USE OF ICT IN TEACHING PHYSICS: A CASE OF SECONDARY SCHOOLS IN KIMILILI DISTRICT, BUNGOMA COUNTY, KENYA

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DECLARATION

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

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DEDICATION

This work is dedicated to my wife Florence, my children Edwin, James and Victor for their support, patience and understanding during the entire period of this study.

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First and foremost, I'm grateful to God for granting me sufficient grace to go through this course successfully.

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ABBREVIATIONS AND ACRONYMS

CDF	Constituency Development Fund
ICT	Information and Communication Technology
INSET	In-service Education and Training
KICD	Kenya Institute of Curriculum Development
KESSP	Kenya Education Sector Support Programme
KCSE	Kenya Certificate of Secondary Education
KEMI	Kenya Education Management Institute
KNEC	Kenya National Examinations Council
LCD	Liquid Crystal Display
MoEST	Ministry of Education Science and Technology
MBL	Microcomputer Based Laboratory
MIS	Management Information Systems
MoE	Ministry of Education
NCSTI	National Council for Science Technology and Innovation
PTA	Parent's Teachers Associations
PIG	Principals Interview Guide
PSQ	Physics Students' Questionnaire
PTQ	Physics Teachers' Questionnaire
SMASSE	Strengthening of Mathematics and Science in Secondary Education
MIC	Ministry of Information and Communication
VVOB	Flemish Association for Development Cooperation and Technical Assistance

ABSTRACT

Information and Communication Technology (ICT) is beginning to be recognised as one of the major instructional components especially in science subjects. This study sought to investigate the status of ICT in the teaching and learning of physics in secondary schools. It investigated: perception of teachers and students towards the use of ICT; physics teachers' ICT competence; access to computers by both teachers and learners; teaching experience; and management's and technical support. This study was conducted in Kimilili District, Bungoma County, Kenya. A descriptive survey design was adopted. The target population comprised 23 secondary schools in the district out of which 11 schools that have had computers for at least three years were selected using a combination of stratified, purposive and random sampling procedures. This study involved 11 secondary school principals, 30 physics teachers and 250 Form Three students comprising 83 girls and 167 boys. It employed questionnaires, interview guide, lesson observation schedule and document analysis guide in data collection. Data collection was preceded by a pilot study mainly to determine the validity and reliability of the instruments. On analysis of data from the pilot study, the instruments were found to be reliable; the Cronbach's alpha coefficient was 0.85 and 0.78 for Physics Students' Questionnaire and Physics Teachers' Questionnaire respectively. The data collected during the study was analysed using Statistical Package for Social Sciences (SPSS) version 17.0. Descriptive statistics comprising frequency counts, percentages, means and correlations were utilised in the analysis of the data gathered. The main findings of the study indicated that ICT competence was fairly high among the physics teachers in the sample schools with most of them using word processing and Internet. This study established that most of the teachers accessed computers for less than one hour per day. A favorable attitude towards ICT use was also evident based on the kind of responses given on the importance of ICT use in instruction. Management and technical support was moderate; mainly in the provision of ICT facilities and employment of computer teachers respectively. It was found that use of ICT in lesson delivery was low due to factors such as inadequate facilities, inadequate time to access computers and lack of appropriate ICT skills among others. This study recommends that physics teachers should make use of technology in their lessons to enhance learners understanding of concepts hence improve performance. Secondly, it is recommended that pre-service training and INSET of teachers should include a component on how to integrate ICT in lesson delivery. Thirdly, the school managers and other stakeholders should endeavor to provide more facilities especially Internet, digital and video cameras which are equally important in supporting technology based learning. Lastly, it is recommended that school principals be sensitised on the importance of having well documented ICT policies which should dove-tail into the MoEST ICT policy in education.

CHAPTER ONE

INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 Introduction

This chapter introduces the study of ICT use in teaching and learning of physics in secondary schools in Kimilili District. It also sets up the problem, objectives, theoretical framework and conceptual model for the study, among others.

1.2 Background to the study

Science subjects play a key role in the scientific, technological and industrial development of the country and hence the achievement of the vision 2030 (GoK, 2007). In order to improve the quality of teaching science and mathematics in both primary and secondary schools, the government of Kenya has put in place several measures which include in-servicing of teachers through SMASSE programme, equipping of schools with laboratory apparatus, materials, and provision of ICT facilities.

The availability and effective use of teaching and learning resources are key determinants of the quality of science and mathematics education in any country. It is against this background that the Government of Kenya (GoK) continues to invest in teaching and learning resources in these areas especially in secondary schools (MoEST, 2005). The government in partnership with development partners has equipped a number of schools with Information and Communication Technology (ICT) facilities such as computers, Television (TV) sets, Digital Versatile Disk (DVD) players, Liquid Crystal Display (LCD) projectors, printer and radio among others (Siele, 2006).

Despite the government's substantial investment in ICT related teaching and learning resources, the performance of students in KCSE examinations in science over the years has been dismal (KNEC reports, 2010). Therefore, it is useful to find out how well these resources are being used and managed, especially for the benefit of the learner.

Students' performance in physics in national examination is low as attested by the Kenya Certificate of Secondary Education (KCSE) statistics in Table 1

Table 1: Performance of students in KCSE physics examination nationally (2007-2009)

Year	Candidature	Maximum score	Mean score	Standard deviation
2007	83,162	200	82.62	35.00
2008	93,692	200	73.42	35.43
2009	104,883	200	62.62	34.02

Source: KNEC (2010)

It is evident that the performance of students in physics is low and has been dropping consistently from 2007 to 2009. The Performance of students in physics in Kimilili District is equally low as attested by the results in Table 2.

Table 2: Performance of students in KCSE physics examination – Kimilili District

Year	Enrollment	Mean Max = 12	Mean grade
2011	619	4.81	C-
2010	623	4.57	C-
2009	597	4.79	C-

Source: DEO's Office, Kimilili District (2012)

The mean score in physics for the three years has been C- . Physics being the bed rock of science and technology that is destined to play a more significant role in spurring technological development (Wang, 2011), ways and means should be found to improve performance of learners in the subject.

According to a survey done by Strengthening Mathematics and Science in Secondary Education (SMASSE) project, one of the causes of poor performance in science subjects and physics in particular is the theoretical approach to teaching and learning of concepts in these subjects (SMASSE project, 1998). Given that some of the concepts taught in physics are abstract, learners find it difficult to conceptualise when taught theoretically. This has made learners to develop a negative attitude towards the subject leading to poor performance. It has led to fewer learners; often the bright ones, choosing to pursue physics which is an optional science subject at Form Three and Four level in quite a number of schools.

The use of ICT in teaching can be a relevant and functional way of providing education to learners that will equip them with skills and knowledge required to function in the 21st century. It is against this background that the Government of Kenya (GoK) in various policy documents has articulated the importance and the role ICT could play in education particularly in science and mathematics education. Kenya promulgated a National ICT Policy in January 2006 whose main aim was to improve the livelihoods of Kenyans by ensuring the availability of accessible, efficient, reliable and affordable ICT services. In the policy, the government committed itself to improving the quality of teaching and learning through the use of ICT in schools, colleges, universities and other educational institutions (MIC, 2006). In order to achieve this, the government came up with several strategies.

First, the GoK undertook to facilitate public-private partnerships to mobilise resources in order to support e-learning initiatives through collaboration between the government and the private sector. Through the *computer for schools project*, a number of schools in every district received twenty computers at a subsidized cost. In the case of Kimilili District, such schools include: Chesamisi High School and Maeni Girls Secondary School. Moreover, through the Economic Stimulus Programme (ESP), the government has availed ICT facilities to one thousand and fifty (1050) schools in the country. Each school received eleven desktop computers, one laptop, printer, local area network facilities and an LCD projector. Such schools include: Kimilili Friends

Secondary School and Mapela Mixed Secondary School, among others (GoK, 2010). In each of the constituencies, one teacher, referred to as ICT champion, was trained and is expected to conduct capacity building of other teachers from schools that benefited from this programme. Besides, a number of schools have acquired ICT facilities through funding from the constituency development fund (CDF), Board of Management (BoM) and Parents Teachers associations (PTA). Currently, there are sixteen schools with computers in Kimilili District (Appendix 6).

Secondly, the government mandated the Kenya Institute of Curriculum Development (KICD) to digitalise the secondary school science content and avail it to schools (Ratemo, 2009). This has been done and the digitised science content from Form 1 to 4 in the form of Compact Disks (CDs) is now available to schools at a cost of Ksh. 500 ($5.95).

Thirdly, the government has come up with strategies of training the education managers and teachers on the use of ICT in school management and classroom instruction respectively. The GoK in collaboration with Flemish Association for Development Cooperation and Technical Assistance (VVOB) has set up a National ICT integration center located at University of Nairobi -Kenya Science campus (Wakhaya, 2010). One of the activities of this center, in partnership with Center for Mathematics Science and Technology Education in Africa (CEMASTEA) is to train teachers on ICT integration in mathematics and science education. Consequently, CEMASTEA has revised its In-service

Education and Training (INSET) content to include sessions on ICT integration in mathematics and science. So far, over ten thousand (10,000) science and mathematics teachers have been trained (CEMASTEA, 2012). In teacher training colleges and universities, ICT is offered as a service subject under the education and communication technology. This is aimed at equipping the teachers with requisite skills and knowledge to use ICT as a tool for effective classroom instruction.

In addition, the GoK through Kenya Education Management Institute (KEMI) has facilitated the training of the secondary school principals on the use of ICT in school management. This is aimed at ensuring that the school principals are computer literate and use ICT in managing their institutions effectively and efficiently since this has a bearing on performance.

Use of Management Information Systems (MIS) which is one of the components of ICT can provide support to school employees in daily activities, and improve their performance, effectiveness and efficiency. For instance, MIS will ensure usable and accessible school databases on students, teachers, employees, classrooms, students' test scores, discipline cases, finance and teacher allocation to classes (Barta et al., 2000).

ICT in education is taken in this study to mean the application of digital equipment to all aspects of teaching and learning. ICT consists of the hardware, software, networks, and media for the collection, storage, processing, transmission and presentation of information (World Bank, 2002). Information in this case includes: voice, data, text and images. The use of ICT tools for teaching and learning falls into four major categories:

- constructing knowledge and problem solving through the Internet-e-mail, CD-ROMs, databases and video conferencing
- using process skills
- aiding explanation of concepts
- and communicating ideas.

It is therefore imperative that ICT is integrated in the teaching and learning of physics. It was the intention of this study to find out the extent ICT is being integrated in the teaching and learning of physics given the initiatives and strategies that have been put in place.

1.3 Statement of the problem

The GoK recognises the important role that ICT in education plays in enhancing access, equity, relevance and quality of education. The GoK through the national ICT policy has outlined the various strategies to accelerate ICT uptake in the Kenyan education sector. Further, the Ministry of Education policy on ICT as stated in KESSP is to integrate ICT into education and training institutions so as to prepare the learners for the envisaged knowledge based economy. To realise this, MoE in collaboration with other stakeholders and development partners developed ICT strategy for education and training aimed at making possible the integration of ICT at all levels of education and training. Despite all these efforts, there are concerns over how ICT is being integrated in the teaching and learning process especially for the benefit of the learners.

The act of integrating ICT into teaching and learning is a complex process whose success depends on a number of factors. These factors may generally be categorised into teacher factors and school factors. Teacher level factors include: teacher's confidence in using ICT tools, teacher's competence and training, teacher's attitude towards use of technology and teacher's experience, among others. School level factors include: management and technical support in use of ICT tools. Some research has been done in Bungoma County in the area of ICT integration but not focussing on the detailed school and physics teacher factors in rural schools (Wanjala et al., 2011).

1.4 Purpose of the study

This study aimed at determining the extent of ICT integration in the teaching and learning of physics in public secondary schools. The main interest was in rural schools. Based on the findings, recommendations have been made that could inform future policies on effective use of ICT in teaching and learning of physics.

1.5 Objectives of the study

The study was guided by the following objectives:

a) To investigate the extent of ICT integration in the teaching and learning of physics.

b) To establish the attitude of physics teachers and students towards the use of ICT in teaching and learning of physics.

c) To investigate the extent of (i) management and (ii) technical support given to physics teachers in the use of ICT.

d) To establish physics teachers' ICT competence in integrating ICT in classroom instruction.

e) To identify factors influencing the use of ICT in teaching and learning of physics.

1.6 Research questions

This study sought to answer the following questions:

a) To what extent are teachers using ICT in teaching and learning of physics?

b) What are the attitudes of physics teachers and students towards the use of ICT in teaching and learning of physics?

c) To what extent are teachers getting management's and technical support in use of ICT in teaching and learning of physics?

d) How competent are physics teachers in using ICT?

e) What factors influence the use of ICT in teaching and learning of physics?

1.7 Significance of the Study

The findings of this study could be useful to various stakeholders in education. First and fore most, the findings could inform MoE, BoM and PTA about the status of ICT facilities in schools. This could help them to make informed decisions on provision and maintenance of such facilities. Secondly, the findings could help physics teachers to re-evaluate themselves if they are adequately prepared to use ICT in teaching and learning of physics and if not, the kind of skills upgrading that would suit them. Thirdly, the findings could help schools to come up with policies that promote the use of ICT in teaching and learning. Lastly, the findings could inform both the in-service and pre-service providers of areas to focus on in future trainings that could ensure teachers have the necessary skills to integrate ICT in teaching and learning of physics.

1.8 Scope and Limitations of the Study

1.8.1 Scope

a) The study was limited to integration of ICT in teaching and learning of physics. The impact of the use of ICT on educational output of these schools was not investigated owing to time constraint and limited financial resources.

b) The study was limited to rural public secondary schools because they are supported by MoE in acquisition of computers and other ICT tools.

1.8.2 Limitations

a) This study was limited to a small sample of 11 out of 23 public secondary schools in Kimilili District, Bungoma County.

b) Self-reporting scales were used in the questionnaire to measure variables for analysis. This might have affected the result of the study since some of the respondents may not have been truthful.

1.9 Assumptions of the Study

In carrying out this study, the following assumptions were made:

a) The respondents gave honest information
b) The sampled schools had the necessary ICT tools (facilities)
c) The respondents understood the meaning of ICT

1.10 Theoretical Framework

This study was based on Innovation Diffusion Theory (Rodgers, 1995), that seeks to explain how innovations are taken up in a population. An innovation is an idea, behavior, or object that is perceived as new by its audience. Integration of ICT in classroom instruction is a pedagogical innovation whose adoption depends on several considerations.

First, the adoption rate and effectiveness of any new innovation will be determined by the relative advantage of the innovation compared to the previous one. This is the degree to which an innovation is perceived as better than the idea it supersedes by a particular group of users, measured in terms that matter to those users, like economic advantage, social prestige, convenience, or satisfaction. The greater the perceived relative advantage of an innovation, the more rapid its rate of adoption is likely to be.

The second consideration relates to gauging the compatibility with existing values and practices. This is the degree to which an innovation is perceived as being consistent with the values, past experiences, and needs of potential adopters. An idea that is incompatible with their values, norms or practices will not be adopted as rapidly as an innovation that is compatible.

The third consideration is the simplicity and ease of using the new innovation. New ideas that are simpler to understand are adopted more rapidly than innovations that require the adopter to develop new skills and understandings.

The fourth consideration is the triability to which adopters can implement an innovation. This is the degree to which an innovation can be experimented with on a limited basis. An innovation that is triable presents less uncertainty to the individual who is considering it.

