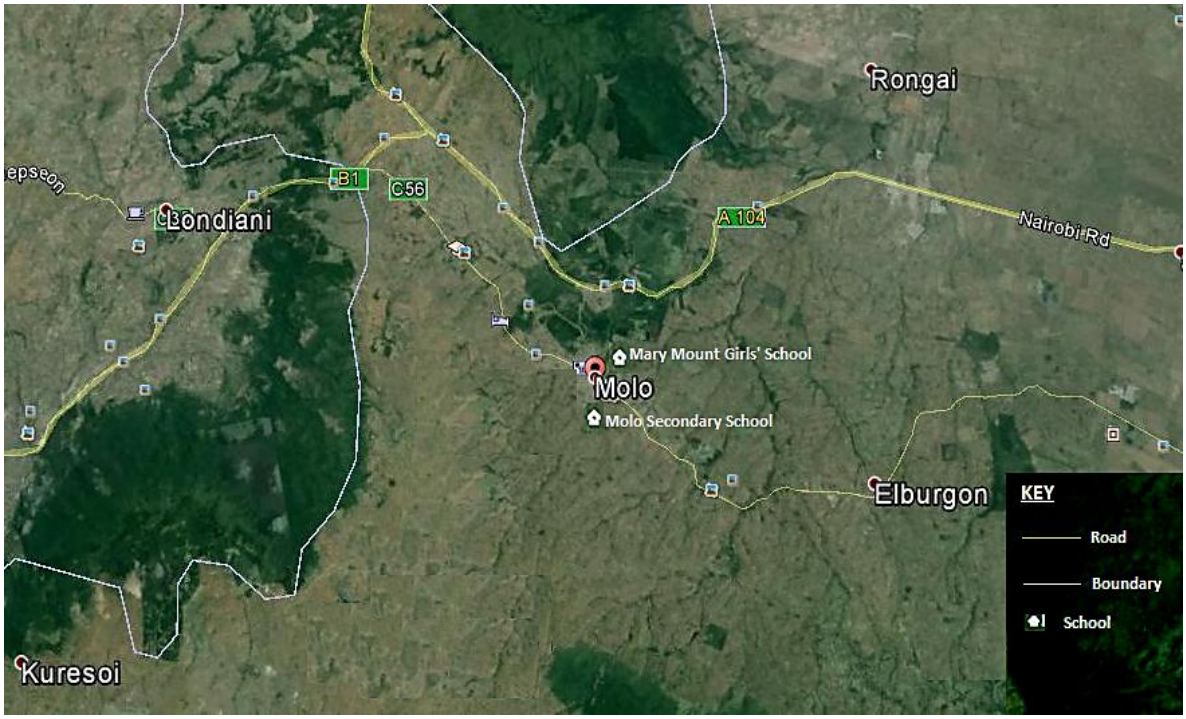
3.1 Introduction

This chapter outlines the nature of the methodology for the research. The research design, sampling, sample and sampling procedures**,** data collection instrument, data collection procedures, validity, reliability and ethical considerations.

3.2 Study Area

This study was carried out in Molo Division. The Division is one of the divisions in Molo sub- county in Nakuru County, Central geo-political zones of Rift valley. This is a wet and cold area with an averagely high population. It is a rich farming area with the farmers planting potatoes, cabbages and maize as well as keeping dairy cattle. It is generally an economically stable region hence this reduces influence of lack of educational resources on performances.

The fact that the area is one which is rich agriculturally means that, the schools in the area can easily afford to equip their schools with ICT gadgets, particularly if they can be educated on the role ICT can play in their children's education and its expected impact on performance. The researcher also understands the area well having worked there hence reducing the challenges associated with access to the schools of study considering the short duration.



Source: Google maps

Figure 3.1: Map of the Study Area

3.3 Research Design

A quasi-experimental research design was used for this study. The choice of this design was because of the nature of the subjects which do not allow for complete randomization

process, hence, intact classes were randomly assigned to the groups. It was also unethical to randomize students for the purpose of this study because secondary school students in Kenya are found in fixed classes and the schools management in the schools where the study was conducted did not allow randomization of students for the purpose of this study. The students' achievement was considered as dependent variables while the conventional and computer-based instruction modes of teaching were independent variables whose changes could affect the achievement in biology. The intervening variables that were controlled in the study include: The teacher characteristics (professional qualifications, teaching experience and readiness to practice ICT approach); and teaching and learning resources and facilities (laboratory, charts, computers, apparatus, syllabuses and textbooks).

The design is strong enough to compare the effect of a treatment and can control all major threats to internal validity except those associated with maturation, history and instrumentation (Khan and Saleh, 2001). For this study, form three students of relatively the same age were used to control maturation. The instrument used in this study was assessed by a team of three Biology KNEC examiners for content validity. This design has been used successfully in research studies to determine the effect of teaching approaches on student achievement scores in Kenya (Wambugu and Changeiywo 2008; Wachanga, 2002).

This experimental design adopted symbols as proposed by William (2009). Groups E1 and E2 were co-educational classes that were randomly assigned to the experimental and control groups. O1 and O3 were pre-tests while O2, O4 were post-tests. Both the pre-test

and post-test was the Biology Achievement Test (BAT) which was constructed by the researcher for the purpose of the study. X represents the treatment variable which in this study was the ICTuse , while C represents the control condition which in this study was the regular teaching method.

Table 3.1: Pre-test and Post-test research design

GROUPS	PRE-TEST	PROCESS	POST TEST
E1	O1	X	O2
E2	O3	C	O4

Source: Khan and Saleh(2001).

As can be seen in Figure, notations are: E1=Experimental group, E2=Control Group, O1, O2_= Pre-test and Posttest(Experimental group) scores, O2, O4 = Pre-test and Post-test (Control group) scores, X=Process that stands for the experimental variable of the computer based lesson.

3.4 Population of the Study

The population of this study was one thousand, four hundred and twenty (1,420) form three students in 17 secondary schools in the area. The schools were made up of twelve (12) public and five (5) privately owned schools. Only the public schools were considered in the study to allow for generalization of the results since most of the secondary schools in Kenya are public schools.All the secondary schools in the area offer biology. The selected topic was being covered at the time of the visit and this made it easy for the researcher to be granted permission by the school authority. The students saw

the exercise as normal classroom activity since the school time table was followed strictly

3.5 Sampling Procedures

Purposive sampling was used to select schools by visiting all the secondary schools to identify those with computers; hence, seven schools were identified but only three schools based on suitability were purposively selected due to their proximity. The schools had male and female students which took care of gender as a variable under consideration. The target population of this research was form three secondary biology students in Molo division. This is because a research on ICT must necessarily be conducted in schools where computers are available for students' use and where the students have basic computer knowledge. The sampled schools were also grouped into three as shown in the Table 3.2 below;

Table 3.2: Types of sampled schools

Type of school	Number	Percent
GIRLS ONLY	83	34.6
MIXED	78	32.5
BOYS	79	32.9
Total	240	100.0

3.6 Sample Size

Two hundred and forty students were drawn from the three (3) public schools in Molo

Division; Simple random sampling was used (by hat and draw) to assign two intact classes to experimental and control groups each with a total of 120 students in the selected schools.

Table 3.3: Number of students per teaching method

Group	Frequency	percentage
Traditional/ conventional	120	50
ICT	120	50
Total	240	100

Source: Field Data

3.7 Study Variables

This study was meant to determine the effect of ICT assisted approach on Biology mean achievement scores of secondary school students. Therefore the study was designed as an experiment where the teaching approach was the independent variable while the mean achievement scores in biology was the dependent variable. ICT assisted approach was the experimental variable while the regular teaching method was the control condition. According to Robson (2011), an experimental design is employed where participants are assigned to different conditions; there is manipulation of one or more independent variables by the experimenter; there is measurement of the effects of this manipulation on one or more dependent variables; and there is control of all other variables. This study

fitted into this description of an experimental design in that the effect of ICT approach was compared with the regular teaching method at the end of the two week treatment period to determine whether it had a significant effect on secondary school students' mean achievement scores in biology. An experimental design is a strong design for a researcher to test hypotheses to reach valid conclusions between independent and dependent variables (Best and Kahn 2003). According to Best and Kahn (2003), it is difficult to ensure equivalence of the experimental and control groups in a school by random assignment of students because classrooms are formed as intact groups that cannot be dismantled for the purpose of a study.

3.8 Data Collection Instrument

There were 10 test items which were open ended with a total of 50 marks (Appendix 3). The test items tested knowledge, comprehension and application of knowledge. The test was based on the Form three topic; reproduction in animals. The test was validated by three secondary school Biology teachers with at least five years teaching experience and who are national examiners in the subject. The test was piloted in a secondary school with similar characteristics as the sample schools in Kericho County.

The Biology Achievement Test is the instrument used in the study to measure students' mean achievement score in biology. The test was developed by the researchers, re-organized and used as a post-test. It consisted of 10 structured test items with a maximum score of 50 based on "reproduction in animals", the topic is considered one of the difficult topics in Biology (KNEC, 2013) and its non- practical nature makes it amenable

to computer based instruction teaching strategy. This topic is taught at form three as prescribed in the Secondary Education Syllabus Volume Three (KIE, 2002). The short answer item format was modeled on the KNEC Biology Paper One which is considered appropriate as it is a familiar format at secondary school level in Kenya (KNEC, 2005). The 9 test items were set and categorized into three cognitive domain levels adapted from the Blooms Taxonomy of Educational Objectives in the Cognitive Domain (Bloom and Krathwohl, 1956). The test instrument was a 9 item structured objective test drawn from the past Kenya National Examination Council (KNEC) Examination biology paper questions. Test items carried different scores ranging from 1- 20 and the test content was based on a table of specifications to sample the content in the three cognitive levels during the construction of the test items. The BAT instrument was evaluated by researchers in biology to ascertain its content validity. These experts were trained biology teachers with a teaching experience of over 10 years. In addition the experts have experience as examiners in Biology and in-service trainers of Biology teachers in Kenya. They ascertained that the BAT test items were based on the content and specific objectives of "Reproduction in animals" as prescribed in the Secondary School Biology Syllabus (KIE, 2005). The experts also ascertained that the BAT items were accurately categorized into knowledge, comprehension, and application cognitive domain levels.