Lastly, people are likely to adopt an innovation if it yields observable results. Visible results lower uncertainty and also stimulate peer discussion of a new idea, as friends and neighbors of an adopter often request information about it.

Rogers' work has proved valuable theoretical framework for implementation of ICT programmes (Maithya and Ndebu, 2011). Use of ICT in classroom instruction is fairly a new innovation in secondary schools, especially in Kimilili District. In carrying out this study, the adoption analysis approach was used by examining the factors that influence use of ICT in teaching and learning of physics. The focus was on the school as a social system with the school principals, teachers and learners as members.

1.11 Conceptual framework

This study isolated teacher and school factors as the main factors that may influence integration of ICT in teaching and learning of science subjects and physics in particular (becta, 2004). Teacher related factors are those that directly influence teachers' use of ICT in the teaching-learning process and include: teachers' knowledge and skills in the use of ICT, attitudes of teachers towards teaching using ICT and teacher's experience, among others. School factors on the other hand, refer to factors influenced by the institution. They include: support given to teachers by the school management which has a bearing on access to ICT facilities, school ICT policy, technical support in terms of availability of experts, spare parts and software required to keep the ICT tools functioning. Government policies influence both the adoption of new technologies by the teachers and the schools, which in turn, will affect the extent of integration of ICT in teaching and learning of science subjects. Figure 1 summarises the conceptual framework for this study.

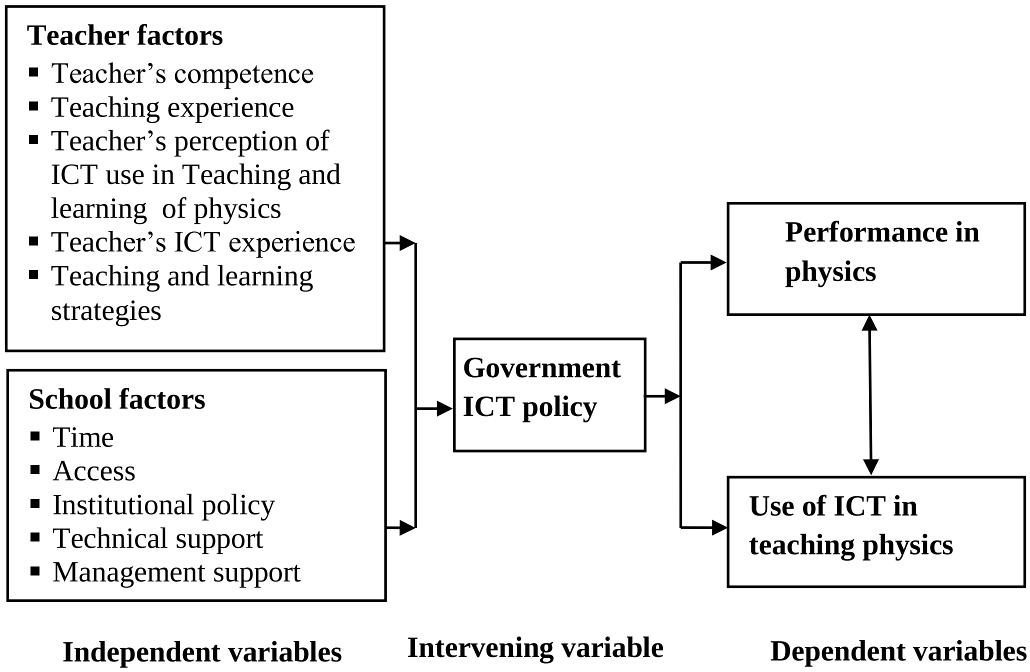

Figure 1. Conceptual framework of the study. Source: Adapted from Maithya R. and Ndebu S. (2011)

Adoption of ICT in teaching and learning will depend on both the teacher and school factors. For instance, if a teacher has the necessary skills and knowledge on how to integrate ICT in pedagogical practice, then he or she will be willing to try out this innovation and with time, he or she becomes confident in using ICT in teaching. Moreover, the teacher's pedagogical beliefs will influence the teaching strategy adopted when teaching a given lesson. The attitude of the teachers towards integrating ICT in classroom instruction could be influenced by the level of support by the school management. This study investigated how teacher and school related factors influence the use of ICT in the teaching and learning of physics.

1.12 Operational Definitions of Terms

Attitude	A way of thinking or feeling about something or somebody usually reflected in a person's behaviour when she or he reacts towards or against some situation, person or object in a particular manner.
Information and Communication Technology	Computer hardware, software and networks, and any communication device or application, encompassing: radio, television, and cellular phones, among others.
ICT competence	ICT knowledge and skills possessed by an individual.
Influencing	Ability to have the power to affect something in a given way.
Public schools	Schools that are formally supported by the government especially in terms of recruitment of teachers and provision of other teaching and learning resources.
Performance in physics	The mean scores learners obtain in KCSE physics examinations.
Physics	One of the subjects taught in the Kenyan secondary school curriculum that is concerned with the study of matter in relation to energy.
Teaching	The number of years one has been teaching physics.
Teacher's ICT experience	Number of years the physics teacher has been using ICT tools especially the computer, related hardware and software.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

The related literature to this study was reviewed under the following sub-headings: Use of ICT in classroom instruction, changes in instructional methods in science education, ICT and lesson planning in physics, factors influencing adoption and use of ICT in teaching and learning, and finally related studies on use of ICT in teaching and learning in physics education.

2.2 Use of ICT in Classroom Instruction

ICT is an umbrella term that includes any communication device or application, encompassing: radio, television, cellular phones, computer, network hardware, software and satellite systems as well as the various services and applications associated with them, such as video conferencing and distance learning.

The use of computers in education dates back to 1924 when Sidney Presley tried out the so called ‘teaching machine’ for revision and testing at Ohio University in the United States of America. However, use of technology in education was generally slow until the coming of computers (Kavagi, 2010). Integrating technology into curricula with the sole aim of influencing positively the teaching and learning process has been evolving since 1980 when a number of countries in the world introduced computers in their education systems (Wakhaya, 2010). This change was mainly as a result of hardware and software evolution, computer accessibility in educational settings and popular instructional technology trends. Technology integration cover a wide area ranging from instruction on programming skills, self-directed drill, testing, instructional delivery, and Internet based accessibility to information and communication.

It has been argued by certain scholars that the use of new technologies in the classroom is essential for providing opportunities for students to acquire knowledge and skills that will enable them to function in an information age (Bingimlas, 2009). It is therefore evident, as Yelland (2001) argued, that traditional educational environments do not seem to equip the learner with adequate skills to be productive in their places of work in today's society. She asserts that organizations which do not integrate the use of new technologies in schools cannot claim to prepare the learners for life in the modern technological age.

There are several roles that ICT can play in the teaching and learning process. First, ICT has a great potential to enhance learner achievement (Bransford et al., 2000). A number of theorists and scholars assert that the use of computers can make the learners to become knowledgeable, reduce the amount of direct instruction given to them and provide a learning environment where teachers can assist learners with special needs. In addition, use of new technology will motivate the learners and hence develop favorable attitude towards science subjects.

2.3 Changes in Instructional Methods in Science Education

According to Osborn and Hennesy (2003), science curriculum has changed over the past few decades in line with the new aims of science education and it will continue to do so. Science teaching has progressed through three sequential phases. The first phase was characterised by "chalk and talk" and which still resists the incursion of learner-centered interactive phase. The latter espouses constructivist theories of learning, and has been a subject of qualitative research by many educationists (Miles, 2010). The third phase which is referred to as scientific literacy is concerned with social purposes of science curricula, literacy awareness that views students as citizens of tomorrow's world. Scientific literacy emphasises on lifelong learning and assists learners to interrogate the crucial relationship between, on one hand the world of science and scientists and on the other hand the society; it extends narrative pedagogy which is universal human faculty. It focuses on environmental aspects of science learning; and it recognises that human values are a powerful component in citizens' essential participation in socio-scientific issues. In the spirit of Internet, knowledge is passed on across communities of learners rather than being dished out like a commodity. As a result of these changes, teachers have to shift from traditional modes of teaching to modern ones that incorporate ICT as a means of gainfully engaging the learner actively in the teaching-learning process.

2.4 Integrating ICT in the Teaching and Learning of Science Subjects

Integrating ICT in teaching of science embraces the functions of planning and preparation of suitable learning activities and their execution in the classroom (Newton, 2003). There is a wide range of ICT facilities that science teachers should use in planning for a lesson and actual classroom instruction. They include: software, CD-ROMs, the Internet, DVD players, television and radio, image capture devices that include still and video cameras, video recorders among others (Steve and Keith, 2001).

A teacher wishing to integrate ICT in science teaching should start by thinking about the needs of science curriculum rather than about technology. Indeed, computers should be used in the service of the teacher and for individual lessons. Planning for teaching entails preparation of schemes of work, lesson plans, identification and trying out of learning activities and teaching notes, among others. When planning for a lesson, science teachers could use the Internet to identify and develop learning activities and search for up to date information on the concept or skill to be learned. Besides, they could use the computer to type schemes of work, lesson plans, lesson notes and assessments which saves on planning time as compared to using pen and paper.

Contemporary science teaching has been influenced by constructivist theory of learning (Driver et al., 1997). This puts the learner at the center of the teaching-learning process. Therefore, learners should be engaged in activities that provoke them to think and come up with solutions to problems using the scientific process. Mental alertness and active participation are key elements in this mode of learning and is widely accepted to underpin effective science teaching (Newton, 2003). The most crucial part and yet which has been given less attention by not only researchers but also science teachers is ICT integration in classroom instructional process. For many years, ICT in education has been used as an object of study or as an aspect of discipline or profession. Focus should now be shifted to using ICT in the classroom as a medium of instruction (Plomp et al., 1996). To be able to achieve this, there are several strategies that can be employed.

2.4.1 Modeling and Experimenting Using Virtual Laboratories

Scientists make computer models as a way of testing their hypotheses. The results of manipulating the model are compared with reality in order to test their theories. According to Cox (1999), learners should be introduced to the idea of modeling in science and at some stage so that they gradually learn to create their own models. Computer models are also used to allow students to perform virtual experiments using virtual laboratories. Using virtual laboratories, learners are able to investigate systems that are too fast, too slow, too remote, too dangerous or too expensive; for example when studying radioactive materials and exploring the human body in 3-D. Software for virtual experiments are available on Internet and others on recorded CD-ROMs. These kind of software are available in the three science subjects; physics, chemistry and biology. For example in biology, the virtual laboratory available at www.biologylab.awlonline.com allows learners to carry out a wide range of Drosophila breeding experiments in minutes instead of weeks (Alsop and Hicks, 2001). In physics, learners can practice electric circuit connections using a virtual laboratory available at www.construction.kit.dc.virtual-lab-en.

According to Niran (2003), the learners have always rated physics with the three Ds (Dull, Dry and Difficult) but not anymore. He argues that with the advent of new technologies (CDs, Videos, computer simulations) and the big range of ideas offered on the Internet, physics teaching has changed for the better.

2.4.2 Microcomputer Based Laboratory (MBL)

Microcomputer-based laboratory (MBL) involves use of a microcomputer as a laboratory tool to collect and analyse data. Students utilise a microcomputer and accompanying probes to collect, record and graph data to support the construction of their science concepts. Different probes, interfacing boxes and software are needed in order to use the microcomputer as a laboratory to collect laboratory data that include temperature, motion, force, pH, sound, light and pressure.

Microcomputers used as laboratory tools may offer a fundamentally new way of aiding students' construction of science concepts (Linn et al., 1991). They also allow students to experience what it is like to do science (Tinker & Papert, 1989). MBL provides opportunities for asking and refining questions, making predictions, designing plans and/or experiments, collecting and analysing data, debating ideas, communicating ideas and findings with others, drawing conclusions, and asking new questions. In addition, the use of the microcomputer may strengthen students' graphing and problem solving skills (Linn et al., 1986). For example, a temperature probe helps students construct an understanding about temperature and heat energy by allowing them to monitor the temperature of physical systems.

According to Mokros and Tinker (1987), students using probeware "have unprecedented power to explore, measure, and learn from the environment." An important outcome of using MBL may be that students spend less time gathering, and more time interpreting and evaluating the data, allowing for more activities central to critical thinking, problem solving, and self-monitoring skills. Hence, students are more willing to replicate, to evaluate, and improve the experiment. MBL has instructional advantages that include: environmental simplicity, fast feedback, more direct experience, student control and interest, and ease of data transformation (Bentillo et al., 2004).

2.4.3 Web-based Approach

This approach makes use of Internet and web based resources. Internet is rich a resource where both the teacher and learners can get up to date information on science concepts. The teacher can assign students to visit websites, search for knowledge and answer some questions (Balbin, 2001). Leaners and teachers can discuss through electronic mail or chat beyond the classroom. Students can chat online with scientists or with other students from other schools or countries. To facilitate the use of web-based approach, the school should have the required infrastructure such as computers and Internet service provider such as Safaricom- Kenya, Telecom-Kenya among others. In the absence of a computer, science teachers and students can still access Internet through mobile phones which are now cheap and affordable. Mobile phones are yet to be exploited fully by science teachers for learning purposes. Research studies on the use of mobile phone for a range of different teaching and learning processes have been carried out worldwide. Ekanayake (2009) argues that due to a wide range of attributes such as spontaneous, personal, informal, contextual, portable, and pervasive and the functions such as talk, text, still camera, video, radio and the Internet, mobile phones could add a completely new dimension to the teaching and learning process.

Despite the potential benefits cell phones have in the teaching of science, their use in the Kenyan secondary schools for learning could be hampered due to the fact that students are not allowed to carry cell phones to school (MoE, Singapore, 2008). However, schools could buy some cell phones that could be used solely for learning purposes just like the conventional laboratory equipment.

2.4.4 Use of Television and Radio

These ICTs have been "used widely" as educational tools since the 1920s (radio) and the 1950s (TV). With the coming of computers and Internet, it is possible to listen to live and recorded radio as well as watch TV programmes. Transmitting recorded radio and TV programmes over Internet is referred to as Personal On Demand (POD) broadcasting. This technique has a unique feature in that programmes can be saved and then downloaded for later listening. The computer makes it possible for the teacher to earmark specific programmes according to subject, topics and date, among others. (Kavagi, 2010). There are three general approaches to the use of radio and TV in education (UNESCO, 2007).

a) Direct Class Teaching

This approach involves broadcast programming as a substitute for a teacher on a temporary basis. 20-30-minutes direct teaching and learning exercises are provided via radio or TV to the classroom on a daily basis. The lessons are developed around specific learning objectives at particular levels of the subject. The aim is to improve the quality of classroom teaching and to act as a regular, structured aid to poorly trained classroom teachers in under-resourced schools.

b) School Broadcasting

This involves the provision of broadcast programming - not to substitute the teacher but, rather, to enrich traditional classroom instruction (particularly where resources would not otherwise be available). Often deployed with print materials, cassettes and CD-ROMS, school broadcasting is geared to national curricula and developed for a range of subject areas; teachers decide how they will integrate the materials into their classes. This is the approach adopted by KICD where lessons are broadcast to schools through radio and teachers decide how and when to integrate them in their teaching.

c) General Educational Programming

General educational programming involves providing non-formal educational opportunities for all types of learners over community, national or international stations. This programming could include news and documentary programmes, quiz shows, educational cartoons and so on. Examples that use this approach are the children's "edutainment" television show Sesame Street, the television channels National Geographic and Discovery, the radio programme Voice of America and the Farm Radio Forum, which began in Canada in the 1940s.