Training was conducted for the three subject teachers from the sampled schools. The teachers were qualified teachers with B.Ed (Science) Biology who have had 5-years and above of teaching experience for the period of four days on the use of computer-based instruction packages and lesson plans for the treatment groups. The training was carried

out through micro-teaching whereby the teachers were allowed to teach with the instrument. This was to ensure homogeneity of instructional situation on the groups as much as possible.

3.9 Administration of the Research Instruments

Research authorization and permit to conduct this study was granted by the National Council for Science, Technology and Innovation (NACOSTI), a government agency in the Ministry of Higher Education, Science and Technology (MOHEST) in Kenya. Before commencement of the study, the researcher visited the then District Education Office in the study sub-county and the study schools to determine the workability of schedule of activities. This involved determining extent of syllabus coverage in biology at form three, allocation of Biology lessons in the master time table and the schools' calendar of events for the first school term of 2014. At the commencement of the study a BAT pre-test was administered to students in Groups E1 and E2. Group E1 is an experimental group while Group E2 is a control group. At the end of the experimental treatment which lasted two weeks, a BAT post-test was administered to students in all two groups. Both the pre-test and post-test was administered under similar conditions in both experimental and control classes and supervised by the researcher and the regular teacher. The pre-tests and post-tests were then scored by the researcher using a marking scheme prepared and validated by the team of experts in biology. The team of experts then validated the scoring of the BAT pre-test and post-test.

During the experiment, the researcher visited the classes so as to ascertain the use of ICT approach as prescribed. The teacher in the control class used the regular teaching methods (RTM) to teach “Reproduction in animals”. The researcher also visited the classrooms in the control classes and ascertain that computer aided instruction was not used. A total of 8 lessons was taught in both the experimental and control groups during this study.

To reduce anxiety among students under the control group, a meeting was called to inform them of the research process and their teacher was still able to re-teach them by use of ICT facilities as the experimental group. The re- teaching was done after the end of the research.

To minimize the effect of intervening variables and ensure that the effect on performance was due to ICT alone the researcher did as follows: neighboring schools were used to ensure local and environmental influences were the same; the schools also had close academic performance to allow for their performance to be compared reliably. The same teacher was used for both experimental and control groups to reduce teacher influence, the teachers used in the three schools also had equal educational qualifications (degree) and almost the same teaching experience to reduce teacher factor.

3.10 Methods of ICT integration

ICT integration involved Topic level and Lesson level. CDs and DVDs containing topics and sub-topics prepared by the researcher were used by the teachers during the ICT lessons. The topic was ‘Reproduction in animals’ while the lessons included ‘ structure

of gametes', 'process of fertilization', 'gestation period in human' and 'process of parturition'. The students were allowed to watch lessons on reproduction observed through animations and simulations by use of projector screen. The teacher took students through a discussion after each session of watching. Animation or simulations can be used to integrate pedagogical teaching with ICT to improve pedagogical teaching of these abstract concepts.

3.11 Reliability and Validity

3.11.1 Validity

Validity has been defined as the degree to which a test or measuring instrument actually measures what it purports to measure or how well a test or a meaning instrument fulfills its function (Anastasi *et al.,* 1999). However, recent views of validity seem not to be on the instrument itself but on the interpretation and measuring of the scores derived from the instruments. For example, Cook and Beckman (2006) conceptualized validity as the extent to which theory and evidence support the proposed interpretation of test scores for an intended purpose. Relatedly, Whiston (1996) views validity as the degree to which evidence and theory support the interpretation of test scores entailed by proposed uses of tests. Similarly, Further, McBurney and White (2009) view validity as an indication of accuracy in terms of the extent to which a research conclusion corresponds with reality. The foregoing suggests that validity hinges on the extent to which meaningful and appropriate inferences or decisions are made on the basis of scores derived from the instrument used in a research. Cook and Beckman (2006) asserts that any piece of research is worthless unless it is valid, while Bashir *et al.* (2008) refers to validity as

whether the research measures that which it is intended to, or how truthful the research results are. Whiston (1996) argues that validity refers to the interpretation and potential to generalize results. Validity in this research hinge on the extent to which meaningful and appropriate inferences or decisions was made on the basis of scores derived from the instrument used in a research. To further improve on validity of the research, the researcher involved the supervisors and their input was carefully considered.

3.11.2 Reliability of the Instrument

Reliability is one of the most desirable technical merits in any educational research though its meaning differs in quantitative and qualitative research. Quantitative research assures the possibility of replication. That is, within a certain limit of experimental error or random error, if the same methods are used with the same sample, then the results should be the same (Cohen and Manon, 2007). In a more explicit way, Bowling and Hammond (2008) views reliability in quantitative research as synonymous to dependability, consistency, reproducibility over time, over instruments and over groups of respondents. Indeed, for a research to be reliable, it must demonstrate that if it were to be carried out on a similar group of respondents in a similar context, similar results would be obtained. On the other hand, qualitative research strives to record the multiple interpretations of intention in and meanings given to situations and events (Cohen and Manon, 2007).

Consequently, reliability in qualitative research is regarded as a fit between what researcher record as data and what actually occurs in the natural setting that is being

researched. Meanwhile, Bogdan and Bilken (2007) have earlier argued that qualitative research is not to strive for uniformity but accuracy and comprehensiveness of courage, noting that two researchers who are studying a single setting may come up with very different findings but both sets of findings being reliable. Interestingly, Stenbacka (2001) suggest that reliability in qualitative research should be replaced with terms such as credibility, neutrality, conformability, dependability, consistency, applicability, trustworthiness and transferability

Quantitative data also displays reliability in that sampling was careful, appropriate instruments was used and later the data was analyzed appropriately, using recognized statistical analysis software (SPSS).

Bratti (2002) show that the differences in students' performance can be explained by the differences between the areas in economic terms of structures, of devices of regional leisure, type of the institutions and the individual characteristics of the students (family and social characteristic). Didia and Hasnat (1998) examined the determinants of student performance in an introductory finance course. They found that age, as a measure of maturity, had a significant influence on performance.

The 15 items were used in pilot testing. From the trial testing, the scores gathered were used by the researcher to calculate the reliability of the instrument using Pearson Product Moment Correlation Coefficient method. This yielded an r value of 0.71, a coefficient considered to be reliable and having a good internal consistency.

3.12 Data Analysis

The pre-test was conducted for both groups and data was collected for analysis using SPSS version 13.0. Then an experiment was carried out for both groups. For the Treatment Group, they were taught by use ICT during their Biology lessons for 2 weeks. Whereas, for the Control Group, their lessons were carried out without use of ICT. Following the experiments, a post-test was also conducted for both groups for data collection

Data collected from this study were then analyzed by using descriptive (means) and inferential statistics (ANOVA). Descriptive analysis was used to study the effect of ICT use on the achievement of form three students in general and also on the performance of boys and girls. The ANOVA test was used to investigate the relationship between the effects of ICT use in teaching and learning on the achievement, and to determine whether there was a significant difference in students' achievement across gender.

3.13 Ethical Considerations

Ethical integrity is important to ensure the protection of the participants participating in the research, the researcher and the research itself. Research should be honest, respectful, objective and confidential. Cohen and Manon (2007) assert that readers have a right to expect that research is conducted "rigorously, scrupulously and in an ethically defensive manner".

It was also made clear why they had been chosen to participate as well as their right to accept, deny or even withdraw from participating in the research (Bogdan and Biklen, 2007). All the respondents participated with informed consent.

3.14 Summary

In this chapter on methodology; description of the study area was given, sample size and how sampling was carried out was also discussed. The chapter also argued on the selection of the experimental study design. How data collection was carried out, instrument validity and reliability and ethical considerations were also described in details.

CHAPTER FOUR

DATAPRESENTATION, ANALYSIS AND INTERPRETATION

4.1 Introduction

This chapter presents the analysis of the data collected, interpretation and presentation of the findings with respect to hypotheses. The purpose of this study was to assess the impact of ICT use in the teaching and learning of biological concepts, as evidenced in achievement scores in biology. Data was collected and analyzed to determine the achievement of the following objectives:-

a) To investigate the effect of ICTuse on students achievement scores in biology in secondary schools.

b) To establish whether there is any gender difference in achievement scores among boys and girls taught with the use ICT.

This study was meant to determine how ICT affected Biology mean achievement scores of secondary school students. Therefore the study was designed as an experiment where the teaching approach was the independent variable while the mean achievement scores in biology was the dependent variable.

The Biology Achievement Test was the instrument used in the study to measure students' mean achievement score in biology. Data collected was analyzed using both descriptive and inferential statistics to test hypotheses tested in the study that were;-

H_{01}There is no significant difference on the achievement scores of students in Biology when ICT is used in teaching.

H_{02}There is no significant difference on the achievement scores among boys and girls who are taught biology through ICT instruction.

Descriptive statistics and inferential statistics were used in this study. The level of significance was $\alpha=0.05$ and appropriate degree of freedom.

4.2 Effect of ICT use on Performance of Students in Biology in Secondary Schools

The study sought to investigate effect of ICT use on students' performance in Biology, BAT test was administered to students of both experimental and control groups and the scores obtained were scored out of 100 %.Their achievement scores were then averaged and compared to determine the effect of ICT.

4.2.1 Effect of ICT use on Performance of Students in Mary Mount Secondary

In Mary Mount 42 students were used in the control group while 41 students were involved in the experimental group. Descriptive statistics were used to compare their mean achievement scores as seen in Table 4.1 below.

Table 4.1: The comparison of students' achievements in pre-test session between the Treatment Group and the Control Group in Mary Mount (Descriptive)

Group	N	Mean	Std. Deviation

Traditional/ Conventional	42	51.2381	9.11661
ICT	41	54.7561	8.73436
Total	83		

Thepre-test mean scores show that the ICT group had higher mean than the traditional group. Secondly to find out whether the difference in performance noted were significant or due to chance, the data was tested using one- way analysis of variance (ANOVA). The details of the findings are presented in the table 4.2 below.

Table 4.2: The comparison of students' achievements in pre-test session between the Treatment Group and the Control Group in Mary Mount (ANOVA)

	Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
Between Groups	256.772	1	256.772	3.220	.076
Within Groups	6459.180	81	79.743		
Total	6715.952	82			

The p-value is higher than the level of significance (0.05) then there is no significant difference in pre –test scores of students before treatment.