As reported by research studies, there are benefits of using ICT in teaching and learning of science. Using ICT in science education exposes the teacher to more pedagogical resources. For example, use of Internet allows learners to search for up to date information rather than rely on being given facts by the teachers or reading textbooks some of which may be outdated. Knelleher (2000) argues that although ICT cannot replace the normal classroom teaching, it can foster deeper understanding of science concepts and provide new and authentic teaching and learning activities that could motivate the learners. ICT encourages communication and collaboration in science research activities. According to Gillespie (2006), new technologies can be used in science education to enable learners to collect information and interact with resources such as videos and images to encourage communication and collaboration.

2.5 Factors that Influence the use of ICT in Teaching and Learning

According to Maithya and Ndebu (2011), there are a number of factors that influence the use of ICT in teaching and learning. These factors are either institutional or teacher related.

2.5.1 Teacher Related Factors

Teacher related factors determine to great extent the success of computer projects in education (Kavagi, 2010). Teachers play a very important role in the teaching-learning process, they must be able to prepare young people for the knowledge society in which the competence to use ICT to access information is very important (Samah et al., 2009). According to literature reviewed, there are a number of teacher related factors that influence the use of ICT in teaching science. They include:

a) Teaching Experience

Some research findings show that teachers' adoption of new technology is influenced by age. Studies conducted by Roberts et al., (2003) revealed that teachers who were educated 20 years ago were trained by people who themselves were trained before the arrival of computers in educational institutions and therefore such teachers were unlikely to use ICT in their classrooms. However, a study carried out by Albirini (2006) found that age did not significantly influence teachers' attitude towards the use of ICT. These two contrasting findings call for further research on age factor as a predictor of teachers' use of ICT.

b) Teachers' ICT Experience

Several studies show that teachers who are inexperienced in using ICT will most likely avoid using it in the classroom for fear of failure. According to Balanskat et al., (2006) and (Bingimlas, 2009), limitations in teacher's ICT knowledge makes them feel anxious about using ICT in the classroom and thus not confident in using it in their teaching. This is in line with findings of a study by Becta (2004) who found that many teachers who do not consider themselves to be well skilled in using ICT feel anxious about using it in front of a class of children who perhaps know more than they do.

c) Teacher Competence in ICT Use

Teachers are key to the success of ICT integration in education. They must be equipped with basic ICT skills to meet their individual administration and teaching requirements. In addition, teachers have to undergo ICT based pedagogical training so as to ensure effective use of technology in teaching and learning (MoE, Singapore, 2008).

Research studies in Australia found that teachers who lacked knowledge and skills to use computers were not enthusiastic about integrating ICT in teaching and learning (Newhouse, 2002). Research done in developing countries revealed that lack of technological knowhow is the main obstacle to acceptance and adoption of new technology by teachers in classroom instruction (Pelgrum, 2001). Further, studies conducted in Bungoma by Wanjala et al., (2011), confirmed that indeed to adopt any educational technology effectively, teachers must feel confident in its operation and their own ability to use it in classroom instruction. The purpose of this study was to examine the factors that are significant in professional staff development that contribute to efficacy of secondary school teachers' use of ICT in instruction. The study was more general in terms of the target population and covered use of ICT in all subjects of the curriculum.

d) Teachers' Perceptions

The role and importance of attitude and beliefs in education is a very well documented area in educational research. This is also true when it comes to studying the relationship between attitudes and the usage (or lack of usage) of ICT in education (Ertmer, 1999 and Jegede, 2008).

Teachers' attitude determines the extent of ICT use in the teaching and learning process as revealed by a number of studies. According to Gakuu, (as cited in Maithya, 2011), how people perceive and react to technologies is far more important than technical obstacles in influencing ICT implementation and use. Watson (1998), an Australian researcher argues that integrating new technologies into educational settings requires change and different teachers will handle the change differently. Drent and Meelissen (2007) conducted a study on the use of ICT by teachers in classroom instruction in Netherlands and found that positive ICT attitude has direct positive influence on the innovative use of ICT by the teacher. Educational theorists and researchers have alluded to the fact that teacher's attitude is an important factor in the adoption of new technologies in classroom instruction (Koohang, 1989). It has also been argued that attitudes towards ICT not only affects teachers' use of computers in the classroom but also their likelihood of benefiting from training (Kluever et al., 1994). In addition, Tay (2012:7) asserts that:

> Teachers have very often been identified as one of the most significant resources in the integration of technology into schools but they could also be one of the main barriers. The teacher's attitude, knowledge, and skills in the use of computer for the purpose of teaching and learning have a considerable impact on the outcomes to be achieved.

However, a study conducted in Ghana to establish the relationship between teachers' perception and ICT integration in teaching and learning brought to the fore contradicting results. The Study revealed that teachers' perceptions with regards to the use of ICT were positive and low but not statistically significant (Buabeng, 2012). This revelation casts doubts on other findings which have reported that teachers' actual ICT use related to their perceptions (Keengwe & Onchwari, 2008; Lau & Sim, 2008).

This finding, on the other hand, is in agreement with Eugene (2006) who explored the effect of teachers' beliefs and attitudes towards the use of ICT in classrooms. The study revealed that there was inconsistency between teachers' beliefs and their actual use of technology in classroom. Teachers' beliefs and teaching practices were found not to match. The inconsistency between teachers' actual use of ICT and perception can be attributed to inadequate supply of ICT resources, lack of access to the right kinds of technology, inadequate ICT pedagogical training and insufficient administrative support.

2.5.2 Institutional Factors

a) Time

Studies carried out by various scholars indicate that availability of time, determines the use of ICT in teaching and learning of mathematics and science (Becta, 2004). According to Kozma et al., (2004), lack of time available in classes, and in teachers' own schedules for planning is a major factor influencing ICT integration in teaching science subjects. Further, a study carried out in Saudi Arabia shows that time is an important factor affecting the application of new technologies in science education and is attributed to busy school schedules since teachers work from about 7.00 am to 2.00 pm and have on average 18 lessons per week (Al-Alwani, 2005). Both teachers and students have little time to work on integrating ICT in science education.

b) Access to ICT Facilities

Access to ICT facilities is an important factor that could influence the teachers' use of ICT in conducting science lessons. Various research studies show that barriers related to accessibility to new technologies for teachers are wide spread and differ from country to country. A study conducted in Europe found that lack of access is the largest barrier to using ICT. Teachers gave reasons such as: lack of computers and related hardware, lack of appropriate software, slow Internet (Empirica as cited in Bingimlas, 2009). Further, a study carried out at the Kenya

Technical Teachers College revealed that most lecturers (96%) had ICT skills but many (75%) had difficulties in integrating ICT into their subjects. The lecturers cited lack of sufficient Internet facilities for this scenario (Maithya and Ndebu, 2011). Keiyoro (2010:175) conducted a case study involving Cyber and NEPAD E-schools on factors influencing ICT integration in teaching science subjects curriculum. From his findings, he asserts that:

> There is no point in spending any time and effort in equipping teachers with necessary skills to integrate ICT into their teaching if schools do not have computer laboratories and other ICT resources necessary to put those skills into practice with learners.

c) Technical Support

Good technical support both in the classroom and in the whole school resources will help the teachers to overcome the barriers preventing them from using ICT (Lewis, 2003 as cited in Bingimlas, 2009). According to Sicilia (2005), technical problems were found to be a major barrier for teachers. Such technical problems include: waiting for website to open due to slow Internet, failing to connect to Internet, malfunctioning computers and printers as well as old and slow computers. These barriers affected the smooth delivery of lessons or natural flow of classroom activities. Gomes (2005) argues that ICT integration in science teaching needs a technician and if one is not available, lack of technical support can be an obstacle.

d) Management Support

Successful integration of ICT in the teaching and learning depends to a large extent on the support given by the school management to the teachers and students. It plays a significant role in adoption of technology as part of the school culture and which in turn influences people's perception. William et al., (as cited in Maithya and Ndebu, 2011) argues that culture developed within an institution can act as a barrier to change. This is further supported by Gakuu (2006) who cites organizational culture as playing a key role in implementing change in an organization. According to Kara (2008), management of ICT should involve continuously reviewing and putting in place the most appropriate ways of exploiting ICT, acquisition and utilising new ICT required by an organization. The institutional management should also ensure that the capacity of the staff is enhanced, monitor and ensure effectiveness of ICT usage in the institution.

e) School ICT Policy

The GoK formulated a number of policy recommendations aimed at having coordinated approach to ICT integration in education (MoEST, 2006). Educational institutions are expected to make their ICT policies based on these recommendations. School policies are intended to guide the integration of ICT in teaching and learning by articulating the expected characteristics and experiences; and how they will be used to enhance the use of ICT in the teaching and learning process. The ICT policy further influences the school culture which is an important aspect in ICT integration. According to Dawson & Rakes (2003) school policies play a significant role in promoting ICT integration in teaching and learning. School ICT policy entails the development of a shared vision concerning how ICT is to be used for teaching and learning, and putting in place systems to support the same.

2.6 Summary of the Existing Gaps in the Literature Review

According to the literature reviewed, the studies show that there are a number of factors that influence the use of ICT in teaching and learning of science subjects. Most of the research findings revealed that teachers' adoption of new technology is influenced by teaching experience while some of the studies found otherwise. Further, most of the researches have been conducted in developed countries and not much has been done in Kenya and Kimilili District in particular. Moreover, most of the studies carried out on ICT integration in teaching and learning in a number of countries were general because all the three science subjects, i.e. chemistry, biology and physics were covered in a given research. This study will help in filling the above gaps by focusing on use of ICT in teaching and learning of physics in secondary schools in Kimilili District.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

The areas of focus in this chapter include: research design, location of the study, the target population and the sample size involved in the study, research instruments, piloting of research instruments, data collection procedures, data analysis, logistical and ethical issues.

3.2 Research Design

A descriptive survey research design was employed in this study. This is a method of collecting information by interviewing or administering questionnaires to a sample of individuals (Orodho, 2003). Survey studies are made use of in the investigation of phenomena in their natural settings (Koul, 1984). They allow the use of research tools such as questionnaires, observation schedules and document analysis among others in the collection of data. In using questionnaires for example in this study, both qualitative and quantitative data was gathered from teachers, students, and School principals regarding the use of ICT in teaching and learning of physics. The design and process of the study that was used is summarised in Figure 2.

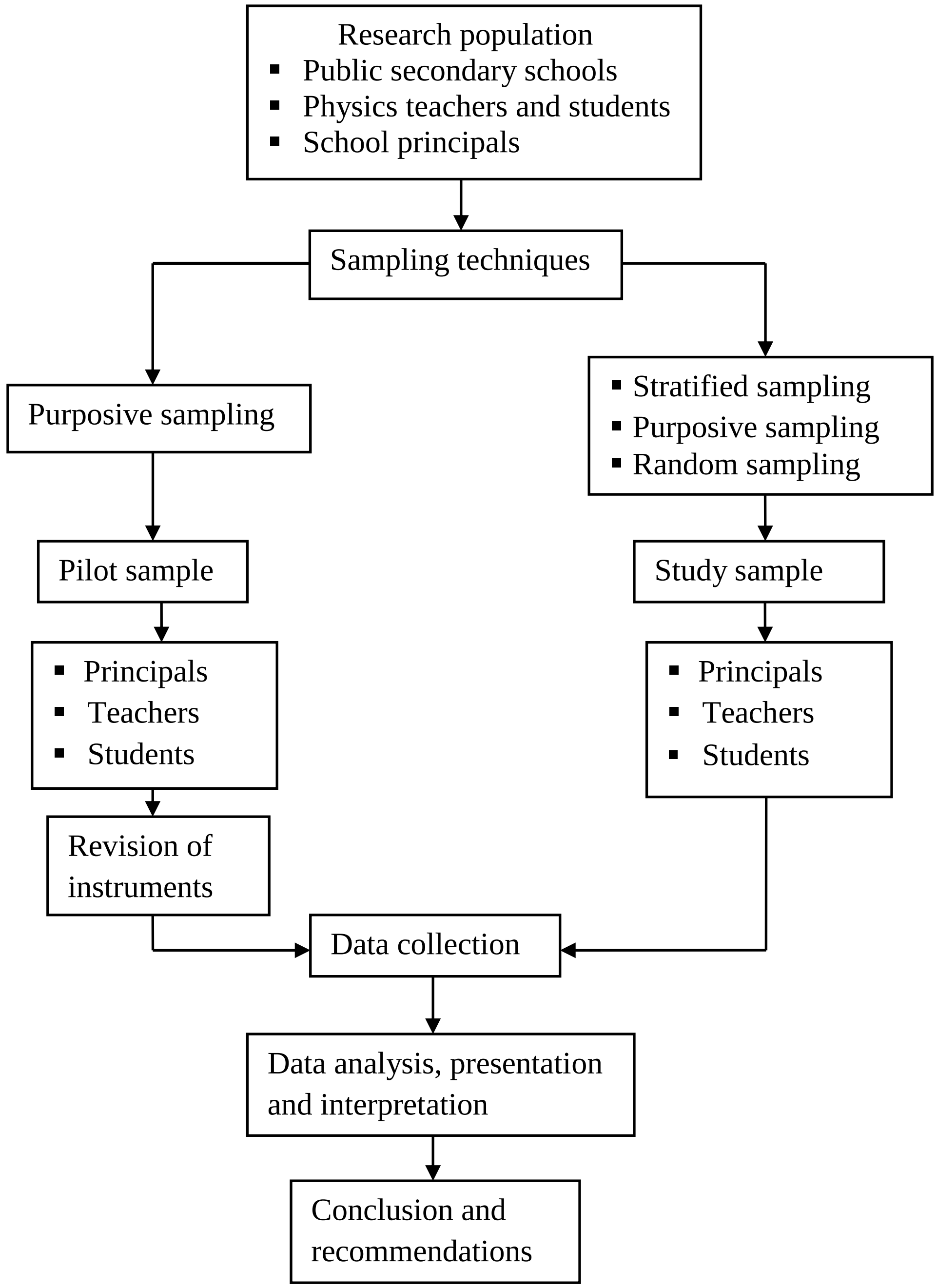

Figure 2. Survey research design and process of study.

Source: Adapted from Cohen et al (2011)

3.3 Variables

(a) Independent Variable

In this study, the independent variables are teacher and school factors in secondary schools that influence the integration and use of ICT in teaching and learning of physics. Teacher factors include: teaching experience, teacher competence in ICT use, teacher experience in using ICT and teachers' attitude. School factors include: technical and management's support, and school policy.

(b) Dependent Variable

A dependent variable sometimes referred to as criterion variable attempts to indicate the total influence arising from the effects of the independent variable (Mugenda and Mugenda, 1999). In this study, the dependent variable is 'the use of ICT in teaching and learning of physics.'

(c) Intervening Variable

An intervening variable is caused by the independent variable and is a determinant of the dependent variable. In this study, the intervening variable is the Government ICT policy.

3.4 Location of the Study

This study was conducted in Kimilili District in Bungoma County located in the western part of Kenya. Bungoma County borders Kakamega, Busia and Transnzoia Counties (appendix 10). The choice of the locale was guided by the fact that performance of learners in KCSE examinations especially in physics is low and also the district has a cross section of schools and therefore making it possible to cater for the various categories of schools. Besides, the researcher has a good geographical knowledge of the district and therefore challenges that may have been encountered while going round the schools were minimized. The other supporting reason is that the majority of the public secondary schools, sixteen out of twenty three have acquired computers which are key in this study.

3.5 The Target Population

Kimilili District has two groups of schools: public and private. In this study, all the public secondary schools were targeted because they are supported by the government and hence they are bound to have ICT facilities that are comparable. The study sample comprised schools that have had computers for at least three years (Appendix 6). The expectation is that teachers, students and management in the schools have had adequate time to interact with the computers. The targeted schools comprised national (N), County (C) and district (D) schools.

3.6 Sampling Techniques and Sample size

3.6.1 Sampling Techniques

The study sample comprised of 11 schools that have had computers for at least three years. The schools were selected using stratified, random and purposive sampling techniques. This was to ensure that all categories of schools: National (N), County (C), District (D) and different school types, Boys only (B), Girls only (G) and mixed (M) were represented in the sample. The only national school in the district was purposively sampled. The rest of the schools were stratified according to school category to ensure that County and district schools were represented. The schools were then stratified according to school type; boys (B), girls (G) and mixed (M) and then the sample was selected. In each of the sample schools, all the physics teachers were purposively sampled. To obtain the sample of the physics students, random sampling technique was used. The number of students selected per sample school depended on the total population of physics students in the school. At least 25 students were selected from each of the schools with high population of physics students. For the schools with less than 25 physics students, all of them were purposively sampled.

3.6.2 Sample size

A total of 11 out of 23 public secondary schools that have had computers for some time were sampled for this study. These comprised of one (1) national school, four (4) county schools and six (6) district schools, and these represented 47.8% of the total number of public secondary schools in the district. A study sample in the range of 10-20% of the total population is acceptable as a sample in descriptive research (Ary et al., 1972). A total of 250 out of 698 form threes comprising of 85 girls and 165 boys, representing 35.8% of physics students in the district were sampled for this study. Thirty (30) out of 41, which represents 71.2% of the physics teachers participated in the study. Eleven (11) school principals out of 23 participated in the study. This represents 47.8% of public secondary school principals in the district. Table 3 shows a summary of the study sample.

Table 3: Sample for the study

	Total	sample	%
Number of secondary schools in Kimilili	23	11	47.8
Number of Physics teachers in Kimilili	41	30	71.2
Number of Form 3 physics students in Kimilili District	698	250	35.8
Number of school principals in Kimilili District	23	11	47.8

Source: DEO Kimilili District, (2013)

3.7 Research Instruments

The following instruments were used to collect data.

a) Questionnaires

Researchers in social sciences and education often employ questionnaires (Orodho, 2003). In this study, questionnaires were used to collect information from the physics teachers and students. The researcher used this tool because of its objectivity since the questions are presented on paper and there is no opportunity for interviewer's bias (Saunders et al., 2007). In addition, questionnaires generate quantifiable data ready for statistical analysis (Mugenda and Mugenda, 1999). However, use of questionnaires has some limitations. The researcher may not have the opportunity to ask for further information from the respondents directly.

i) Physics Teachers' Questionnaire (PTQ)

The items in this questionnaire were adapted from those developed by Wakhaya (2010). It was divided into five sections, A, B, C, D and E (Appendix 2). Section A sought information regarding biographical data relating to the teacher and his or her experience in using computers. Section B was used to assess teachers' ICT competence using 0 to 4 Likert-type scale (with response options as follows: poor, fair, good, very good, excellent). It comprised of 10 closed statements aimed at gathering information on the physics teachers' knowhow in using various ICT software and hardware. Section C comprised 12 closed ended questions that sought information on extent of ICT use in teaching physics. The teachers' responses ranged from "Very often (every lesson) to Never". Section D, comprising of 10 closed ended questions focused on management and technical support. The last section, E focused on teacher's perception on the use of ICT in teaching of physics. This section had nine items on a likert scale of 1 to 5 and teachers were expected to respond by either 'strongly agree', 'agree', 'not sure', 'disagree' or 'strongly disagree'.

ii) Physics Students' Questionnaire (PSQ)

This instrument whose structure is similar to the teachers' questionnaire was used to gather data from the students (Appendix 3). The data covered areas such as: background information, student's perception on the use of ICT in learning Physics, extent to which ICT is used in classroom instruction, management and technical support.

b) Principals' Interview Guide (PIG)

Collection of data from the school principals was done using an interview guide. This is a convenient way of gathering data from the school principals who are often quite busy and may not have adequate time to respond say to a questionnaire. In addition, it is a flexible tool for data collection, enabling multi-sensory channels to be used: verbal, non-verbal, spoken and heard. Although an interview is a powerful tool for researchers, it is open to the researcher's bias. Using this tool, the researcher collected data regarding management and technical support given to physics teachers in making use of ICT in teaching (Appendix 1).

c) Lesson Observation Schedule (LOS)

Data gathering through observation entails observing people's behavior so as to get information about phenomena of interest (Johnson and Christensen, 2004). Observation is a matter of collecting information about the physical and social world as it unfolds before us directly via senses rather than via the accounts of others. Observation is important because it is a way of verifying information obtained through self-reporting by respondents.

Lesson observation tool provided information on whether or not physics teachers make use of ICT in teaching and learners response to such an approach (Appendix 4). This is an important tool because it provides information about the actual behavior of those under observation.

d) Document Analysis Guide (DAG)

The research also utilised document analysis (Appendix 5) to gather data. Among the documents analyzed were schemes of work, lesson plans, and stores ledgers. This was to ascertain whether physics teachers utilise ICT tools in preparation of documents such as schemes of work, lesson plans and lesson notes, among others. In addition, the tool was used to ascertain if the teachers plan with ICT tools in mind. Stores ledgers were analysed to ascertain the availability and management of ICT tools and facilities.

3.8 Pilot Study

Piloting was conducted to determine the reliability and validity of the research instruments. This involved four public secondary schools in Kimilili District that were not part of study schools. The schools were purposively sampled and included two Boys' District schools and two Girls' District Secondary schools. Four (4) physics teachers, 32 Form Three students and four school principals participated in the study. Four physics lessons were observed in Form Three.

3.8.1 Validity of the research instruments

Validity is a measure of the degree to which a research instrument measures what it is meant to measure. In determining the content validity of the instruments, care was taken to ensure that all items covered all the issues under investigation (Carmines and Zeller, 1979). To ensure construct validity, the clarity of the items and level of language were checked. This was done through piloting of the instruments and thereafter consultations with the researcher's course supervisors and ICT specialists.

3.8.2 Reliability of research instruments

Reliability is the measure of the degree to which a research instrument yields consistent results or data after repeated trials. The reliability of the PTQ and PSQ, was determined during the pilot phase by calculating Crombach's alpha using SPSS. Crombach's alpha is a measure of internal consistency and is suitable for multi item scales such as those used in the PTQ and PSQ. The alpha coefficient of reliability was found to be 0.85 and 0.78 for PSQ and PTQ questionnaires respectively. According to Mugenda and Mugenda (1999), if the value of r is 0.6 or greater, then the data obtained is reliable.

3.9 Data Collection Procedure

Preliminary visits were made to each of the sample schools before carrying out the study. Through the visits the researcher established a good working relationship with the teachers and students by talking to them and explaining the purpose of the study. This helped in minimizing Hawthorne effect in the study. The researcher collected Form Three class time tables which enabled him to prepare a schedule to guide the school visits. During the familiarisation visits the researcher sat at the back of the classroom and observed how learning was taking place without taking notes. It was anticipated that this would make both the teacher and the students be at ease during the actual study. In order to avoid interrupting lessons during the familiarisation visits, and actual observation, the researcher entered the classroom with the respective physics teachers. To avoid the teacher making any specific preparations, no special appointments were given.

During the actual study, the researcher arrived in the school and proceeded to the principal's office for a courtesy call and carry out an interview. He then proceeded to the Departmental offices where he requested for documents such as physics schemes of work, stores ledgers for physics and computer laboratories. The documents were checked to gather data on availability of ICT facilities and if teachers planned their lessons with these facilities in mind. Questionnaires were administered to the physics teachers after which the researcher accompanied one of them to the classroom to observe a 40 minutes lesson. PSQ were administered to the students after the lesson. The researcher then thanked the school principal, teachers and the students and proceeded to the next school.

3.10 Data Analysis Plan

All the questionnaires were checked to ensure they had all been correctly filled. Then the quantitative data collected was coded appropriately and then analysed using Statistical Package for Social Sciences (SPSS) version 17.0. Descriptive statistics including percentages, means and frequency tables were employed in the analysis. These are the most commonly used methods of presenting data in descriptive research. The items in the research instruments were designed to elicit information that would be used to answer a given research question.

To determine the extent of ICT use in teaching physics, relevant items in the PTQ and PSQ were analysed. ‘ICT use mean score’ was computed and interpreted based on a guide developed for this purpose (Appendix 7).

To determine the extent of the school’s management and technical support given to physics teachers in use of ICT, relevant items in PTQ and PSQ were analysed by calculating the mean rating which was then interpreted based on the guide (Appendix 7). Data from PIG and LOS was appropriately analysed.

To establish the attitudes of teachers and students towards use of ICT in teaching and learning of physics, respondents were required to give their views regarding certain statements on use of ICT in teaching and learning. The physics teachers and students were required to respond by: strongly agree (SA), agree (A), not sure (NS), disagree (D), or strongly disagree (SD). The mean score for all the respondents was calculated for both the negative and positive items. Use of both the negative and positive items is important for triangulation. The mean scores was then interpreted accordingly (Appendix 7).

To identify the factors influencing use of ICT in teaching and learning of physics, Pearson Product Moment Correlation was used to find the relationships between dependent variable and independent variables. This is one of the two mainly used measures of association or correlation among variables in educational research (Cohen et al., 2011).

3.11 Ethical and logistical considerations

The researcher sought and obtained permission from the relevant authorities before carrying out this study. The research permit was obtained from the National Council for Science, Technology and innovation (NCSTI). Consent to conduct the study in Kimilili District was sought from the County Director of Education, Bungoma County and District Education Officer, Kimilili District. The researcher also sought permission from the principals of sample schools to allow the researcher to conduct the study in their schools. The consent of the physics teachers and the students to participate in this study was also sought before administering the instruments. The data collected was treated with confidentiality and was used only for the purpose of the study.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND DISCUSSION

4.1 Introduction

Data collected using research instruments was analysed and the summary presented in this chapter. Also, the analysed data was interpreted and discussions of the same presented in this chapter. The variables as isolated from instruments were: extent of ICT use in teaching and learning of physics, teachers' and students' attitude towards use of ICT in teaching and learning of physics, access to ICT facilities, technical and management's support, teaching experience, teachers' ICT competence and school policy on use of ICT.

This study sought to investigate the extent of ICT integration in teaching and learning of physics, establish the attitude of physics teachers and students towards the use of ICT in teaching and learning of physics, investigate the extent of (a) management and (b) technical support given to physics teachers in use of ICT, establish physics teachers' ICT competence in integrating ICT in instruction and identify factors influencing use of ICT in the teaching and learning of physics.

4.2 Presentation and discussion of analysed data

The analysed data was presented using tables, pie and column charts. The presentation and interpretation of the analysed data was done under the following headings: background information, extent of ICT use in teaching and learning of physics, Teachers' and students' attitudes towards use of ICT in teaching and learning of physics, School management's and Technical support, teachers' ICT competence and factors influencing ICT use in teaching and learning physics.

4.2.1 Background Information

The background information regarding the physics teachers and students as well as the principals of the sample schools is presented in this section.

4.2.1.1 Teachers

a) Gender

The results indicated that 13% and 87% of the physics teachers in the sample schools were females and males respectively (see figure 3). This skewed ratio is a reflection of the low population of girls pursuing physics to higher levels of education.

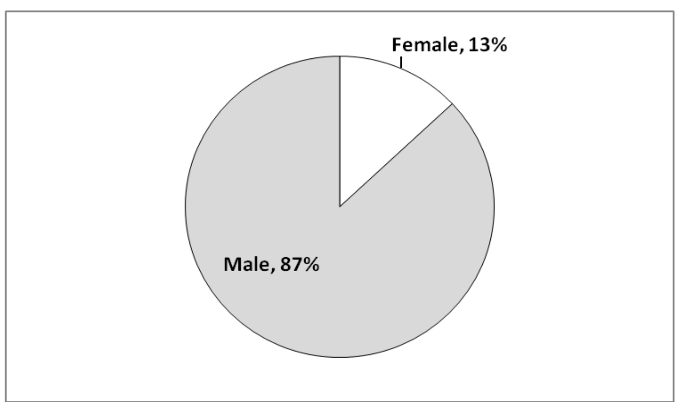

Figure 3. Distribution of physics teachers by gender.

b) Professional qualification

Information on physics teachers' professional qualification was obtained through the PTQ. Table 4 shows the results.

Table 4: Professional Qualification of Physics Teachers

Qualification	Frequency	%
Diploma	8	26.7
Bachelor's degree	18	60.0
Masters	4	13.3
Total	**30**	**100.0**

This study showed that all physics teachers in the sample schools are professionally qualified with 60% and 13.3% having Bachelors and Masters Degrees respectively. This is an important aspect since according to Allison (1997) skilled and knowledgeable workforce is closely linked with successful implementation of technology.

c) Teaching experience

Teachers' teaching experience was considered in a range of five years. This information was obtained using a questionnaire (PTQ). Table 5 shows a summary of the findings.

Table 5: Teaching Experience in Years

Teaching experience	Frequency	%	Cumulative %
below 5 years	6	20.0	20.0
between 5 and 9	9	30.0	50.0
between 10 and 14	7	23.3	73.3
between 15 and 24	8	26.7	100.0
Total	**30**	**100.0**	

The results showed that the majority of the teachers have a working experience of above five years (Table 5). Long experience of teaching a particular subject is important because it could contribute to good content mastery by the teacher.

d) Experience in using computers

Teachers were asked to indicate their experience in handling computers in one form or another. The findings are summarized in table 6.

Table 6: Physics Teachers' Experience in using Computers

Experience in computer use	Frequency	%	Cumulative %
Below one year	7	23.3	23.3
1-2 years	4	13.3	36.7
3 to 4 years	9	30.0	66.7
more than 5 years	10	33.3	100.0
Total	**30**	**100.0**	

The study showed that 43.3% of the teachers in the study sample have interacted with computers for between one and four years while 33.3% have computer experience of more than five years (Table 6).

e) Training on How to use Computers

Training is a useful component when it comes to skill development. This information was sought using PTQ and the emphasis was on general training in use of computers.

Table 7: Physics Teachers Trained in use of Computers

Trained	Frequency	%	Cumulative %
No	9	30.0	30.0
yes	21	70.0	100.0
Total	**30**	**100.0**	

From table 7, a good proportion (70%) of the teachers in the sample schools have been trained on use of computers. Some of the teachers were trained during their pre service teacher training since computer studies are offered in teacher training institutions as a service subject while others have done so through initiatives such as SMASSE INSET.

f) Physics Teachers Trained on How to Integrate ICT in Teaching and Learning of Physics

The main interest was training specifically in ICT integration. Such training is said to be effective if teachers are able to use ICT in teaching physics in the classroom.