Table 4.3: The comparison of students' achievements in post-test session between the Treatment Group and the Control Group in Mary Mount (Descriptive)

Group	N	Mean	Std. Deviation
Traditional/ Conventional	42	59.2381	8.60745
ICT	41	66.3415	10.81575
Total	83		

Table 4.3 show that the treatment had higher achievement scores than the control group. These scores were then tested for significance as shown in table 4.4

Table 4.4: The comparison of students' achievements in post-test session between the Treatment Group and the Control Group in Mary Mount (ANOVA)

	Sum of Squares	Df	Mean Square	F	p-value
Between Groups	1046.848	1	1046.848	10.988	.001
Within Groups	7716.839	81	95.270		
Total	8763.687	82			

Since the p-value is less than the level of significance (0.05) then there is indeed a significant difference in performance of students taught using ICT and those taught by traditional methods in Mary mount. The comparison of students' achievements showed that the Treatment Group had higher achievement than the Control Group and that the difference in post test scores is not by chance but caused by the teaching method used.

4.2.2 Effect of ICT use on Performance of Students in Kikambala Secondary

In Kikambala, 38 students were used in the control group while 41 students were involved in the experimental group. Descriptive statistics were used to compare their mean achievement scores as seen in Table 4.5 below.

Table 4.5: The comparison of students' achievements in pretest session between the Treatment Group and the Control Group in Kikambala secondary (Descriptive)

Group	N	Mean	Std. Deviation
Traditional/ Conventional	38	46.7368	8.89483
ICT	41	46.1707	10.85104
Total	79		

Table 4.5reveals that the students in both traditional and ICT groups had equal average achievement scores before treatment. The data was then subjected to ANOVA to test significance of the scores as shown in Table 4.6 below.

Table 4.6: The comparison of students' achievements in pretest session between the Treatment Group and the Control Group in Kikambala secondary (ANOVA)

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	6.320	1	6.320	.064	.801
Within Groups	7637.173	77	99.184		
Total	7643.494	78			

The p-value is higher than the level of significance (0.05) then there is no significant difference in performance of students in control and experimental groups before treatment.

Table 4.7: The comparison of students' achievements in post-test session between the Treatment Group and the Control Group in Kikambala secondary (Descriptive)

Group	N	Mean	Std. Deviation
Traditional/ Conventional	38	53.9737	9.75507
ICT	41	58.8293	11.25367
Total	79		

Table 4.7 reveals that the students taught using ICT had higher average achievement scores than those taught using traditional method after treatment. To find out whether the difference in performance noted were significant or due to chance, the data was tested using one- way analysis of variance (ANOVA). The details of the findings are presented in the table 4.8 below.

Table 4.8: The comparison of students' achievements in post-test session between the Treatment Group and the Control Group in Kikambala secondary (ANOVA)

	Sum of Squares	Df	Mean Square	F	P –value
Between Groups	464.968	1	464.968	4.169	.045
Within Groups	8586.779	77	111.517		
Total	9051.747	78			

Since the p-value is lower than the level of significance (0.05) then there is indeed a significant difference in performance of students taught using ICT and those taught by traditional methods.

4.2.3.1 Effect of ICT use on Performance of Students in Molo Secondary

In Molo secondary, 78 students participated in the study.37 were used in the control group while 41 students were involved in the experimental group.18 boys and 22 girls were in the control group while 23 boys and 15 girls were instructed using ICT. Descriptive statistics were used to compare their mean achievement post- test scores differently as shown in Table 4.9 below.

Table 4.9: The comparison of girls' achievements in pre-test session between the Treatment Group and the Control Group in Molo secondary (Descriptive)

Group	N	Mean	Std. Deviation
Traditional/ Conventional	22	42.9091	7.68988
ICT	15	42.0667	7.02512
Total	37		

The pre- test table shows that the mean scores for female students' in the control and experimental groups before treatment was almost the equal before treatment.

Table 4.10: The comparison of girls' achievements in pre-test session between the Treatment Group and the Control Group in Molo secondary (ANOVA)

	Sum of Squares	Df	Mean Square	F	P-value
Between Groups	6.330	1	6.330	.115	.737
Within Groups	1932.752	35	55.221		
Total	1939.081	36			

The pre-test table shows that the mean value of female students' scores in biology before treatment was not significant ($p = 0.737$, $\alpha = 0.05$).

Table 4.11: The comparison of girls' achievements in post-test session between the Treatment Group and the Control Group in Molo secondary (Descriptive)

Group	N	Mean	Std. Deviation
Traditional/ Conventional	22	47.1364	9.45312
ICT	15	50.4000	10.87461
Total	37		

As seen in Table 4.11, the Treatment Group attained mean scores of 50.4, while the Control Group attained 47.13. The significant value from Table 4.12 was .339 and these results showed that there were no significant differences in the achievement of both groups in the post-test. Results indicated that performance of girls did not change after treatment.

Table 4.12: The comparison of girls' achievements in post-test session between the Treatment Group and the Control Group in Molo secondary (ANOVA)

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	94.998	1	94.998	.941	.339
Within Groups	3532.191	35	100.920		
Total	3627.189	36			

Table 4.13: The comparison of boys' achievements in pre-test session between the Treatment Group and the Control Group in Molo

Group	N	Mean	Std. Deviation
Traditional/ Conventional	18	45.6111	10.82556
ICT	23	43.2174	6.60548
Total	41	44.2683	8.67475

Table 4.13shows that the mean value of boys' achievements in biology by traditional methods was higher than for those taught using ICT before treatment.

Table 4.14: The comparison of boys' achievements in pre-test session between the Treatment Group and the Control Group in Molo secondary (ANOVA)

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	57.858	1	57.858	.764	.387
Within Groups	2952.191	39	75.697		

Total	3010.049	40

Table 4.14 shows that the mean value of male students' achievements in the two groups was not significant before treatment as the p-value was higher than the significant value.

Table 4.15: The comparison of boys' achievements in post-test session between the Treatment Group and the Control Group in Molo secondary (Descriptive)

Group	**N**	**Mean**	**Std. Deviation**
Traditional/ Conventional	18	49.2778	8.55986
ICT	23	52.3043	8.71485
Total	41		

The mean score for the Treatment Group was 52.30 and the mean score for the Control Group, was 49.27 as shown in table 4.8A .ANOVA analysis in table 4.16showed that the p value was 0.273. These results showed that there was no significant difference in boys' achievement in biology between both groups after treatment.

Table 4.16: The comparison of boys' achievements in post-test session between the Treatment Group and the Control Group in Molo secondary (ANOVA)

	Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
Between Groups	92.495	1	92.495	1.237	.273
Within Groups	2916.481	39	74.782		

Total	3008.976	40

4.2.4 Effect of ICT use on Performance of all Students in the Sampled Schools

An analysis was then finally done on the average scores for all the 240 students to determine the effect of ICT use on achievement scores of students in the test and the findings are presented in the table 4.17 below.

Table 4.17: Comparison of performance in pre-test among the control and experimental groups (Descriptive)

Group	**N**	**Mean**	**Std. Deviation**
Traditional/ Conventional	120	47.4417	9.48488
ICT	120	48.0250	10.23872
Total	240	47.7333	9.85267

Table 4.17 the Treatment Group attained mean scores of 48.02, while the Control Group attained 47.44. The significant value from table 4.18 was 0.647 and these results showed that there was no significant difference in the achievement of both groups before treatment.

Table 4.18: A Comparison of performance in pre-test among the control and experimental groups (ANOVA)

	Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
Between Groups	20.417	1	20.417	.210	.647

Within Groups	23180.517	238	97.397
Total	23200.933	239	

After 2 weeks of treatment, both the control and the experimental groups were subjected to the BAT test. Their mean scores were then subjected to descriptive analysis as shown in tables 4.19 below.

Table 4.19: The comparison of students' achievements in post-test session between the Treatment Group and the Control Group (Descriptive)

	N	**Mean**	**Std. Deviation**	**Minimum**	**Maximum**
Traditional/ Conventional	120	53.8583	10.15369	28.00	75.00
ICT	120	59.0917	12.09972	28.00	88.00
Total	240	56.4750	11.45006	28.00	88.00

The table 4.19 reveals that the students taught using ICT performed much better than those taught using traditional method, the average mean mark for the ICT taught students was higher.

Secondly to find out whether the difference in performance noted were significant or due to chance, the data was tested using one- way analysis of variance (ANOVA). The hypothesis, **H01,** was ICT use in teaching will not have any significant impact on the performance of students in biology. The details of the findings are presented in the table4.10B below.

Table 4.20: The comparison of students' achievement in post-test session between the Treatment Group and the Control Group (ANOVA)

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1643.267	1	1643.267	13.172	.000
Within Groups	29690.583	238	124.750		
Total	31333.850	239			

Since the p-value (sig.) is less than the level of significance (0.05) then there is indeed a significant difference in performance of students taught using ICT and those taught by traditional methods. Hence the H01 is rejected. The difference in performance is not by chance but caused by the teaching method used. The comparison of students' achievements showed that the Treatment Group had higher achievement scores than the Control Group. It was concluded that there was a significant difference in achievement of biology between both groups. This indicated that the achievement of students was increased when teachers used ICT in their teaching and learning.

This finding conforms to the earlier findings of Pittard *et al.* (2003), who said ICT provide significant contribution to teaching and learning in all subjects and to all ages. ICT can motivate children and engage them in learning, besides meeting individual learning needs. According to the Bruner and Kumar (2005) theory, to achieve better results, children need motivation to learn. It has been proven in this study where ICT has been used in teaching for 2 weeks in the Biology classes. As a result, the students were more interested to study and this helped to improve their performance. These results also

agreed with Hennessey *et al.* (2003) who also found that ICT increased the interest and motivation for pupils in schools.Norzita (2004) in a similar study also proved that teaching and learning using ICT improved the achievement of moderate learners.Odera(2011)also found out that the experimental group that used systematically designed traditional instruction supplemented with CAI obtained significantly better academic achievement compared to the control group that adopted a conventional teaching approach.

Papastergiou (2009) Meta - analysis study revealed that on average, students who used ICT - based instruction scored higher than students without computers. The students also learn more in less time and they like their classes more when ICT based instruction was included.Lazarowitz and Huppert (1993) in Israel investigated the impact of a biology simulation 'The Growth Curve of Microorganisms' on high school students' academic achievement and their science process skills. The study focused on the relations between academic achievement, mastery of process skills, gender and cognitive stages. The findings indicated that the achievement of students using the simulation was higher than those not using the simulation, with girls achieving equally with boys.

Cotton (1991) concluded, among others, that the use of CAI as a supplement to conventional instruction produces higher achievement than the use of conventional instruction alone. Students' use of ICT simulations was more effective than using non-ICT teaching activities for improving basic science ideas including science understanding and the scientific approach (Norzita, 2004). Pittard *et al.* (2003) also suggested that ICT provided significant contribution to teaching and learning in all subjects and to all ages.

The results were positively related to that done by Lazarowitz and Huppert (1993) who concluded that material like VCD and television are motivating devices when used to synchronize a lesson presentation to the experimental group in Biology produced greater academic performance in the experimental group than in the control group.

4.3 Gender Difference in Achievement Scores among Boys and Girls

The study also sought to investigate whether there is gender difference in performance of biology for students taught by ICT method, BAT test was administered to both boys and girls taught using ICT method and the scores obtained were scored out of 100%. The test was administered both before and after the treatment. The findings are presented in the table below.

Table 4.21: Gender difference in pre-test performance of boys and girls taught by ICT methods (Descriptive)

Group	N	Mean	Std. Deviation
Female	120	49.7667	9.79945
Male	120	45.7000	9.51831
Total	240	47.7333	9.85267

The table 4.21 reveals that the average mean mark for girls is higher than that for the boys before the treatment. Table 4.22 shows that the difference in performance is actually significant because the P-value is less than the level of significance

Table 4.22: Gender difference in pre-test performance of boys and girls taught by ICT methods (ANOVA)

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	992.267	1	992.267	10.634	.001
Within Groups	22208.667	238	93.314		
Total	23200.933	239			

Table 4.23: Gender difference in post test performance of students taught by ICT methods (Descriptive)

	N	Mean	Std. Deviation	Minimum	Maximum
Female	56	62.0714	12.88107	28.00	88.00
Male	64	56.4844	10.81151	30.00	86.00
Total	120	59.0917	12.09972	28.00	88.00

The table 4.23 shows that the girls' mean mark is higher than those of boys taught using the same ICT method. The data suggests that the use of ICT method may have helped the girls more than the boys. To find out whether the findings were significant or due to chance, the data were tested using ANOVA. The hypothesis tested, **H02,** was**:** There is no significant difference in achievement scores among boys and girls who are taught biology through ICT instruction. Details of the findings are in the table 4.12B below.

Table 4.24: Gender difference in post test performance of students taught by ICT methods (ANOVA)

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	932.293	1	932.293	6.671	.011
Within Groups	16489.699	118	139.743		
Total	17421.992	119			

Since the p-value (sig.) is less than the level of significance (0.05) then there is a significant difference in performance of the two groups. Hence the H02 is rejected. The female students taught using ICT performed better than the boys.

This difference in performance was explained by Volman and van Eck (2001) who reported that females favored the social-problems approach to teaching science more than did males. The authors observed that females might learn science more effectively if scientific, societal and technological concepts were integrated into the curriculum and finally, instruction that places emphasis and lowers anxiety of science for females. It can also be supported by Whyte *et al.* (1990) who established that certain teaching styles and methods tend to favor boys. In his study, he indicated that most teachers of biology still use the traditional lecture method. The author asserted that boys show greater adaptability to traditional approaches of teaching which require memorizing abstract and unambiguous facts which have to be acquired quickly. The use of ICT therefore may not have favored boys as compared to girls.

In contrary, some past studies revealed that male students perform better than the females

in physics, chemistry, and biology (Danmole, 1998) while others revealed that female students are better off than males (Volmanand van Eck, 2001). However, some studies such as those of Bello (1990) did not find any form of influence being exerted by gender on students' academic performance in the sciences. In a review of studies on access, use, attitude, and achievement with computer, Yildirim (2000) concluded that when female and male students at all levels of education had the same amount and types of experiences on computers, female achievement scores and attitudes are similar in computer classes and classes using computer. Bratti*et al.* (2002) show that the differences in students' performance can be explained by the differences between the areas in economic terms of structures, of devices of regional leisure, type of the institutions and the individual characteristics of the students (family and social characteristic). However, such differences did not exist since students who participated were generally of equal economical, institutional and individual characteristics. The findings in this study do not also agree with those of Lazarowitz and Huppert (1993) who investigated the impact of a biology simulation 'The Growth Curve of Microorganisms' on high school students' academic achievement and their science process skills. The findings indicated that the achievement of students using the simulation was higher than those not using the simulation, with girls achieving equally with boys. It did not also agree with the findings of Huppert *et al.* (2002) who found that there was no significant difference in the achievement of male and female students when computer assisted instruction was used.

Papastergiou (2009) examined the determinants of student performance in an introductory finance course. They found that age, as a measure of maturity, had a

significant influence on performance. However, in this study, students who participated were generally of the same age and could not have influenced differences in gender performance.

CHAPTER FIVE

SUMMARY OF THE FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of the findings, conclusions and recommendations. The summary of the findings will be given, the conclusions from the findings will be made and the appropriate recommendations from the study are given in this chapter.

The following were the objectives of this study:

1. To investigate the effect of ICT use on students achievement scores in biology in secondary schools.

2. To establish whether there is any gender difference in achievement scores among boys and girls taught with the use ICT.

The following research hypotheses were tested in the study.

H_{01}ICT use in teaching will not have any significant impact on the achievement scores of students in biology.

H_{02}There is no significant difference in achievement scores among boys and girls who are taught biology through ICT instruction.

5.2 Summary of the Findings

The findings of this study were that student taught using ICT performed much better than those taught using traditional method, the average mean mark for the ICT taught students

was higher.

The results also showed that the girls' mean achievement scores were higher than those of boys taught using the same ICT method. The data thus suggests that the use of ICT method had greater impact in performance of girls than in boys.

5.3 Conclusion

The study set to examine the effect of ICT use on performance of students in biology in secondary schools. The findings of this study were that student taught using ICT performed much better than those taught using traditional method, the average mean mark for the ICT taught students was higher. The conclusion is ICT use in teaching is effective and helps to improve performance in biology. Evidence available indicates that boys' performance in science subjects is better than that of girls (KNEC 2014, 2013; 2012; 2011; 2010).The study sought to determine whether there was any gender difference in performance of students taught by ICT method. The results showed that the girls' mean achievement scores were higher than those of boys taught using the same ICT method. The conclusion is the girls had higher achievement scores than boys when ICT method is used in teaching. The ICT teaching strategy therefore appears to help overcome the gender disparity in achievement.

It is necessary to be proactive and to develop a stronger understanding of future learning needs and future learning environments. Prospective work on ICT-enabled learning would help to grasp the opportunities offered by ICT to prepare for learning in the 21st Century that embraces digital technologies for better learning, for better assessment of

learning outcomes and achievements, for better teaching and for better social inclusion.

Realizing the potential of ICT needs to be accompanied by the necessary resources and human support, and by a social and institutional environment that is open to innovation and change. Moreover, progress is still needed in providing attractive learning content and learning technologies. However, to disregard the needs of the new digital generation of learners as they enter education and training, and the new requirements of the networked, digital society is not an option either.

The use of ICT in teaching and learning helps students to expand knowledge, experience and increase understanding, especially in the Science subjects that require visual, audio, flow chart, video presentation and so on. The findings concluded that using ICT in Biology lesson has positive impact on students' achievements. Schools must strive to increase usage of ICT amongst teachers. On the other hand, teachers should put more effort to use ICT in their Biology lessons in order to increase students' achievements. Teachers who are weak in the use of ICT need to participate in ICT training courses. ICT facilities provided by the government in schools must be fully utilized by the teachers.

Using ICT in Biology lesson can also help students to understand biological concepts through a relationship with a real life situation. The use of ICT in Biology lessons can improve students' achievements compared to using traditional approaches. Moreover, it can make teaching and learning process become more interesting, encouraging and effective. Using ICT in study encourages students to process information better and thus enhances the understanding and improves students' memory (Kinuthia, 2009).

Both gender showed improvement in Biology subject. However, female students had greater achievement than male students. Differences in cognitive style, interest and motivation between boys and girls might be the causes of the difference in their achievements. Following Barak (2007), boys were more cognitive than girls. Hence, when ICT was used in the Biology lesson, we can see the differences in both genders' achievements. It is concluded that ICT promotes better learning outcomes on female students' achievement in Biology. The overall conclusion from this study reveals that ICT has a significant and positive impact on teaching and learning specifically for Animal reproduction. ICT contributes greater performance or achievement of students. Teachers should replace traditional teaching approach with attractive learning style by involving ICT in their lesson. Science field needs investigation and practical works needs ICT to assist in teaching.

5.4 Recommendations

The study set to examine the effect of ICT use on performance of students in biology in secondary schools. The findings of this study were that student taught using ICT performed much better than those taught using traditional method, the average mean mark for the ICT taught students was higher. The conclusion is ICT use in teaching is effective and helps to improve performance in biology. The recommendation is teachers should integrate traditional teaching approach with attractive learning style by involving ICT in their lessons. Science field that needs investigation and practical works needs ICT to assist in teaching.

The study also sought to determine whether there was any gender difference in

performance of students taught by ICT method. The results showed that the girls' mean mark was higher than those of boys taught using the same ICT method. The conclusion is the girls had higher achievement scores than boys when ICT method is used in teaching and can therefore be used to improve performance in biology by girls.

5.5 Summary of the study

The overall conclusion from this study reveals that ICT has a significant and positive impact on teaching and learning specifically for biology subject. ICT contributes greater performance or achievement of students especially girls.

The ICT teaching strategy results in higher students' achievement and overcomes the gender disparity. The strategy should therefore be used in Biology teaching at secondary school level. ICT should also be integrated in the teaching of biology because it enhances students' achievement and creates interest in learning. Evidence available has indicated that there is a gender disparity in achievement in science subjects in national examinations. The findings in this study have indicated that ICT has the capacity to bridge this gender disparity. Teachers should, therefore, integrate ICT in their teaching. Teacher education also needs to incorporate ICT concepts in the teacher education curriculum to empower teachers to use this strategy. Educational administrators and curriculum developers should emphasize the use of ICT in biology lessons and, indeed, other science subjects.