Table 8: Training on Integration of ICT in Teaching of Physics

Trained	Frequency	%	Cumulative %
No	12	40.0	40.0
yes	18	60.0	100.0
Total	**30**	**100.0**	

The study showed that 60.0% of the physics teachers in the sample schools have been trained on how to integrate ICT in the teaching and learning of physics. However, the trainings have been offered by different institutions with varying training contents. Some of the teachers indicated that they were trained through SMASSE INSET, others through the Hp programme being implemented by Kenyatta University, while others attended Intel teach course sponsored by Intel Corporation and implemented by trainers drawn mainly from CEMASTEA.

4.2.1.2 Form Three Physics Students

As indicated earlier, the main focus of this study was the students. This formed a total of 250 from 11 secondary schools.

a) Form three physics students by gender

A total of 250 Form three students responded to PSQ. Figure 4 shows their distribution by gender.

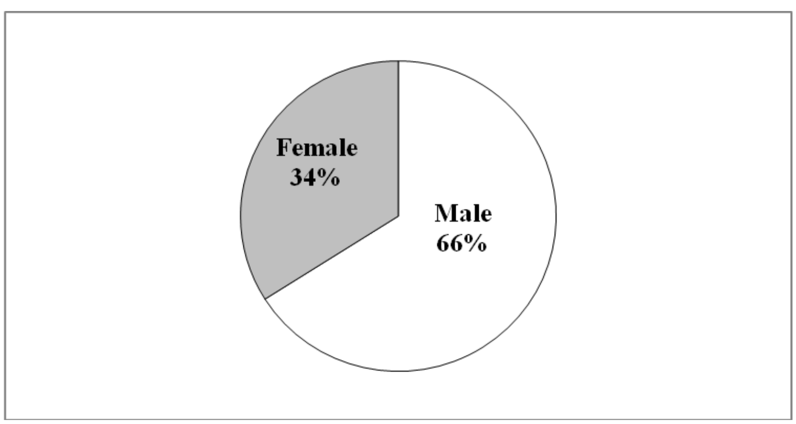

Figure 4. Distribution of Form Three physics students by gender

This ratio, which reflects the population of physics students by gender in the district, suggests that there is still a disparity among students pursuing physics to higher levels. Physics has been perceived for a long time as a male domain.

b) Students' Experience in using computers

The focus was on the length of time a student has used computers for whichever purpose. This information was sought using the PSQ and Table 9 shows the results.

Table 9: Physics Students' Experience in Using Computers

Experience in computer use	Frequency	%	Cumulative %
none	45	18.0	18.0
Below one year	43	17.2	35.2
1-2 years	74	29.6	64.8
3 to 4 years	42	16.8	81.6
more than 5 years	46	18.4	100.0
Total	**250**	**100.0**	

The study showed that 82.0% of the Form Three physics students in the sample schools have interacted with computers as compared to only 18.0% that have never. This means that most students have an opportunity to access a computer either at home or cybercafé for those who can afford, or at school. The fact that some of the students have never handled computers could mean lack of proper policies in some schools that would ensure that every student can access computers.

c) Students' Experience in Using Internet

Internet is an important ICT tool for communication, conducting research and entertainment. The students were required to indicate how long they have been using Internet for whatever purpose. Table 10 shows the results.

Table 10: Physics Students' Experience in Using Internet

Experience	Frequency	%	Cumulative %
none	26	10.4	10.4
Below one year	113	45.2	55.6
1-2 years	40	16.0	71.6
3 to 4 years	39	15.6	87.2
more than 5 years	32	12.8	100.0
Total	**250**	**100.0**	

The study showed that 89.6% of the students have used Internet. This proportion is higher compared to those who have interacted with computers (82.0%). This could mean that the students access Internet using other ICT tools such as mobile phones and Ipads among others.

4.2.1.3 School Principals

School principals can play a very important role when it comes to formulation and implementation of school ICT policy as well as supporting teachers and students. Information was sought from 11 school principals through face to face interviews.

a) Distribution by Gender

Out of the 11 principals sampled, five were female while six were male. Figure 5 shows the distribution by percentage.

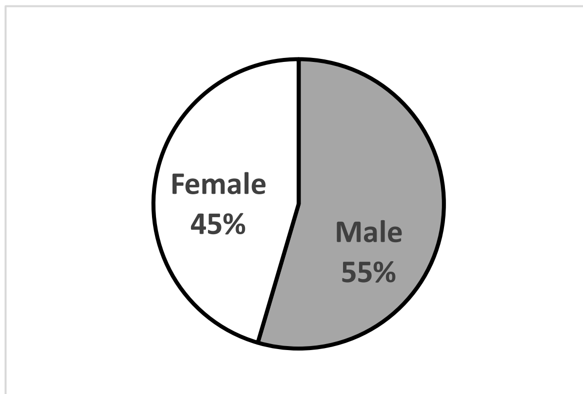

Figure 5. Distribution of school principals by gender

The study showed that 45% and 55% of the sampled school principals were female and male respectively. It was observed that the majority of the sampled mixed schools were headed by male principals and hence the skewed proportion by gender.

b) Working experience as a school principal

Effectiveness and efficiency of a principal in managing a school could depend on his or her working experience because of leadership skills gained over time. The focus of this item was on the number of years one has been a principal. Table 11 shows the results.

Table 11: Working Experience of the Principals in Sample Schools

Working experience	Frequency	%
More than 24 years	0	0
between 15-24 years	1	9.1
between 10-14 years	2	18.1
between 5-9 years	5	45.5
below 5 years	3	27.3
Total	**11**	**100.0**

The study showed that 72.7% of the school principals in the sampled schools had working experience of more than 5 years. Long working experience is good because a principal will be able to understand, articulate and implement GoK ICT policies better.

c) School principals trained in use of computer

The principals were required to state whether they have attended any formal training in computer use. This is considered important because a principal who is computer literate could easily use knowledge and skills gained to guide other teachers on the same. Six out of 11 principals have been trained. Figure 6 shows the results by percentage.

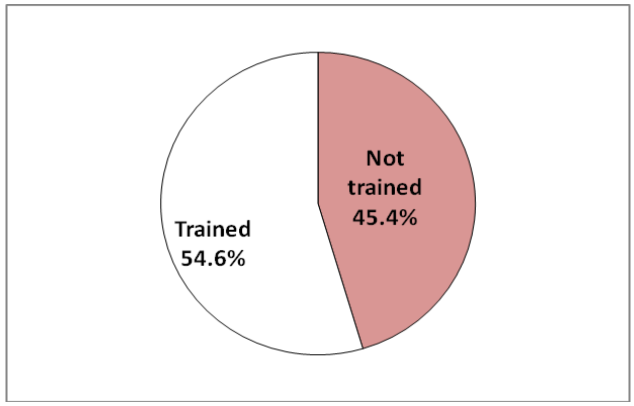

Figure 6. School principals trained in computer

The findings showed that 54.6% have been trained on computer use. The others (45.4%) have learned how to use computers on their own.

4.2.2 Availability of ICT facilities in sample schools

Although schools that were known to have computers were targeted, this study also established the availability and adequacy of other ICT tools through document analysis and interviews.

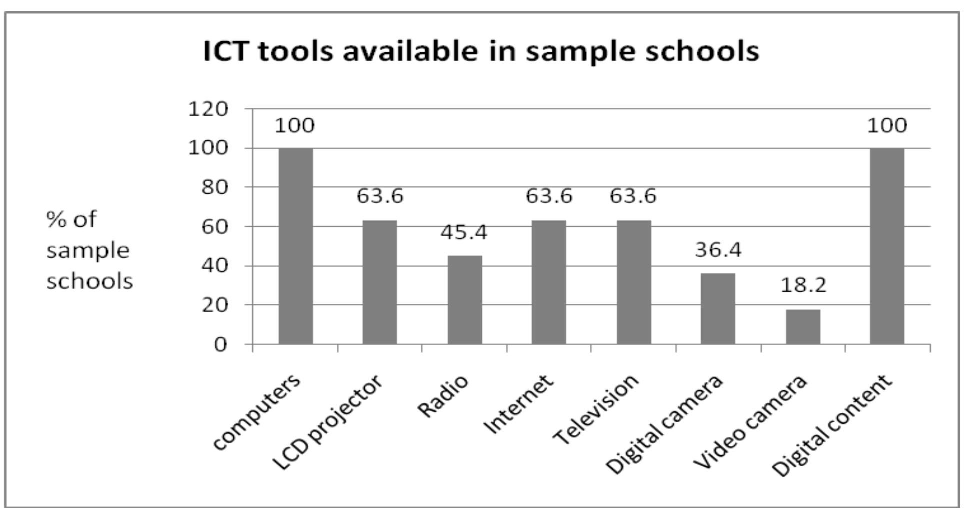

Figure 7. ICT facilities available in sample schools

From Figure 7, all the sample schools (100%) had at least some computers. In addition, all the schools had digital content in physics that were sourced from different authors including KICD. Few schools had video cameras (18.2%) and digital cameras (36.4%) despite the fact that these are essential ICT tools that could be useful in preparing ICT integrated lessons. An interview with school principals revealed that the ICT facilities are inadequate.

4.2.3 Extent of ICT integration in Teaching and Learning of Physics

The PTQ, PSQ, LOS and DAG were used to gather information regarding the extent of ICT use in teaching physics. Using PTQ and PSQ, Physics teachers and students were expected to rate their extent of ICT use in teaching and learning physics using a four point rating scale of 3-*very often*, 2-*often*, 1-*rarely*, 0-*never*. The mean ratings were interpreted using the guide; $2.25 < x \leq 3.0$ (Very high), $1.5< x \leq 2.25$(high), $0.75< x \leq 1.5$(moderate), $0\leq x \leq 0.75$ (low). Through lesson observation, information was gathered regarding whether ICT is used in teaching physics and how. Table 12 shows the findings based on PTQ.

Table 12: Mean rating of extent of ICT use in Teaching/Learning of physics as rated by teachers

ICT tool	N	Extent of ICT use mean score (Max = 3)	Std. Deviation
Microsoft office word	30	1.70	0.988
Internet	30	1.83	1.020
Microsoft excel	30	1.63	1.033
Educational CDs	30	1.20	1.031
Radio	30	0.50	0.777
Television	30	0.73	0.980
Microsoft power point	30	1.33	1.061
Computer	30	1.43	0.898
LCD projector	30	0.93	1.015
Mobile phones	30	1.10	1.094
Digital camera	30	0.87	1.074
Video camera	30	0.77	1.073
Overall mean rating = 1.17			

Use of word processing, Internet and Microsoft excel were rated high (mean ratings = 1.70, 1.83, and 1.63 respectively). This is consistent with the findings of Becker, Ravitz and Wong (1999) who established that word processing and World Wide Web (WWW) browsing software were the most commonly used applications by teachers regardless of the subject they taught. The use of the other ICT tools, including mobile phones, which every teacher could be having was rated as moderate. This could mean that teachers are yet to realise that a mobile phone is a useful ICT tool that could be used in the teaching and learning of physics.

Students were also asked to indicate how often they used certain ICT tools in learning physics. Table 13 shows the results as rated by the physics students.

Table 13: Extent of ICT use in T/L of Physics as Rated by Students

ICT tool	N	Extent of ICT use mean score (Max = 3)	Std. deviation
Computer	250	1.12	1.087
LCD projector	250	0.80	0.982
Television	250	0.92	1.085
Internet	250	0.77	0.965
Radio	250	0.75	1.070
Mobile phones	250	0.83	1.032
Digital camera	250	0.56	0.973
Overall mean rating = 0.82			

Use of ICT tools such as digital camera and radio were rated as low; mean rating of 0.56 and 0.75 respectively. The rest of the ICT tools were moderately used. Generally, the use of ICT in teaching and learning of physics is moderate (mean rating of 1.17 and 0.82 for teachers and students respectively).

A total of 11 physics lessons were observed in Form Three. The topics that were taught included: Waves, The gas laws, Current electricity, Heating effect of electric current and Quantity of heat. Information and communication Technology was integrated in only two of the 11 lessons observed despite the fact that nearly all the sample schools had digital content in form of CDs on the topics that were taught. In one of the ICT integrated lessons, a computer together with LCD projector was used to display information on the wall. The teacher explained the concept of ‘waves’ and asked learners to copy notes. The lesson was largely teacher centered. In the other lesson, virtual lab was used to demonstrate experiments on the topic ‘gas laws’. Demonstrations were done by students and the teacher paused carefully selected questions that engaged the learners. The lesson was lively as evidenced by active learner participation. The lesson was more learner-centered. From the foregoing discussion, one would argue that it is not a question of merely using ICT but how it is integrated in teaching and learning is much more important.

From document analysis of the schemes of work, it turned out that physics teachers in nine out of the 11 schools type their schemes of work by themselves, while in the other two schools it is done by the secretary (see Figure 8).

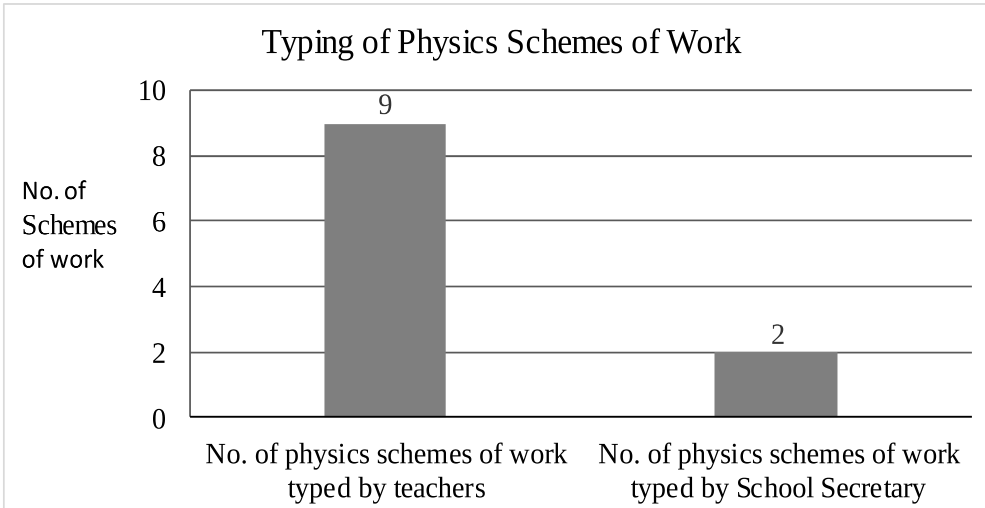

Figure 8. Typing of schemes of work

In addition, the study revealed that only three out of eleven schemes of work had ICT resources included as part of teaching and learning resources in physics. (See Figure 9).