The school BOGs, with assistance from the government, should look for private sector partners who would be able to install Internet facilities and e-libraries for the public

schools having ICT facilities to enhance and improve learners' personal information base. This would assist the government in achieving their objective of making "education the natural platform for equipping the nation with ICT skills" (Government of Kenya, 2007). Local software companies could liaise with the education sector policy makers to provide country and curriculum specific software relevant to the needs of the nation. These companies could offer, for instance, to forward personnel to the KIE to fast track their change of curriculum content to e-content. Further empirical studies should be carried out on the use of computer for instructional purposes, on different subjects and at different levels to provide sound basis for the integration of computer in Kenyan schools.

The government, with the help of county governments, should set up ICT laboratories in each county in the country to serve as a learning resource center to all learning institutions and the community in that division. Finally, future research should identify sensitivities among learner characteristics, subject matter areas, and interactive learning technologies with regard to their compatibilities for best practices.

REFERENCES

Adeyemi, B. A. (2008). Effects of cooperative learning and problem-solving strategies on junior secondary school students' achievement in social studies. *Electronic Journal of Research in Educational Psychology*, *6*(3), 691-708.

Aker, J. C., &Mbiti, I. M. (2010).Mobile phones and economic development in Africa.*The Journal of Economic Perspectives*, 207-232.

Akwee, P. E., Toili, W. W.&Palapala, V. A. (2012). Effectiveness Of Computer Based Technology Integration In Teaching And Learning Of Gene Concept Among High School Students, Kenya. *European journal of health and biology education*, *1*, 31- 52.

Ally, M. (Ed.). (2009). *Mobile learning: Transforming the delivery of education and training*. Athabasca University Press.

Amunga, J. K., Amadalo, M. M. &Musera, G. (2013). *Disparities in Chemistry and Biology achievement in secondary schools*: Implications for Vision 2030.

Anastasi, M. C., Sawyer, R. G.&Pinciaro, P. J. (1999).A descriptive analysis of students seeking HIV antibody testing at a university health service. *Journal of American College Health*, *48*(1), 13-19.

Anderson, R. D. (2002). Reforming science teaching: What research says about inquiry? *Journal of Science Teacher Education*, *13*(1), 1-12.

Arends, D.&Kilcher, A. (2010). *Teaching for student learning: Becoming an accomplished teacher*. Routledge.

Arends, R. I. (2004). Learning to teaching. *Mcgraw-Hill Companies, New York*.

Aristovnik, A. (2012). *The impact of ICT on educational performance and its efficiency in selected EU and OECD countries*: a non-parametric analysis. *Available at SSRN 2187482*.

Bahar, M., Johnstone, A. H.&Hansell, M. H. (1999).Revisiting learning difficulties in biology. *Journal of Biological Education*, *33*(2), 84-86.

Baker, E. L., Barton, P. E., Darling-Hammond, L., Haertel, E., Ladd, H. F., Linn, R. L. & Shepard, L. A. (2010). *Problems with the Use of Student Test Scores to Evaluate Teachers.EPI Briefing Paper# 278*. *Economic Policy Institute*.

Balanskat, A., Blamire, R.&Kefala, S. (2006*). The ICT Impact Report–A review of ICT impact on schools in Europe.Retrieved Nov 11th 2014*.

Barak, M. (2007).*Transition from traditional to ICT-enhanced learning environments in undergraduate chemistry courses*. *Computers& Education*, *48*(1), 30-43.

Bashir, M., Afzal, M. T.&Azeem, M. (2008).Reliability and validity of qualitative and operational research paradigm. *Pakistan Journal of Statistics and Operation Research*, *4*(1), 35-45.

Bayraktar, S. (2001).A meta-analysis of the effectiveness of computer-assisted instruction in science education.*Journal of research on technology in education*, *34*(2), 173-188.

Becker, J., Knackstedt, R.&Pöppelbuß, D. W. I. J. (2009).*Developing maturity models for IT management.Business& Information Systems Engineering*, *1*(3), 213-222.

Best, J. W., & Kahn, J. V. (2003).*Research in education (9th ed.).* Boston: Allyn and Bacon.

Bingimlas, K. A. (2009). Barriers to the successful integration of ICT in teaching and learning environments: A review of the literature. *Eurasia Journal of Mathematics, Science & Technology Education*, *5*(3), 235-245.

Biodun, A. (2002). *Methodology in formal and non-formal education technical/vocation education.*Nsukka: University of Nigeria press.

Bishop, A. P., Bruce, B. C.& Jones, M. C. (2009). *Community inquiry and informatics: Collaborative learning through ICT*. In *Learning in communities* (pp. 3-5).Springer London.

Bitok, B.E. (2014) *Availability of Information and Communication Technology Resources in Teaching and Learning of Biology by Secondary Schools in Uasin Gishu County,* Kenya

Bloom, B. S.& Krathwohl, D. R. (1956). *Taxonomy of educational objectives: The classification of educational goals*. Handbook I: Cognitive domain.

Bogdan, R. C.&Biklen, S. K. (2007). *Research for education: An introduction to theories and methods*. New York: Pearson.

Borlaug, N. E. (2000). The green revolution revisited and the road ahead. *Special 30th Anniversary Lecture, Norwegian Nobel Institute, Oslo*.

Bowling, N. A.& Hammond, G. D. (2008).A meta-analytic examination of the construct validity of the Michigan Organizational Assessment Questionnaire Job Satisfaction Subscale. *Journal of Vocational Behavior*, *73*(1), 63-77.

Bratti, M. (2002). Does the choice of university matter?: a study of the differences across UK universities in life sciences students' degree performance. *Economics of Education Review*, *21*(5), 431-443.

Changeiywo, J. M., Wambugu, P. W.&Wachanga, S. W. (2011).Investigations of Students' motivation towards Learning Secondary School Physics through Mastery Learning Approach. *International Journal of Science and Mathematics Education*,*9*(6), 1333-1350.

Chiappetta, E. L. &Fillman, D. A. (2007).Analysis of five high school biology textbooks used in the United States for inclusion of the nature of science. *International Journal of Science Education*, *29*(15), 1847-1868.

Çimer, A. (2012). What makes biology learning difficult and effective: Students' views. *Educational Research and Reviews*, *7*(3), 61-71.

Cohen, L. and Manon, M.K. (2007). *Research Methods in Education* (6th ed.).

London: Routledge Flamer.

Collis, B., &Moonen, J. (2001). *Flexible learning in a digital world: Experiences and expectations*. Psychology Press.

Condie, R., & Munro, B. (2007). *The impact of ICT in schools*: Landscape review.

Cook, D. A., & Beckman, T. J. (2006). Current concepts in validity and reliability for psychometric instruments: theory and application. *The American journal of medicine*, *119*(2), 166-e7.

Cotton, K. (1991). Computer-assisted instruction.*School improvement research series*.

Cox, B. E., & Hopkins, C. J. (2006). Building on theoretical principles gleaned from Reading Recovery to inform classroom practice. *Reading Research Quarterly*, *41*(2), 254-267.

Cox, M., Webb, M., Abbott, C., Blakeley, B., Beauchamp, T., & Rhodes, V. (2004*). An I investigation of the research evidence relating to ICT pedagogy.*

Cuban, L., Kirkpatrick, H., & Peck, C. (2001). High access and low use of technologies in high school classrooms: Explaining an apparent paradox.*American educational research journal*, *38*(4), 813-834.

Danmole, B. T. (1998). The influence of teacher preparation and use of instructional materials on primary school pupils' performance in integrated science.*Ilorin Journal of Education, 12, 56*, *64*.

Darling-Hammond,L.,(2006). *Constructing 21st century Teacher education: Journal of teacher education*,57:300. Retrieval from http://,re.sagepub.com on May 10th 2014.

Darling-Hammond, L. (2008). Teacher learning that supports student learning.*Teaching for intelligence*, *2*, 91-100.

Dawes, L. (2001). 5 What stops teachers using new technology?. *Issues in teaching using ICT*, *61*.

DeVries, R., Zan, B., Hildebrandt, C., Edmiaston, R., & Sales, C. (2002).*Developing constructivist early childhood curriculum: Practical principles and activities*.New York: Teachers College Press.

Didia, D., &Hasnat, B. (1998). *The determinants of performance in the university introductory finance course*. Financial Practice and Education, 8(1), 102–107.

Driscoll,M P. , Spector,J. M., Merrill,M.D., (2007)*Handbook of Research on Educational Communications and Technology*: Routledge

Entwistle, N. J. (1998). Improving teaching through research on student learning. *University teaching: International perspectives*, 73-112.

Fawe, A., Abou-Zaid, M., Menzies, J. G., &Bélanger, R. R. (1998).*Silicon-mediated accumulation of flavonoid phytoalexins in cucumber. Phytopathology*, *88*(5), 396-401.

Forrester, D., &Jantzie, N. (1998).Learning theories and the brain. *Retrieved April*, *10*, 2002.

Fosnot, C. T. (1996). *Constructivism: Theory, perspectives, and practice* (pp. 8-33). New York: Teachers College Press

Glewwe, P., & Kremer, M. (2006).Schools, teachers, and education outcomes in developing countries. *Handbook of the Economics of Education*, *2*, 945-1017.

Government of Kenya (2007).*Kenya Vision 2030*.Government Printers. Nairobi.

Graham, R. D., Welch, R. M., &Bouis, H. E. (2001).*Addressing micronutrient malnutrition through enhancing the nutritional quality of staple foods: principles, perspectives and knowledge gaps.* Advances in Agronomy, 70, 77-142.

Gülbahar, Y. &Güven, I. (2008).*A Survey on ICT Usage and the Perceptions of Social Studies Teachers in Turkey. Educational Technology & Society*, *11*(3), 37-51.

Hammerness, K., Darling-Hammond, L., Bransford, J., Berliner, D., Cochran-Smith, M., McDonald, M., &Zeichner, K. (2005). *How teachers learn and develop*. *Preparing teachers for a changing world: What teachers should learn and be able to do*, *1*.

Heinrich, C. (2001). *ICT Infrastructure and Externalities Affecting Spatial Structures*.Working Paper of the Globalization and World Cities Study Group and Network, November, http://www.lboro.ac.uk/gawc/rb/rb67. html (4.10. 2003).

Hennessy, S., Ruthven, K., &Deaney, R. (2003).*Pedagogic strategies for using ICT to support subject teaching and learning: An analysis across 15 case*

studies.University of Cambridge, Faculty of Education.

Hennessy, S., Wishart, J., Whitelock, D., Deaney, R., Brawn, R., Velle, L. L. &Winterbottom, M. (2007). *Pedagogical approaches for technology-integrated science teaching. Computers & Education*, *48*(1), 137-152.

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn?. *Educational Psychology Review*, *16*(3), 235-266.

Huang, J., Pray, C., &Rozelle, S. (2002). *Enhancing the crops to feed the poor*. *Nature*, *418*(6898), 678-684.

Huppert, J., Lomask, S. M., &Lazarowitz, R. (2002). Computer simulations in the high school: Students' cognitive stages, science process skills and academic achievement in microbiology. *International Journal of Science Education*, *24*(8), 803-821.

Illeris, Knud (2004). *The three dimensions of learning*. Malabar, Fla: Krieger Pub. Co. ISBN 9781575242583.

Iqbal, M. J., & Ahmed, M. (2010).Enhancing quality of education through e-learning: the case study of AllamaIqbal Open University.*The Turkish Online Journal of Distance Education*, *11*(1), 84-97.

Jonassen, D. H., Carr, C., &Yueh, H. P. (1998). Computers as mind tools for engaging learners in critical thinking.*TechTrends*, *43*(2), 24-32.

Jones, M. G., Howe, A., &Rua, M. J. (2000).*Gender differences in students' experiences,*

interests, and attitudes toward science and scientists. Science Education, 84(2), 180-192.

Juma, C., & Yee-Cheong, L. (Eds.). (2005). *Innovation: applying knowledge in development*. Earthscan.

Kang, S. H., Gratch, J., Wang, N., & Watt, J. H. (2008, May). Does the contingency of agents' nonverbal feedback affect users' social anxiety?.In *Proceedings of the 7th international joint conference on Autonomous agents and multiagent systems-Volume 1* (pp. 120-127).International Foundation for Autonomous Agents and Multiagent Systems.

Kavulya, J. M. (2007). Training of library and information science (LIS) professionals in Kenya: a needs assessment. *Library Review*, *56*(3), 208-223.

Kenya Institute of Education, KIE (2002).*Secondary Education Syllabus Volume Two*. Kenya Institute of Education, Nairobi.

Kenya Institute of Education, KIE (2005).*Secondary Education Syllabus Volume Two*. Kenya Institute of Education, Nairobi.

Kenya National Examinations Council, KNEC (2006).*The Year 2005 KCSE Examination Report. Nairobi:* Kenya National Examinations Council.

Kenya National Examinations Council, KNEC (2008).*Year 2007 KCSE candidates' performance report*, Nairobi.

Kenya National Examinations Council, KNEC (2009) Kenya Certificate examination

report. Nairobi: *Kenya National Examinations Council*

Kenya National Examinations Council, KNEC (2010) Kenya Certificate examination report. Nairobi: *Kenya National Examinations Council*

Kenya National Examinations Council, KNEC (2011) Kenya Certificate examination report. Nairobi: *Kenya National Examinations Council*

Kenya National Examinations Council, KNEC (2012) Kenya Certificate examination report. Nairobi: *Kenya National Examinations Council*

Kenya National Examinations Council, KNEC (2013).Release of 2012 KCSE Results on 28th March 2012 by Hon. M.Kilonzo; Education Minster, Kenya.

Kenya National Examinations Council, KNEC, (2014).*Kenya Certificate examination report.* Nairobi: Kenya National Examinations Council.

Kenya National Examinations Council, KNEC, (2015).*Kenya Certificate examination report.* Nairobi: Kenya National Examinations Council.

Kesidou, S.&Roseman, J. E. (2002). How well do middle school science programs measure up? Findings from Project 2061's curriculum review. *Journal of Research in Science Teaching*, *39*(6), 522-549.

Khan, A. M., & Shah, Q. A. (2004).*Study on Impact of Information and Communication Technology on Decent Work in Pakistan*. Islamabad: Pakistan Manpower Institute, Ministry of Labour Manpower & Overseas Pakistanis, Government of Pakistan.

Khan, S., &Saleh, A. M. E. (2001). On the comparison of the pre-test and shrinkage estimators for the univariate normal mean. *Statistical Papers*, *42*(4), 451-473.

Kiboss, J.K. (1997). *Relative effects of a computer based instruction on students' attitudes, motivation and understanding about measurement and perceptions of classroom e environment*. Unpublished PhD Thesis, University of Western Cape, Bellville.

Kinuthia, W. (2009).Educational development in Kenya and the role of information and communication technology.*International Journal of Education and Development using ICT*, *5*(2).

Kiptalam, G. K., & Rodrigues, A. J. (2010). Internet utilization: A case of connected rural and urban secondary schools in Kenya. *International journal of computing and ICT research*, *4*(1), 49-63.

Klein, J. T. (2000). A conceptual vocabulary of interdisciplinary science. *Practicing interdisciplinary*, 3-24.

Kolawole, E. B. (2008). *Effects of competitive and cooperative learning strategies on academic performance of Nigerian students in mathematics*. *Educational Research and Reviews*, *3*(1), 033-037.

Korte, W. B.&Hüsing, T. (2006).*Benchmarking access and use of ICT in European schools 2006*.Empirica, Ges.für Kommunikations-und Technologieforschung.

Kozma, R. B. (2008). Comparative analysis of policies for ICT in education. In

International handbook of information technology in primary and secondary education (pp. 1083-1096).Springer US.

Kozma, R. B., & Anderson, R. E. (2002).Qualitative case studies of innovative pedagogical practices using ICT. *Journal of computer assisted learning*, *18*(4), 387-394.

Langlois, J. A., Rutland-Brown, W., & Wald, M. M. (2006). The epidemiology and impact of traumatic brain injury: a brief overview. *The Journal of head trauma rehabilitation*, *21*(5), 375-378.

Lazarowitz, R., & Huppert, J. (1993).Science process skills of 10th-grade biology students in a computer-assisted learning setting.*Journal of Research on Computing in Education*, *25*(3), 366-382.

Lynch, J., Sheard, J., Carbone, A., & Collins, F. (2005). Individual and organizational factors influencing academics' decisions to pursue the scholarship of teaching ICT. *Journal of Information Technology Education: Research*, *4*(1), 219-236.

Machin, S., McNally, S., & Silva, O. (2007). New Technology in Schools: Is There a Payoff?*. *The Economic Journal*, *117*(522), 1145-1167.

Martin, L. M., &Matlay, H. (2001). "*Blanket" approaches to promoting ICT in small firms: some lessons from the DTI ladder adoption model in the UK*. *Internet research*, *11*(5), 399-410.

Matiangi, F 2015.*Press statement on digital Literacy programme in kenya*

http://www.icta.go.ke/downloads/digital_literacy_program_launch.pdf

McBurney, D., & White, T. (2009).*Research methods*. Engage Learning.

McDowell, G. R. (2001). A student-centered learning approach to teaching soil mechanics. *International Journal of Engineering Education*, *17*(3), 255-260.

McFarlane, A., &Sakellariou, S. (2002). The role of ICT in science education. *Cambridge Journal of Education*, *32*(2), 219-232.

Ministry of Education (2005).*National Report on the Development of Education in Kenya presented at the International Conference on Education 46th session*, Geneva, 5-7thseptember. http://www.ibe.unesco.org/International/ICE/natrap/Kenya.pdf

Minner, D. D., Levy, A. J., & Century, J. (2010). Inquiry-based science instruction—what is it and does it matter? Results from a research synthesis years 1984 to 2002. *Journal of Research in Science Teaching*, *47*(4), 474-496.

Mooij, T., &Smeets, E. (2001).*Modeling and supporting ICT implementation in secondary schools. Computers & Education*, *36*(3), 265-281.

Mumtaz, S. (2000). Factors affecting teachers' use of information and communications technology: a review of the literature. *Journal of information technology for teacher education*, *9*(3), 319-342.

Muraya, D. N., &Kimamo, G. (2011). *Effects of cooperative learning approach on biology mean achievement scores of secondary school students in Machakos District, Kenya.* Educational Research and Reviews, 6(12), 726-745.

Musasia, A. M., Nakhanu, S. B., &Wekesa, W. D. (2012).Investigation of factors that influencesyllabus coverage in secondary school mathematics in Kenya. *International Journal of Humanities and Social Science*, *2*(15), 51-59.

Newton, L., & Rogers, L. (2001).*Teaching science with ICT* (Vol. 1).Bloomsbury Publishing.

Njeru, E. H. N., &Orodho, J. A. (2003). *Education financing in Kenya: Secondary school bursary scheme implementation and challenges*. Institute of Policy Analysis & Research.

No, H., & Colony, K. (2014). *ICT in Schools*. Darpan International Research Analysis, 1(8), 33.

Norzita, M. D. (2004). *Review of the implementation of the willingness of teachers in teaching of Science and Mathematics in English*. Master's project paper of education, University Kebangsaan Malaysia.

Nwagbo, C., &Chukelu, U. C. (2011).Effects of Biology Practical Activities on Students' Process Skill Acquisition. *Journal of Science Teachers' Association of Nigeria*, *46*(1), 58-70.

Odera, F. Y. (2011). Integrating Computer Science Education in Kenyan Secondary Schools. *International Journal of Information*, *1*(5).

Oludipe, D. I. (2012). Gender difference in Nigerian junior secondary students' academic achievement in Basic Science. *Journal of Educational and Social Research*, *2*(1),

93-99.

Ong'amo, B.,Ondigi, S.,Maundu, J.(2014). *Integration of ICT in the teaching of Biology*.A case of selected secondary schools in Mumias sub county,Kenya.

Ormorod, J.(2012). *Human learning* (6th ed.). Boston: Pearson. ISBN 9780132595186.

Orokpo, A. (2006) *Attitude of secondary school students towards practical work and their performance in science examinations in Makurdi Metropolis*. Unpublished M.Ed. Dissertation, Benue state University, Makurdi

Osborne, J., & Dillon, J. (2010).*Good Practice In Science Teaching: What Research Has To Say: What research has to say*. McGraw-Hill International.