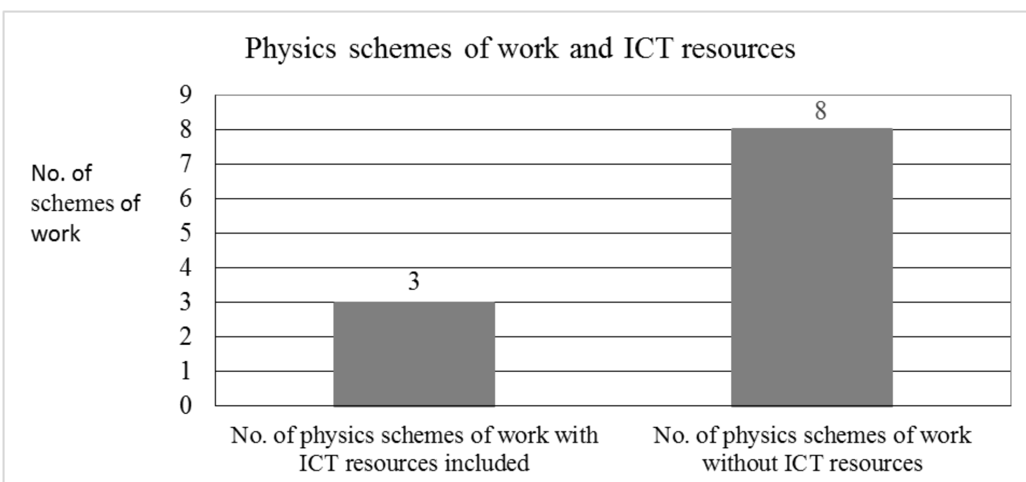

Figure 9. ICT resources included in schemes of work

Only two ICT tools were mentioned in the schemes of work: computer and LCD projector. This indicates that the physics teachers rarely make deliberate effort to plan with ICT facilities in mind.

Generally, the use of ICT in teaching and learning of physics is moderate; mainly during preparation of schemes of work and analysis of students' test scores and not much in lesson delivery.

4.2.4 Attitudes of physics teachers and students towards the use of ICT in teaching and learning of physics

The information on the physics teachers' and students' attitudes towards ICT use in teaching and learning of physics was obtained from the PTQ and PSQ questionnaires. In items 40 to 48 and items 31 to 40 in the teachers' and students' questionnaires respectively, respondents were expected to give their views regarding given positive statements as 5-*strongly agree*, 4-*agree*, 3-*not sure*, 2-*disagree*, 1-*strongly disagree* and a reverse for negative statements. The mean scores for both the positive items and negative ones were calculated. The mean scores (x) ranged from $3 < x \leq 5$ for favorable feelings and $1 \leq x < 3$ for unfavorable feelings for positive statements and vice versa for negative statements.

a) Students' attitudes towards use of ICT

Table 14: Mean ratings for both positive and negative statements based on students' responses

Statements	N	Mean (Max = 5)	Std. Dev.
Use of ICT enables me understand physics concepts better	250	4.26	1.058
Use of ICT makes learning more enjoyable	250	4.42	1.024
Social media makes communication among students easier	250	4.21	1.199
ICT supported learning makes learning more effective	250	4.44	1.060
A computer is a valuable tool for learning physics	250	3.92	1.231
Use of ICT may slow down syllabus coverage	250	2.01	1.212
Use of computers in learning physics is time consuming	250	2.00	1.303
I can still learn physics better without the computer	250	3.21	1.364
The computer is not conducive for learning	250	1.66	1.038
TV, computer and radio are only good for entertainment and not for learning physics	250	1.77	1.222

From Table 14, mean rating for all the positive statements were in the range $3 < x \leq 5$ while those for negative statements except one were in the range $1 \leq x < 3$. This implies that students understood the value of using ICT in teaching and learning of physics. They were also aware that ICT tools such as TV, computer and radio are not only for entertainment but can also be useful in learning physics. However, their response to the statement 'I can still learn physics better without the computer' was surprising. Most of the students seemed to agree with the statement. This means that although learners appreciate that using ICT would make teaching and learning of physics better, they are yet to see the value of a computer as an ICT tool in doing the same.

b) Attitudes of teachers towards use of ICT

Tables 15 shows the mean ratings for both positive and negative statements

Table 15: Mean rating for both positive and negative statements from PTQ

Statements	N	Mean (Max = 5)	Std. Dev.
Use of ICT makes me more effective as a teacher	30	4.27	0.944
I think that using ICT makes it easier to source for teaching/learning materials	30	4.47	0.937
Use of ICT increases the interest of students towards physics	30	4.53	0.819
Use of ICT enables students to understand physics concepts better	30	4.40	0.724
Lesson planning using ICT is time consuming	30	2.87	1.456
Use of ICT may slow down syllabus coverage in physics	30	2.43	1.223
Use of ICT may in the long run replace the teacher	30	2.10	1.155
I can do what a computer can do equally well	30	2.47	1.196
Use of computers in teaching and learning of physics is time consuming	30	2.43	1.104

From Table 15, the mean ratings for all the positive statements were in the range $3 < x \leq 5$ while those for the negative statements were in the range $1 \leq x < 3$. This implies that physics teachers in the sample schools have favorable attitudes towards the use of ICT in teaching and learning of physics. However, this positive attitude towards use of ICT in teaching and learning physics is not reflected in actual use of ICT especially in lesson delivery. This revelation is inconsistent with other findings which have reported that teachers' actual ICT use is related to their perceptions (Altun, Alev & Yigit, 2009; Keengwe & Onchwari, 2008; Lau & Sim, 2008). This finding, on the other hand, is in confirmation with Eugene (2006) who explored the effect of teachers' beliefs and attitudes towards the use of ICT in classrooms. The study revealed that there was inconsistency between teachers' beliefs and their actual use of technology in classroom. Teachers' beliefs and teaching practices were found not to match. The inconsistency between teachers' actual use of ICT and perception can be attributed to inadequate supply of ICT resources, lack of access to the right kinds of technology, inadequate ICT pedagogical training and insufficient administrative support.

4.2.5 School management's and technical support to physics teachers and students in use of ICT in teaching and learning

Management support refers to the support given by the school principal and the entire administration to teachers and students. It is important because it is at this level where decisions on implementation of new policies such as adopting new educational innovations are made. Technical support is equally important because teachers could fear using computers when they are not sure of where to get assistance when something goes wrong.

Information on school management's and technical support was gathered through, PSQ and PIG. Using questionnaires (PTQ and PSQ), teachers and students were required to rate the extent to which they experience certain challenges with regard to use of ICT in the teaching of physics using; *very great*-4, *great*-3, *little*-2, *very little*-1, *Not at all*-0. The mean score (x) was calculated and interpreted based on the guide; $2.5 < x \leq 4$ for *low support*, $2 < x \leq 2.5$ for moderate *support* and $0 \leq x \leq 2$ for *big support*. In addition, the respondents were required to indicate how many hours per week computers are accessible to them.

Also the school principals were interviewed on the kind of support they give to both the teachers and students in integrating ICT in teaching and learning of physics.

a) Challenges faced by teachers and students when using ICT

Table 16 shows the findings based on PTQ.

Table 16 : Challenges faced by teachers

Challenge	N	Mean (Max = 4)
Lack of clear plan to access computers in the school	30	1.83
Slow Internet	30	2.40
Inadequate time to use computers in class	30	2.27
Frequent power failure	30	2.23
Inadequate number of ICT tools	30	2.53
Break down of ICT tools	30	1.90
Slow and old computers	30	1.90
Lack of technical support	30	2.37
Overall mean		**2.18**

The study showed that management and technical support as reported by teachers is moderate. One of the major challenges being experienced is inadequate ICT facilities (mean 2.53).

Students were also asked to indicate the challenges they experience in the use of ICT in learning physics. Table 17 shows the findings based on PSQ.

Table 17: Challenges faced by students

Challenge	N	Mean (Max = 4)
Lack of clear plan to access computers in the school	250	2.14
Inadequate time to use computers in class	250	2.10
Frequent power failure	250	1.72
Inadequate number of ICT tools	250	2.00
Break down of ICT tools	250	1.50
Slow and old computers	250	1.58
Lack of technical support	250	1.89
Overall mean		**1.85**

The study showed that management and technical support in use of ICT in teaching and learning of physics is moderate as reported by students. The major challenge being experienced is inadequate ICT facilities (mean = 2.00) which is in agreement with what teachers reported. This was also alluded to by the school principals. Indeed, a comment by the principal in school D illustrates this challenge:

> "We are grateful to GoK for providing us with basic ICT facilities, but they are inadequate due to large number of students in our schools occasioned by free day secondary education. For example, in my school, I have almost 1000 students who share 20 computers. I'm appealing to all stakeholders in education
> to continue supporting us in this area"

Lack of clear plan by the schools for the students to access ICT facilities especially computers, inadequate time to use computers in class, slow Internet and lack of adequate time to access computers were also sighted by both the teachers and students as other barriers to ICT uptake in schools.

b) Number of hours computers are accessible to physics teachers

This was considered important as it determines the experience being gained by the teachers which in turn could affect the adoption rate of ICT in the schools. Table 18 shows the results.

Table 18: Hours per week computers are accessible to teachers

Number of hours	Frequency	%	Cumulative %
None	2	6.7	6.7
less than 1	3	10.0	16.7
1 to 2	6	20.0	36.7
3 to 4	6	20.0	56.7
more than 5	13	43.3	100.0
Total	**30**	**100.0**	

The study revealed that 43.3% of teachers access computers for more than 5 hours per week. Thirty percent of them access computers for less than two hours per week. This time is insufficient for teachers to prepare ICT integrated lessons using computers. According to Sicilia (2005), teachers take much more time to design projects that include the use of new ICT than to prepare traditional lessons. The biggest barriers to the use of computers identified by teachers participating in the 1998-1999 *survey assessing the World Links schools* *programme* were the lack of time available in classes, and in their own schedules for planning (Kozma et al., 2004)

Few of the teachers (6.7%) hardly access computers. These limiting ratios could mean that they are not interested or there is inadequate support by the school.

c) Number of lessons (both subjects) taught per week by Physics teachers

Table 19: Total Number of lessons taught per week by physics teachers

Number of lessons	Frequency	%	Valid Percent	Cumulative %
below 15	1	3.3	3.3	3.3
15 to 19	7	23.3	23.3	26.7
20 to 24	20	66.7	66.7	93.3
25 to 29	2	6.7	6.7	100.0
Total	**30**	**100**	**100.0**	

Most of the physics teachers (66.7%) teach between 20 and 24 lessons per week. This is below 27 lessons per week recommended by TSC and such a load can be considered modest. Teachers would be expected to use this advantage to learn ICT skills and plan for integration. However, this appears not to be the case. This could be due to inadequate ICT facilities, lack of interest by the teachers or lack of requisite skills to integrate ICT in teaching of physics, among other reasons. It is a common misconception that access to technology on its own motivates teachers to apply it in their teaching.

d) Support by school principals

Information on support given to teachers by school principals was obtained through interviews. A total of 11 school principals were interviewed and the results are shown in table 20

Table 20: Support by School Principals

Variable	No. of school principals	%
Implementation of school policy on ICT integration	7	63.6
Employment of a computer teacher	11	100
Acquisition of ICT tools	5	45.5
Facilitation of training of teachers on ICT integration	3	27.3

The study results indicated that 63.6% of the schools have some form of policy to support ICT use in teaching and learning. The policies were in form of dos and don'ts. For example, teachers are required to type schemes of work, lesson plans and tests before handing them in. In school B, the principal said:

> "The workload for my secretary has now reduced since I introduced the policy requiring that all teachers type their own schemes of work, lesson plans and examinations. I have placed computers in each department as well as in the staff room to facilitate my teachers in this. I have also placed computers in the library with e-content in biology, chemistry and physics. On average, fifty students and at least eleven teachers access them daily."

The remaining 36.4% of the schools did not have any policy on ICT use in teaching. The principals of all the sample schools had computer teachers employed either by TSC or BoM. Computer teachers come in handy in assisting other teachers on technical issues. Only 27.3% of the school principals had taken some initiative to have their teachers trained on how to integrate ICT in teaching. From the responses, one can conclude that the principals are making quite an effort to promote ICT in general and ICT integration in particular.

4.2.6 Physics Teachers' ICT Competency

Information on physics teachers' ICT competency was sought through a questionnaire (PTQ). The respondents were required to rate their extent of knowhow in using various ICT tools in teaching physics. They rated themselves using: *excellent*-4, *very good*-3, *good*-2, *fair*-1 and *poor*-0. The mean score (x) for competence was calculated based on the items in the questionnaire and interpreted based on the guide; $3.4 < x \leq 4$ - *excellent*, $2.4 < x \leq 3.4$- *very good*, $1.4 < x \leq 2.4$- *good*, $0.4 < x \leq 1.4$ - f*air* and $0 \leq x \leq 0.4$ - poor. Table 21 shows the results.

Table 21: Physics teachers ICT competence

Variable	N	Mean (Max = 4)
Extent of Knowhow in use of Microsoft office word	30	2.7
Extent of knowhow in use of Microsoft office excel	30	2.4
Extent of knowhow in use of Microsoft office powerpoint	30	2.4
Extent of knowhow in use of Internet	30	2.9
Extent of knowhow in use of computer printer	30	2.6
Extent of knowhow in use of digital camera	30	1.8
Extent of knowhow in use of video camera	30	1.6
Extent of knowhow in use of LCD projector	30	1.5
Extent of knowhow in use of computer	30	2.2
Overall mean		**2.2**

The study showed that most of the teachers perceive themselves as very good in use of software such as Microsoft office word (mean = 2.7) and Internet (mean = 2.9). They also rated themselves as being very good in use of computer printer (mean = 2.6). The result is in agreement with Jegede et al., (2007), and Lau and Sim (2008) who found teachers to be more proficient in word processing than the other computer applications. This could mean that teachers lack skills in other computer application programmes. Evidence reveals that teachers' mastery in ICT skills is critical to successful integration of ICT into teaching (Rosenfield et al., 2005). Most of the teachers are fairly competent in use of the computer as an ICT tool. However, most of them seem to be less skilled in the use of essential ICT tools such as digital and video cameras, and LCD projectors which could be used together with a computer when integrating ICT in teaching and learning of physics.

Most of the teachers rated themselves as 'very good' in using Internet which is an important ICT tool. Using Internet, teachers can access up to date information on various concepts in physics and ways of teaching some concepts perceived to be challenging by both teachers and students. Internet can facilitate collaboration among physics teachers and hence creating a platform where they share ideas on how to teach physics better. Generally, the physics teachers in the sample schools are fairly competent in the use of various ICT tools.

4.2.7 Factors influencing the use of ICT in teaching and learning of physics

The main factors which came out as responsible for influencing teachers in the use of ICT in teaching were: perception, competency, teaching experience, access to ICT facilities and experience in computer use. Table 22 shows correlation matrix based on the students responses (N = 250)

Table 22: Correlation Matrix of ICT Use and Independent Variables based on PSQ

Variables	Use of ICT	Experience in computer use	Competence	Access to ICT facilities	Management and technical support	ICT perception
Use of ICT	1					
Experience in computer use	.152* .016	1				
Competence	.324** .000	.563** .000	1			
Access to ICT facilities	.268** .000	.478** .000	.414** .000	1		
Management and Technical support	-.140* .026	-.032 .618	-.009 .889	.001 .986	1	
ICT perception	.137* .030	.224** .000	.217** .001	.167** .008	.018 .779	1

*Correlation is significant at the 0.05 (2-tailed)

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

The correlation between ICT use and competence was positive and statistically significant ($r = 0.324$, $p < 0.01$). The study also revealed that there was a positive and statistically significant relationship between computer experience and ICT use (0.152, $P < 0.05$). The correlation between students attitudes and use of ICT in learning physics was positive although weak but statistically significant ($r = 0.137$, $p < 0.05$). The study further revealed a positive correlation between students' access to ICT tools and use of ICT ($r = 0.268$, $p < 0.01$).

Table 23 shows the correlation between the dependent variable 'use of ICT' and the independent variables based on teachers ($N = 30$) questionnaires.

Table 23: Correlation Matrix of ICT Use and Independent variables based on PTQ

Variable	Use of ICT	ICT perception	Teacher competence	Teaching experience	Experience in computer use	Access to ICT facilities
Use of ICT	1					
ICT perception	.058	1				
	.761					
Teacher competence	.445*	.267	1			
	.014	.153				
Teaching experience	-.053	-.254	-.410*	1		
	.782	.176	.024			
Experience in computer use	.018	-.051	.123	.067	1	
	.925	.789	.516	.723		
Access to ICT facilities	.390*	.305	.513**	-.246	.129	1
	.033	.101	.004	.189	.496	

*Correlation is significant at the 0.05 (2-tailed)

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

The findings showed that there is a positive correlation between physics teachers' use of ICT and competences ($r = 0 .445$, $p < 0.05$). Newhouse (2002) found that many teachers who lacked the knowledge and skills to use computers were not enthusiastic to use them in teaching. The analysis revealed a low positive correlation between teachers' perceptions and ICT use, although not statistically significant. The study further revealed a positive correlation between teachers' access to ICT tools and use of ICT ($r = 0.39$, $p < 0.05$). This is in support of Empirica's (2000) European study which found that lack of access is the largest barrier to using ICT in teaching.

The study also showed positive relationship (although not statistically significant) between computer experience and ICT use. Petrogiannis (2010) examined 396 kindergarten teachers' perceived preparedness for computer use in the pre-school classes and the potential difference between computer experienced and non-experienced teachers. They concluded that computer experienced teachers were more ready to use ICT in their classes than non-experienced teachers.

Finally, the study revealed inverse correlation between ICT use and teaching experience although not statistically significant. This finding supports Van Braak et al., (2004), Inan and Lowther (2010), Roberts et al., (2003) assertions that ICT use falls with teaching experience and that younger teachers integrated ICT into their teaching more than experienced teachers. This study also revealed inverse correlation between teaching experience and competence. Therefore, the veterans' less use of computers could be attributed to limited computer competence (Bingimlas, 2009).

4.3 Summary of the chapter

From the foregoing presented data, interpretation and discussion, physics teachers in sample schools were in a fairly good position to use ICT in teaching and learning physics. The teachers were among other things: well qualified professionally, had long teaching experience, had positive attitude towards use of ICT, were fairly competent in use of certain ICT tools, teaching load was within the limit specified by TSC and managements' support to the teachers and students was moderate. Physics students too had positive attitude towards use of ICT in learning physics. The study revealed that the number of students taking physics up to Form Four is low as compared to other science subjects. Use of ICT in teaching physics would help to persuade the students to have a more favorable attitude towards the subject.

It emerged from the discussions that although most of the schools had the basic ICT facilities, the teachers were not utilising them to the fullest. In addition, use of ICT was more evident during the lesson preparation than in actual lesson implementation. ICT will have greater impact if it is made use of during lesson planning, lesson implementation and for assessment. The support given to teachers and students in integrating ICT in teaching and learning was limited to provision of resources. The training of teachers on ICT integration in teaching was not a priority in most of the schools.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This study sought to investigate the use of ICT in teaching and learning of physics. A number of issues were investigated. The issues included: extent of ICT use in teaching and learning of physics and the factors influencing the use of ICT in teaching and learning of physics. This chapter summarises the findings. In addition, the conclusions and recommendations are outlined.

5.2 Summary and Implications of the Findings

5.2.1 Teacher Related Factors Influencing use of ICT in Teaching and Learning of Physics

A number of factors that influence use of ICT in teaching physics were considered in this study. They are: teachers' and students' attitudes, management and technical support, ICT competence, teaching experience, school policy, access to ICT facilities and availability of time.

a) Teachers' attitudes towards use of ICT in teaching and learning of physics

The study revealed that physics teachers have a positive attitude towards use of ICT in teaching and learning of physics. While positive attitude of teachers is expected to increase ICT uptake in schools, barriers such as inadequate skills to integrate ICT in physics lessons and insufficient time to plan for ICT integrated lessons among others could be a hindrance.

b) Physics Teachers' ICT competence

Physics teachers in the sample schools were found to be fairly competent in ICT especially use of hardware such as computer and software such as Microsoft word processing, Internet and Microsoft excel. However, the teachers in the sample schools were less skilled in the use of digital and video cameras which could be useful in preparation of ICT integrated lessons. The study showed that there is positive correlation between physics teachers' ICT competency and use.

c) Teaching experience

The study revealed inverse correlation between ICT use and teaching experience. This means that ICT use falls with teaching experience and that younger teachers integrated ICT into their teaching more than experienced teachers.

5.2.2 School related Factors Influencing the use of ICT in teaching and learning of Physics

a) Availability of time to plan ICT integrated lessons and access to ICT facilities

Findings of this study revealed that most teachers in the sample schools access computer on average less than one hour per day and also most of them have up to 24 lessons per week which is below the recommended number of 27 lessons. The implication of this is that even if the teachers have manageable teaching loads, the limited time they have to access computers may be a hindrance to effective integration of ICT in teaching physics.

b) Management and Technical support

The study showed that management and technical support to teachers and students in their effort to use ICT in teaching and learning was moderate. This support is mainly through acquisition of resources, formulation of rules and regulations, and employment of computer teachers. However, there was minimal support in facilitating teachers to acquire more skills in use of ICT.

5.2.3 Students' Attitudes Towards use of ICT in Learning Physics

The attitudes of students towards the use of ICT in teaching and learning of physics was found to be positive. They were upbeat that indeed ICT not only makes learning more enjoyable but also enhances understanding of concepts that are abstract.

5.2.4 Extent of ICT use in teaching and learning of physics

The results of this study revealed that teachers were in a good position to use ICT in teaching and learning of physics. The teachers were professionally qualified, experienced, fairly competent in ICT, had manageable work load and positive attitude towards use of ICT in teaching and learning of physics. However, ICT use in teaching and learning of physics was found to be moderate within the sample schools in Kimilili District. ICT, especially computers, were mainly used for typing lesson plans and analysing students' test scores. It was noted that there was little integration of ICT in lesson delivery. The implication is that the real benefits of using ICT in teaching and learning of physics may not be felt by the learners.

5.3 Conclusions

This study investigated the extent of ICT integration in the teaching and learning of physics. In addition, the study established a number of factors that influence the integration of ICT in teaching and learning of physics in the sample schools in Kimilili District.

On the extent of ICT integration in teaching of physics, this study revealed that ICT was mainly used at the planning stage of the lessons especially typing of lesson plans and schemes of work. Teachers also use computers to analyse students' test scores. However, ICT use during lesson delivery was minimal despite the fact that most of the physics teachers in the sample schools had been trained in use of computers. ICT will benefit both the learners and teachers if it is made use of during lesson planning, lesson delivery and in assessment. For this to be realised, all the factors identified should be taken into account, especially provision of relevant training on how to integrate ICT in lesson delivery.

The following factors were identified to influence ICT integration in the teaching and learning of physics in Kimilili District.

First, the possession of the necessary skills and knowledge in use of ICT is an important consideration that determines the extent of ICT integration in teaching and learning of physics. Although a good proportion of the physics teachers in the sample schools rated themselves as 'good' in the use of ICT tools, they moderately employed ICT in the teaching and learning process; mainly at the planning stage of a lesson. This could mean that physics teachers lack the skills to integrate ICT in actual lesson delivery.

Secondly, the attitudes of both teachers and students towards use of ICT in teaching and learning of physics influence ICT use in teaching and learning physics. Physics teachers and students were found to have positive attitudes towards use of ICT in teaching and learning of physics although this was not reflected in actual use. The mismatch between the actual use of ICT by physics teachers and students positive attitudes could be due to other barriers such as lack of inadequate ICT facilities, lack of time, inadequate skills among others.

Thirdly, technical and administrative support encourages teachers to successfully use ICT in classrooms. Yee (2000) believes that a leader who implements technology plans and also shares a common vision with the teachers stimulate them to use technology in their lessons. This study revealed that management and technical support to physics teachers in sample schools is moderate. This support is expected to motivate teachers and students to utilise ICT. More support by the management by facilitating training for teachers could enhance ICT uptake in the schools.

Fourthly, this study established that physics teachers do not have adequate time to plan ICT integrated lessons since access to ICT facilities within the schools is limited to one hour or less per day.

Lastly, the study revealed inverse relationship between teaching experience and ICT use. This implies that the older the teacher, then the less they are likely to integrate ICT in their lessons. The study further established inverse relationship between teaching experience and competence. This means that the older teachers are less competent in use of ICT and therefore they use less of it in their lessons. This could be due to the fact that when the older teachers were being trained in colleges, use of computers had not picked up in educational institutions and therefore they did not get an opportunity to interact with computers.

5.4 Recommendations

Just like other researches, a number of recommendations were made in this study. Some of the recommendations are for action by stakeholders in education while others are for further research.

5.4.1 Recommendations for Action by Stakeholders

1. Physics teachers in the sample schools were found to be experienced and fairly competent in use of ICT. Both the teachers and students had positive attitudes towards ICT use in teaching and learning of physics. As such, it is recommended that teachers should capitalise on the favourable attitude the learners have towards ICT use in the teaching and learning of physics. This could enhance learners understanding of concepts in the subject and this will motivate them to pursue physics related courses to higher levels.

2. The changing landscape of communications and information exchange in the 21st century requires teachers to be at the cutting edge of knowledge production, modification and application – rather than consumption. They need to be prepared for this by being educated to use ICT effectively and creatively. This study revealed that most of the physics teachers were fairly competent in computer literacy. However, integration of ICT in lesson delivery was low and this could be attributed to inadequate skills to integrate. It is therefore recommended that pre-service training and INSET of teachers should include a component on how to integrate ICT in lesson delivery. These are the two most important supports for ICT integration into teaching and learning.
3. BoM and PTA committees as school managers are charged with the responsibility of provision of teaching/learning facilities. This study revealed that schools in the study sample had inadequate ICT facilities. In view of this finding, it is recommended that the school managers look into ways and means of sourcing for more facilities especially computers, LCD projectors, Internet connection, digital and video cameras.
4. Most of the sample schools did not have well documented policies on ICT integration in teaching and learning. It is recommended that school principals be sensitised on the importance of having well documented ICT policies which should dove-tail into the MoEST ICT policy in education.

5.4.2 Recommendations for Further Research

1. Research could be carried out to determine how various ICT software and hardware are made use of in the teaching and learning process. This study focussed more on whether or not these facilities are used in the teaching and learning process.
2. A similar study could also be carried out in other regions of the republic of Kenya to determine whether findings established by this study also apply. This will serve to strengthen the findings of this study.
3. A study could be carried out to investigate ICT use in other science subjects. This study focussed on use of ICT in the teaching and learning of physics.

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APPENDICES

Appendix 1: Principal's Interview Guide (PIG)

The purpose of this interview guide is to elicit information concerning use of Information and Communication Technology (ICT) in teaching and learning of physics. The information provided will be treated with uttermost confidentiality and used ONLY for the purpose of this research.

Section A: Background information

1. What type is your school?…………………………………………………...

2. What category is your school?..

3. What is your gender?...

4. What is your highest professional qualification?...

5. What is your working experience as a principal?..

6. For how long have been using computers?..

7. For how long have you been using Internet?...

Section B: Competence in computer

8. Have you been trained in computer?...

If yes, where did you train?..

9. How proficient are you in using ICT? (MS word, MS powerpoint, MS excel, among others)……………………………………………………………………

Section C: Management and technical support

10. Do you have an ICT policy to guide and promote use of ICT?........................

If yes, what does it entail?..

11. Does your school have a computer teacher(s)?..

If yes, how does he or she support physics teachers in integrating ICT in teaching? ………………………………………………………………………..

12. How would you describe the ICT situation in your school? (in terms of adequacy of facilities, physics teachers ICT knowledge and skills, use of ICT in teaching and learning)……………………………………………………………

13. How does the school support teachers to use ICT in teaching physics?

……………………………………………………………………………………

14. How did the school acquire ICT facilities? (computers, TV, LCD projector, among others)

……………………………………………………………………………………

…………………………………………………………………………………….

Appendix 2: Physics Teacher Questionnaire (PTQ)

The purpose of this questionnaire is to elicit information concerning use of Information and Communication Technology in teaching and learning of physics. The information provided will be treated with uttermost confidentiality and used **ONLY** for the purpose of this research.

Instructions: This questionnaire consists of sections A to E. All are multiple choices with some sub-sections of structured items. Read each question carefully and answer by ticking (√) or writing response choice on the same questionnaire. Please do not write your name on this questionnaire.

Section A: Background information

1. What is your gender? [0] Male [1] Female
2. To what age group do you belong?

[4] 25 years and below [3] 26 to 30 [2] 31 to 40 [1] 41 to 50 [0] above 51

3. What is your highest professional qualification?

[4] PhD [3] Masters [2] Bachelors degree [1] Diploma [0] S1

4. How many years of experience do you have in teaching physics

[4] More than 24 [3] between 15-24 [2] between 10-14 [1] between 5-9 [0] below 5

5. How long have you been using computers?

[4] More than 5 years [3] 3-4 years [2] 1-2 years [1] below one year [0] None

6. Have you been trained on how to use a computer? [1] yes [0] No
7. Have you been trained on how to integrate ICT in teaching physics? [1] yes [0] No

Section B: Teacher competence in use of ICT

Kindly rate your extent of knowhow in the use of the following by putting a tick in the appropriate column.

Key: [0] poor [1] Fair [2] Good [3] Very good [4] Excellent

	ICT tool	**[0]**	**[1]**	**[2]**	**[3]**	**[4]**
8.	Microsoft office word					
9.	Microsoft office excel (Spreadsheets)					
10.	Microsoft office Powerpoint					
11.	Internet					
12.	Computer printers					
13.	Digital camera					
14.	Video camera					
15.	LCD projector					
16.	Overhead (OHP) projector					
17.	Computer					

Section C: Extent of ICT use in teaching and learning of physics

How often do you use the following ICT tools in the teaching and learning of physics?

Key: [3] Very often (every lesson) [2] often (twice or more per week) [1] rarely (once a week) [0] Never

	ICT Tool	**[0]**	**[1]**	**[2]**	**[3]**
18.	Microsoft office word (Typing schemes of work, lesson plans, e.t.c)				
19.	Internet (Sourcing information in physics)				
20.	Microsoft office excel (spreadsheets). Analyzing students' scores in a test/examination				
21.	Educational CDs e.g. digital content from KIE				
22.	Radio				
23.	Television				
24.	Microsoft office Powerpoint (Multimedia presentation)				
25.	Computer				

26.	LCD projector				
27.	Mobile phones				
28.	Digital camera				
29.	Video camera				

Section D: Management and technical support

30. How many hours per week are computers accessible to you while in school?

[4] More than 5 [3] 3-4 [2] 1-2 [1] less than 1 [0] None

31. How many lessons (both your teaching subjects) do you teach per week?

[4] More than 30 [3] 25- 29 [2] 20- 24 [1] 15-19 [0] below 15

To what extent do you encounter the following challenges when using ICT tools in teaching physics? Indicate your response by ticking in the appropriate column

Key: [4] Very great [3] great [2] little [1] Very little [0] Not at all

	Challenge	**[4]**	**[3]**	**[2]**	**[1]**	**[0]**
32.	Lack of clear plan to access computers in the school					
33.	Slow Internet connection to relevant websites and resources					
34.	Inadequate time to use computers in class					
35.	Frequent power failure/blackouts					
36.	Inadequate number of ICT tools such as computers, printers e.t.c.					
37.	Breakdown of computers, printers and other ICT tools					
38.	Slow and old computers					
39.	Lack of technical support					

Section E: Teachers perception on use of ICT in Teaching/Learning of physics

Please consider each of the following statements and indicate the response that reflects your opinion by ticking (√) in the appropriate column.