Palak, D., Walls, R. T., & Wells, J. G. (2006). Integration of Instructional Technology: A Device to Deliver Instruction or a Tool to Foster Learning. *International Journal of Instructional Media*, *33*(4), 355-365.

Papastergiou, M. (2009). *Digital game-based learning in high school computer science education: Impact on educational effectiveness and student motivation. Computers & Education*, *52*(1), 1-12.

Papert, S. (2002). The turtle's long slow trip: macro-educological perspectives on microworlds. *Journal of Educational Computing Research*, *27*(1), 7-27.

Pittard, V., Bannister, P., & Dunn, J. (2003).*The big pICTure: The impact of ICT on attainment, motivation and learning*. DfES.

Putnam, R. T., &Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning?. *Educational researcher*, 4-15.

Republic of Kenya (1999).*Report of the Public Accounts Committee on the Government of Kenya Accounts for the Year 1995/96.Vol 1.* Nairobi: Government Printer.

Republic of Kenya (2002).*National Development Plan 2002–2008*. Nairobi Government Printer

Robson, C. (2011). *Real world research: a resource for users of social research methods in applied settings*. Chichester: Wiley.

Roschelle, J. M., Pea, R. D., Hoadley, C. M., Gordin, D. N., & Means, B. M. (2000). *Changing how and what children learn in school with computer-based technologies. The future of children,* 76-101.

Rutherford, D., & Lloyd, W. J. (2001).Assessing a computer-aided instructional strategy in a world geography course. *Journal of Geography in Higher Education*, *25*(3), 341-355.

Rutledge, M. L., & Mitchell, M. A. (2002).High school biology teachers' knowledge structure, acceptance & teaching of evolution. *The American Biology Teacher*, *64*(1), 21-28.

Salta, K., &Tzougraki, C. (2004). *Attitudes toward chemistry among 11th grade students in high schools in Greece. Science Education,* 88(4), 535-547.

Salvatori, P. (2001). *Reliability and validity of admissions tools used to select students for*

the health professions. Advances in Health Sciences Education,*6*(2), 159-175.

Sansanwal, D. N. (2009).*Use of ICT in Teaching-learning and evaluation.* Educational Technology-Lecture Series.

Schoepp, K. (2005). *Barriers to technology integration in a technology-rich environment*. Learning and teaching in higher education: Gulf perspectives,2(1), 1- 24.

Schunk, D. H. (2000). "*Motivation for achievement: Past, present, and future*". Issues in Education: Contributions from Educational Psychology, 6, 161-165

Segers, E., &Verhoeven, L. (2009). *Learning in a sheltered Internet environment*: The use of WebQuests. Learning and Instruction, 19(5), 423-432.

Serin, O. (2011).The Effects of the Computer-Based Instruction on the Achievement and Problem Solving Skills of the Science and Technology Students. *Turkish Online Journal of Educational Technology-TOJET*, *10*(1), 183-201.

Silverman, D., (2000). *Doing Qualitative Research*: A Practical Handbook. London: Sage.

Shaheeda, J. D., N., & Laura, C.(2007). The role of ICTs in higher education in South Africa: One strategy for addressing teaching and learning challenges. *International Journal of Education and Development using Information and Communication Technology*, *3*(4), 131-142.

Shaikh, I. R. (2009).*Introduction to Educational Technology &ICT*.Tata McGraw-Hill Education.

Shiholo, B. M., &Ocholla, D. N. (2003). *Changing trends in training needs for information professionals in Kenya*. Library and Information Science Research,13(1).

Shihusa, H., &Keraro, F. N. (2009).Using advance organizers to enhance students' motivation in learning biology. *Eurasia Journal of Mathematics, Science & Technology Education*, *5*(4), 413-420.

Sinatra, G. M., Southerland, S. A., McConaughy, F., &Demastes, J. W. (2003).Intentions and beliefs in students' understanding and acceptance of biological evolution. *Journal of Research in Science Teaching*, *40*(5), 510-528.

Sinatra, G. M., Southerland, S. A., McConaughy, F., &Demastes, J. W. (2003*). Intentions and beliefs in students' understanding and acceptance of biological evolution*

SMASSE Project (2000). *Project paper presented on Baseline studies at 3rd cycle of District Inset,* Uasin- Gishu District.Eldoret, August 2008. Unpublished.

Smeets, E. (2005). *Does ICT contribute to powerful learning environments in primary education?.* Computers& Education, 44(3), 343-355.

Ssempala, F. (2005).*Gender differences in the performance of Chemistry practical skills among senior six students in Kampala*. Boston: Bola Baton.

Steinmetz, J. (2001). *Computers and squeak as environments for learning*. Squeak: Open Personal Computing and Multimedia, 453-482.

Stenbacka, C. (2001). *Qualitative research requires quality concepts of its own.* Management decision, 39(7), 551-556.

Stennes, K. (2011). *Service Learning: A Progressive Model for Teachers*(Doctoral dissertation, Hamline University).

Steyn, G. M. & Kamper, G.D. (2001).Towards Distance Learning for Successful Practice: The Role of Reflective Self-Assessment in Educational Management Training. *South African Journal of Education*. 21(1): 36-41

Tekbiyik, A., &Akdeniz, A. R. (2010). *A meta-analytical investigation of the influence of computer assisted instruction on achievement in science.* In *Asia-Pacific Forum on Science Learning and Teaching* (Vol. 11, No. 2, p. n2).Hong Kong Institute of Education. 10 Lo Ping Road, Tai Po, New Territories, Hong Kong.

Tekkaya, C., Özkan, Ö.,&Sungur, S. (2001). *Biology concepts perceived as difficult by Turkish high school students*. HacettepeÜniversitesiEğitimFakültesiDergisi, 21, 145-150.

Tondeur, J., Van Keer, H., van Braak, J., &Valcke, M. (2008*). ICT integration in the classroom: Challenging the potential of a school policy.* Computers & Education, 51(1), 212-223.

Trucano, M. (2005).*Knowledge Maps: ICT in Education*. Washington, DC: Infodev/World Bank.

Udovic, D., Morris, D., Dickman, A., Postlethwait, J., &Wetherwax, P. (2002). *Workshop biology: demonstrating the effectiveness of active learning in an introductory biology course*. Bioscience, 52(3), 272-281.

United Nations Education, Scientific, and Cultural Organization [UNESCO]. (2004). *The 2005 Report: Education for all, the quality imperative.* Paris: UNESCO

United Nations Educational, Scientific and Cultural Organization, UNESCO (2004). *Report on Development of Education Kenya. Ministry of Education*, Science and Technology; UNESCO-Nairobi Office.

United Nations Educational, Scientific and Cultural Organization, UNESCO (1996). *Report on Development of Education Kenya. Ministry of Education*, Science and Technology; UNESCO-Nairobi Office.

United Nations Educational, Scientific and Cultural Organization, UNESCO (2000). *Report on Development of Education Kenya. Ministry of Education*, Science and Technology; UNESCO-Nairobi Office.

Volman, M., & van Eck, E. (2001). *Gender equity and information technology in education: The second decade*. Review of Educational Research, 71(4), 613-634.

Voogt, J. (2003). *Consequences of ICT for aims, contents, processes, and environments of learning.* In Curriculum landscapes and trends (pp. 217-236). Springer Netherlands.

Wachanga, S. W. (2002). *Effects of cooperative class experiment teaching method on secondary school student's motivation and achievement in chemistry*. Unpublished PhD Thesis.Egerton University.

Wachanga, S. W., &Mwangi, J. G. (2004). Effects of the Cooperative Class Experiment

Teaching Method on Secondary School Students' Chemistry Achievement in Kenya's Nakuru District. *International Education Journal*, *5*(1), 26-36.

Wallace, R. M. (2003). *Online learning in higher education: A review of research on interactions among teachers and students*. Education, Communication & Information, 3(2), 241-280.

Wambugu, P. W., &Changeiywo, J. M. (2008). Effects of mastery learning approach on secondary school students' physics achievement. *Eurasia Journal of mathematics, Science & technology education*, *4*(3), 293-302.

Wang, Q. (2008). *A generic model for guiding the integration of ICT into teaching and l learning*. Innovations in Education and Teaching International, 45(4), 411-419.

Wango, G. (2009). *School administration and management Quality assurance and standards in schools in Nairobi*: Jomo Kenyatta Foundation,pg223

Wanjala, A.S.(2013*) Communication technology in the administration of public secondary schools in kimilili district, bungoma county, kenya*

Weimer, M. (2013). *Learner-centered teaching: Five key changes to practice*. John Wiley & Sons.

Wenglinsky, H. (2002). *The Link between Teacher Classroom Practices and Student Academic Performance*. education policy analysis archives, 10(12), n12.

Whiston, S. C. (1996). Accountability through action research: Research methods for practitioners. *Journal of Counseling & Development*, *74*(6), 616-623.

Whyte, M. M., Knirk, F. G., Casey, R. J., & Willard, M. L. (1990). Individualistic versus paired/cooperative computer-assisted instruction: Matching instructional method with cognitive style. *Journal of educational technology systems*, *19*(4), 299-312.

William, W. (2009).*Research methods in education*.Pearson Education India.

Wilson, E. J. (2004). *The information revolution and developing countries*.MIT Press.

Wilson, S. M., & Berne, J. (1999). *Teacher learning and the acquisition of professional knowledge: An examination of research on contemporary professional development*. Review of research in education, 173-209.

Wishart, J., &Blease, D. (1999). Theories underlying perceived changes in teaching and learning after installing a computer network in a secondary school. *British Journal of Educational Technology*, *30*(1), 25-41.

Wong, H. K., & Wong, R. T. (2001). *The effective teacher*. Harry K. Wong Publishing Company.

Woo, Y., & Reeves, T. C. (2007). *Meaningful interaction in web-based learning: A social constructivist interpretation*. The Internet and higher education, 10(1), 15-25.

Yara, P. O., & Catherine, W. W. (2011). *Performance Determinants of Kenya Certificate of Secondary Education (KCSE) in Mathematics of Secondary Schools in Nyamaiya Division, Kenya*. Asian Social Science, 7(2), p107.