Key: 5-strongly agree, 4-Agree, 3- Not sure, 2-disagree, 1-strongly disagree

	Statement	**5**	**4**	**3**	**2**	**1**
40.	Use of ICT enables students to understand physics concepts better					
41.	Use of ICT makes me more effective as a teacher					
42.	I think that using ICT makes it easier to source for instructional materials					
43.	Lesson planning using ICT is time consuming					
44.	Use of ICT may in the long run replace the teacher in the classroom					
45.	Use of ICT may slow down syllabus coverage in physics					
46.	I think that using ICT increases the interest of students towards physics					
47.	The use of computers in teaching and learning of physics is time consuming					
48.	I can do what the computer can do equally as well					

Thank you for sparing your valuable time to respond to this questionnaire

Appendix 3: Physics Students' Questionnaire (PSQ)

The purpose of this questionnaire is to solicit information concerning use of Information and Communication Technology in teaching and learning of physics. The information provided will be treated with uttermost confidentiality and used **ONLY** for the purpose of this research.

Instructions: This questionnaire consists of sections A to E. All are multiple choices with some sub-sections of structured items. Read each question carefully and answer by tick (√) or write response choice on the same questionnaire. Please do not write your name on this questionnaire.

Section A: Back ground information

1. What is your gender? [0] Male [1] Female
2. For how long have you been using computers?
   [4] More than 5 years [3] 3-4 years [2] 1-2 years [1] below one year [0] None
3. For how long have you been using Internet?
   [4] More than 5 years [3] 3-4 years [2] 1-2 years [1] below one year [0] None
4. Have you been trained in using computer? [1] yes [0] No
5. Have you received any training in using Internet? [1] yes [0] No

Section B: Competence in use of ICT

Kindly rate your extent of knowhow in the use of the following ICT tools

Key: [4] Excellent [3] Very good [2] Good [1] Fair [0] poor

	ICT tool	**4]**	**[3]**	**[2]**	**[1]**	**[0]**
6.	Microsoft office word (Word processing)					
7.	Microsoft office excel (Spreadsheets)					
8.	Microsoft office (Powerpoint)					
9.	Internet					

10.	Computer printers					
11.	Scanner					
12.	Mobile phone					
13.	Digital camera					
14.	Video camera					
15.	LCD projector					

Section C: Extent of use of ICT tools in teaching and learning of physics

How often do you use the following ICT tools and facilities in learning physics?

Key: [3] Very often (daily) [2] often (twice or more per week) [1] Rarely (a few times in a month) [0] Never

	ICT tool	**[3]**	**[2]**	**[1]**	**[0]**
16.	Computer				
17.	LCD projector				
18.	Television (e.g. for viewing physics related films, videos and programmes)				
19.	Internet (to source for information in physics)				
20.	Radio (e.g. listening to physics lesson				
21.	Mobile phone e.g. sourcing for information from Internet				
22.	Digital camera (e.g. taking photographs and using them for learning during a physics				

Section D: Management and technical support

23. How many hours per week are computers accessible to you?

[4] More than 5 [3] 3-4 [2] 1-2 [1] less than 1 [0] None

To what extent do you encounter the following challenges when using ICT tools (e.g. computers, TV, Radio among others) in learning physics?

Key: [4] Very great [3] great [2] Little [1] Very little [0] Not at all

	Challenge	[4]	[3]	[2]	[1]	[0]
24.	Lack of clear plan to access computers in the school					
25.	Inadequate time to use computers in class					
26.	Frequent power failure/blackouts					
27.	Inadequate number of ICT tools such as computers, printers, among others					
28.	Breakdown of computers, printers and other ICT tools					
29.	Slow and old computers					
30.	Lack of technical support					

Section E: Perception on use of ICT in T/L of physics

Please consider each of the following statements and indicate the response that reflects your opinion by ticking (√) in the appropriate column.

Key: 5-strongly agree, 4-Agree, 3- Not sure, 2-disagree, 1-strongly disagree

Item	Statement	5	4	3	2	1
31.	Use of ICT makes me understand physics concepts better					
32.	Use of ICT makes learning more enjoyable					
33.	Use of ICT may slow down syllabus coverage in physics					
34.	I believe that tools like e-mail, twitter and Facebook chat make communication with my fellow students easier					
35.	I think that technology supported teaching makes learning more effective					

36.	The use of computers in learning of physics is time consuming					
37.	A computer is a valuable tool for learning physics					
38.	I can still learn physics better without the computer					
39.	The computer is not conducive for learning					
40.	T.V, computer and radio are suitable for use in entertainment and not for learning physics					

Thank you for sparing your valuable time to respond to this questionnaire

Appendix 4: Lesson Observation Schedule

SECTION A: Background information

1. Teacher's gender [0] Male [1] Female
2. Highest professional qualification

   [4] PhD [3] Masters [2] Bachelors degree [1] Diploma [0] others

   Specify if any other…………………………………………
3. Years of experience in teaching physics

   [4] More than 24 [3] between 15-24 [2] between 10-14 [1] between 5-9 [0] below 5
4. Experience in using computers

   [4] More than 5 years [3]3-4 years [2]1-2 years below [1] one year [0] None
5. Experience in using Internet

   [4] More than 5 years [3] 3-4 years [2] 1-2 years below [1] one year [0] None
6. Who types teachers planning documents such as schemes of work and lesson plans?

   [3] Secretary [1] subject teacher [0] they are never typed.

Section B: Lesson preparation

7. Physics topic………………………………………………………………
8. Physics Sub-topic..…………………………………...…………………..

   Indicate the availability of planning documents below by ticking in the appropriate column.

Key: [2] Available and typed [1] Available and not typed [0] Not available

	Planning document	[2]	[1]	[0]
9.	Lesson plan			
10.	schemes of work			
11.	Students worksheets			
12.	hand outs			
13.	other printed materials			

SECTION C: Lesson implementation

Indicate the use of the listed ICT tools/resources by ticking in the appropriate column.

	ICT tool or facility	[1] Used	[0] Not used
14.	Computer		
15.	LCD projector		
16.	Radio		
17.	Internet		
18.	Television		
19.	Digital Camera		
20.	Video camera		
21.	Science digital content CDs/DVDS		

Indicate by ticking in the appropriate column the extent to which instructional method(s) listed below were used during the lesson.

Key: 4 very large extent 3: Large extent 2: average 1: small extent 0: Not at all

	Instructional Method	4	3	2	1	0
22.	Lecture					
23.	Demonstration (By teacher or student)					
24.	Class experiment					
25.	Question -answer					
26.	Project work					
27.	Problem solving					
28.	Field trip					
29.	Dictation of notes					

Appendix 5: Document analysis guide

Name of the School................................ Category of the school.........................

1. Check Store ledgers, inventories to establish the availability, quantity, condition of the listed ICT facilities.

No.	**ICT tool**	**Quantity**	
		Functional	**Spoiled**
1	Computer		
2	LCD projector		
3	Radio		
4	Internet		
5	Television		
6	OHP projector		
7	Digital Camera		
8	Video camera		
9	Science digital content		
10	Others:		

2. Check schemes of work if they are typed by physics teachers and if schemes include ICT related resources. Fill in the table below

School code	Schemes of work Typed by physics teachers (yes/No)	Scheme included ICT Related T/L materials (yes/No)
A		
B		
C		
D		
E		
F		
G		
H		
O		
P		
T		

Appendix 6: Public Secondary Schools in Kimilili District

Code	SCHOOL	CATEGORY	ZONE	AVAILABILITY OF
A	Friends School Kamusinga	National	West	Yes
B	Moi Girls Kamusinga	County Girls	West	Yes
C	Kimilili Boys	County Boys	Central	Yes
D	Chesamisi Boys	County Boys	East	Yes
E	Kamusinde Secondary	County Boys	East	Yes
F	Maeni Girls	District Girls	Central	Yes
G	St. Mary's Sosio	District Girls	East	Yes
H	St. Theresa's Girls	District Girls	Central	Yes
I	Kimilili Friends Girls	District Girls	West	Yes
J	Bituyu Secondary	District Mixed	Central	Yes
K	Kibingei Friends	District Mixed	West	Yes
L	Namawanga Bahai	District Mixed	Central	No
M	Wamalwa Kijana Sec	District Mixed	East	No
N	St. Peters Nakalira	District Mixed	East	No
O	St. James Mapela	District Mixed	East	Yes
P	Chesamisi Girls	District Mixed	East	Yes
Q	St. Emmanuel Miruri	District Mixed	West	No
R	Chebukwabi Secondary	District Mixed	West	No
S	Matili Secondary	District Mixed	Central	Yes
T	Sikhendu Secondary	District Mixed	Central	Yes
U	St. Joseph's Kamusinde	District Mixed	East	No
V	Friends School Kamasielo	District Mixed	Central	Yes
W	St. Jan Namboani	District Mixed	East	No

Source: DEOs office, Kimilili District (2012)

Appendix 7: Guide to Interpretation of Data

1. To investigate the extent of ICT integration in teaching and learning of physics.

Mean rating	Comment
$2.25 < x \le 3.0$	Very High
$1.5 < x \le 2.25$	High
$0.75 < x \le 1.5$	Moderate
$0 \le x \le 0.75$	Low

2. To investigate the extent of school management and technical support given to physics teachers in integrating ICT in teaching and learning.

Mean rating	Comment
$2.5 < x \le 4$	Low support
$2 < x \le 2.5$	Moderate support
$0 \le x \le 2$	Big support

3. To establish the attitude of School principals, physics teachers and students towards the use of ICT in teaching and learning of physics.

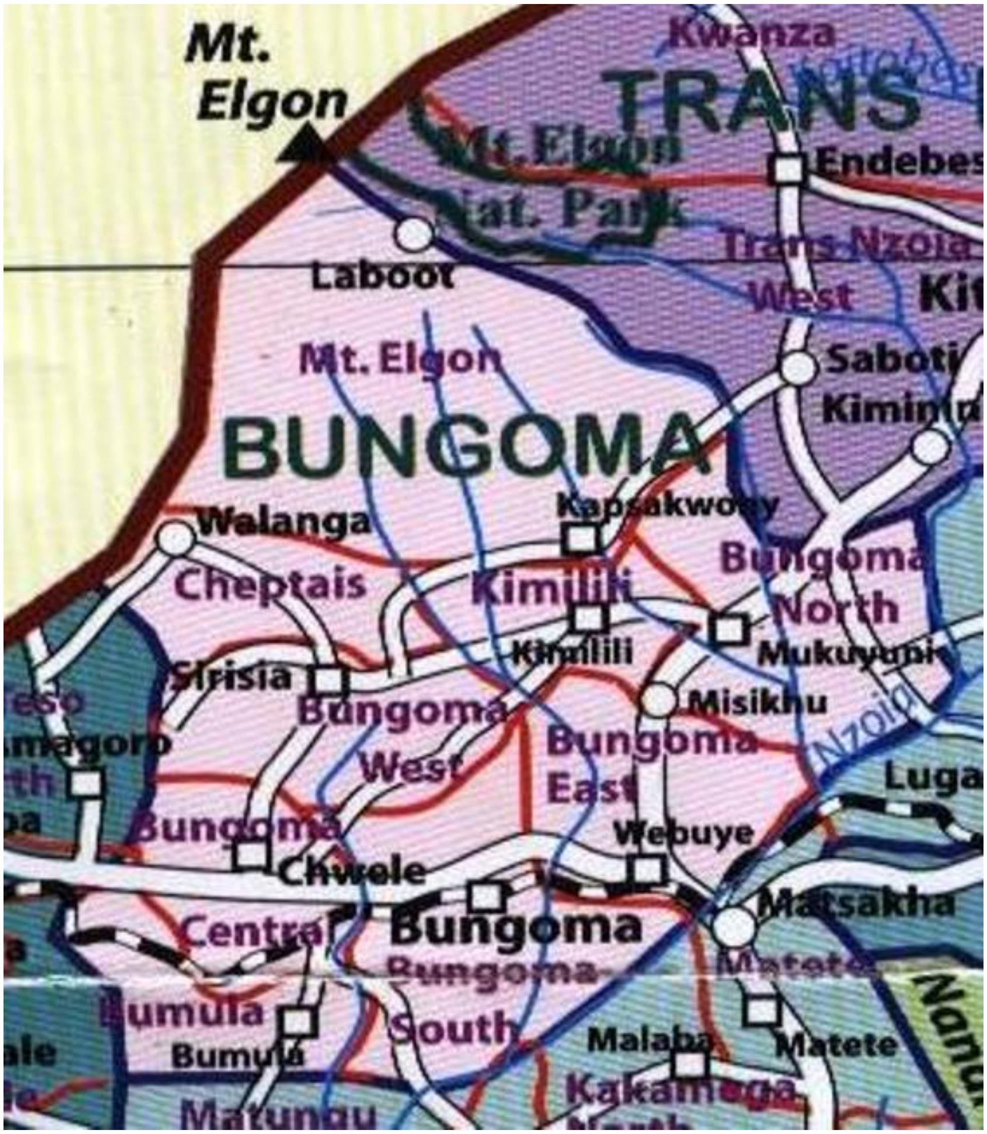
Mean rating for positive items	Comment	Interpretation
$3 < x \le 5$	High	Favorable attitude
$1 \le x < 3$	Low	Unfavorable attitude
Mean rating for Negative items	Comment	Interpretation
$3 < x \le 5$	Low	Unfavorable attitude
$1 \le x < 3$	High	Favorable attitude

4. To investigate how competent physics teachers are in using ICT tools.

Mean rating	Comment
$3.4 < x \le 4$	Excellent
$2.4 < x \le 3.4$	Very good
$1.4 < x \le 2.4$	good
$0.4 < x \le 1.4$	Fair
$0 \le x \le 0.4$	Poor

Source: Adapted from Wakhaya (2010)

Appendix 8: Map of Bungoma County



Source: Albert K. Inima (2011)

Appendix 9: Research permit

THIS IS TO CERTIFY THAT:
MR. MAKANDA JOHN LIVINGSTONE
of KENYATTA UNIVERSITY, 24214-502
nairobi,has been permitted to conduct
research in *Bungoma County*

on the topic: *USE OF ICT IN TEACHING PHYSICS: A CASE OF SECONDARY SCHOOLS IN KIMILILI DISTRICT, BUNGOMA COUNTY, KENYA*

for the period ending:
31st August,2014

Permit No : NACOSTI/P/13/9572/181
Date Of Issue : 25th October,2013
Fee Recieved : Kshs khs1000.00

....
Applicant's Signature

....
Secretary
National Commission for Science, Technology & Innovation

Appendix 10: Research Authorization letter

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:

25th October, 2013

NACOSTI/P/13/9572/181

Makanda John Livingstone
Kenyatta University
P.O.Box 43844-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on "***Use of ICT in teaching Physics: A case of secondary schools in Kimilili District, Bungoma County,***" I am pleased to inform you that you have been authorized to undertake research in **Biungoma County** for a period ending **31st August, 2014.**

You are advised to report to **the County Commissioner and the County Director of Education, Bungoma 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
Bungoma County.

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