Yildirim, S. (2000). Effects of an educational computing course on preservice and in-service teachers: A discussion and analysis of attitudes and use. *Journal of*

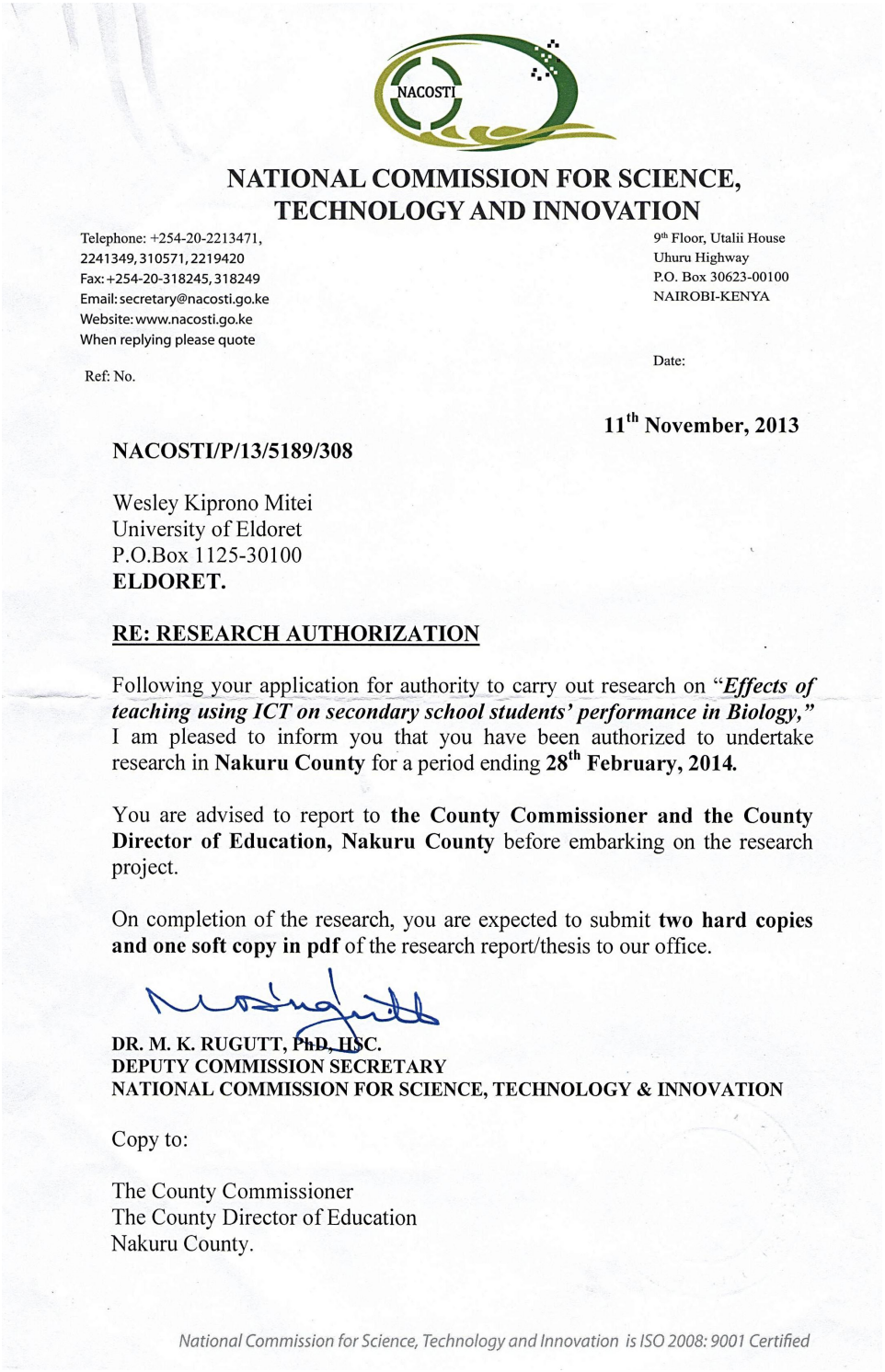
Research on computing in Education, *32*(4), 479-495.

Yilmaz-Tuzun, O. (2008). Preservice elementary teachers' beliefs about science teaching. *Journal of Science Teacher Education*, *19*(2), 183-204.

Yusuf, M. O., &Afolabi, A. O. (2010). Effects of Computer Assisted Instruction (CAI) on Secondary School Students' Performance in Biology. *Turkish Online Journal of Educational Technology-TOJET*, *9*(1), 62-69

APPENDICES

Appendix I: Research Permit from NACOSTI



NACOSTI

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471, 2241349, 310571, 2219420
Fax: +254-20-318245, 318249
Email: secretary@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.

Date:

11th November, 2013

NACOSTI/P/13/5189/308

Wesley Kiprono Mitei
University of Eldoret
P.O.Box 1125-30100
ELDORET.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on "***Effects of teaching using ICT on secondary school students' performance in Biology,***" I am pleased to inform you that you have been authorized to undertake research in **Nakuru County** for a period ending **28th February, 2014.**

You are advised to report to **the County Commissioner and the County Director of Education, Nakuru 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. M. K. RUGUTT, PhD, HSC.
DEPUTY COMMISSION SECRETARY
NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Copy to:

The County Commissioner
The County Director of Education
Nakuru County.

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

Appendix II: Letter of Seeking Authorization to Collect Data

Wesley Mitei

University of Eldoret

P. O. Box 1125 – 30100,

Eldoret - Kenya

Dear Sir/Madam

RE: RESEARCH DATA COLLECTION

I am Master of Philosophy student at University of Eldoret, school of Education and I am doing a research for my Master Degree.

This is an area of great concern to students, teachers, and Education stake holders in the county. I would like to visit your school between JUNE 2013 and JULY 2013 to collect data which will enable me complete the said research.

Kindly contribute towards the attainment of this goal by being honest and giving your answers.

Herein find a letter of introduction from the University.

Thank you in advance.

WESLEY MITEI.

Appendix III: Sample of a BAT test

Mary Mount Girls secondary

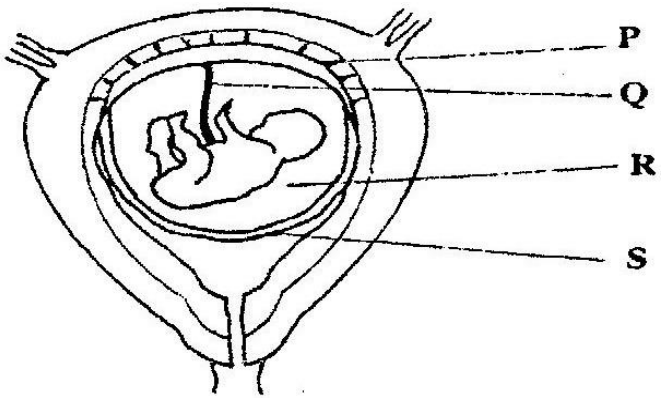
Time: 1Hr

Answer all the questions in the spaces provided.

Name …… class…….

1. Explain the meaning of the following terms as used in animal reproduction.(4mks)
   (i) Fertilization
   (ii) Implantation
   (iii) Caesarean delivery
   (iv) Ectopic pregnancy
2. Compare the structure of human sperm and egg cell. (4mks)
3. State the role of the following in reproduction. (2mks)
   (i) Sertoli cells
   (ii) epididymis
4. Account for the production of large number of sperms by males in human reproduction (2mks)
5. Give **two**adaptationsof the human egg cell (2mks)
6. Differentiate between the male and female secondary sexual characteristics (4mks)

7. Discuss the process of fertilization in humans leading to the production of a diploid zygote (8mks)
8. The diagram below represents human foetus in a uterus.



a) Name the part labeled S. (1mk)

b) i) Name the types of blood vessels found in the structure labeled Q.(2mks)

ii) State the differences in composition of blood found in the vessels named in (b)(i) above.
(2mks)

c) Name two features that enable the structure labeled P carry out its function (2mks)

d) State the role of the part labeled R (1mk)

9. Describe the process of delivery at the end of gestation period. (10mks)

10. Discuss the changes that occur upon the sperm coming into contact with the ovum leading to the formation of a diploid zygote. (6mks)

Appendix IV: Sample of experimental group lesson worksheet

LESSON WORKSHEET

CLASS: 2 SCIENCES **DATE: 26/6/13**

Topic: Reproduction in animals

Video 1: ovum

Objective;

-Draw and label the structure of the human egg cell.

Video 2: sperm cell

Objective;

-Draw and label the structure of the human spermatozoon ***(head, acrosome, tail)***

- Describe the structural adaptations of the sperm to its function. ***(Note: tail, mitochondria)***

Video 3: fertilization

Objective;

-Describe the process of fertilization i.e. the changes that take place upon the sperm fusing with the egg cell. ***(Note: observe the movement of sperm towards the mature egg cell, cilia movement to aid egg and zygote movement upon fertilization)***

-Explain the process of implantation.

Video 4: gestation period

Objective;

-Describe the changes that occur during the development of the foetus in the uterus for 9 months

(Note the trimesterial changes)

Video 5: Delivery/ birth

Objectives:

-Describe the changes on the woman's body during delivery (***note: the position of the foetus, uterine contractions, dilation of the cervix, rupture of the amnion and after birth).***

- State the role of hormones during delivery (oxytocin, progesterone).

Appendix V: Sample of control group lesson workshee

LESSON WORKSHEET

CLASS: 3 SCIENCES (CONTROL) **DATE: 26/6/13**

Topic: Reproduction in animals

Objective 1;

-Draw and label the structure of the human egg cell.

Objective 2;

-Draw and label the structure of the human spermatozoon ***(head, acrosome, tail)***

- Describe the structural adaptations of the sperm to its function.***(note: tail, mitochondria)***

Objective 3;

-Describe the process of fertilization i.e. the changes that take place upon the sperm fusing with the egg cell. ***(Note: The movement of sperm towards the mature egg cell)***

-Explain the process of implantation

Objective 4;

-Describe the changes that occur during the development of the foetus in the uterus for 9 months

(Note the trimesterial changes)

Objective 5:

-Describe the changes on the woman's body during delivery ***(note: the position of the foetus, uterine contractions, dilation of the cervix, rupture of the amnion and after birth).***

- State the role of hormones during delivery (oxytocin, progesterone).