INTEGRATION OF INFORMATION, COMMUNICATION AND TECHNOLOGY IN TEACHING AND LEARNING OF PHYSICS IN SECONDARY SCHOOLS IN TIGANIA WEST SUB-COUNTY, KENYA

BY

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OCTOBER, 2014
DECLARATION

I declare that this thesis is my original work and has not been presented in any other university/institution for consideration of any certification.

Signature ...................................... Date..............................................

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Reg No. E55/ CE/11548/2008

We confirm that, this work reported in this thesis was carried out by the candidate under our supervision as University Supervisors.

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DEDICATION

This work is dedicated to my son Brian and my wife Emily, who had to bear with my absence during my studies, to my late dad Joseph M’ithili who departed so soon and to my mum Mary Kirito whose effort and encouragement has made me a gentleman through her guidance, prayer and support.
ACKNOWLEDGEMENT

May I thank my supervisors Dr. D. Oludhe and Dr. M. Nasibi for firm and devoted support, which included guidance, encouragement, materials and resources, analyzing of my work and timely feedback. You all cared and shared ideas and suggestions throughout. I would like to acknowledge the support given to me by various individuals who made it possible for me process that I was undergoing for your permission to go out of workstation time after time. Moreover, I acknowledge Tigania West District’s physics teachers from various schools and the computer specialists, students and their respective principals for responding to the questionnaires and the interview schedules promptly. In addition, I thank my family members; my wife Emily who tirelessly supported me and encouraged me during the hard times. May I thank my son Brian, who understood the time spent away from him. SON! This is how I spent that time away from you. Finally and most importantly, I thank God for giving me the strength, good health and wisdom to do this work successfully, may the Grace of the Lord be with you all.
TABLE OF CONTENTS

Declaration ........................................................................................................................................... i
Dedication ............................................................................................................................................. ii
Acknowledgement .............................................................................................................................. iii
List of Tables ......................................................................................................................................... x
Table of Figures .................................................................................................................................... xi
List of Abbreviations ........................................................................................................................... xii
List of Achronymes ............................................................................................................................ xiv
Abstract ............................................................................................................................................... xv

CHAPTER ONE ..................................................................................................................................... 1
INTRODUCTION ................................................................................................................................. 1
1.0 Introduction .................................................................................................................................... 1
1.1 Background to the Study ............................................................................................................... 1
  1.1.1 ICT infrastructure .................................................................................................................. 1
  1.1.2 ICT Pedagogy ....................................................................................................................... 2
  1.1.3 ICT Integration Barriers ....................................................................................................... 4
  1.1.4 ICT Competencies ............................................................................................................... 5
  1.1.5 Use of ICT in teaching Physics ............................................................................................ 7
1.2 Statement of the Problem ............................................................................................................. 10
1.3 Purpose of the Study .................................................................................................................... 11
1.4 Objectives of the Study .............................................................................................................. 11
1.5 Research Questions ..................................................................................................................... 12
1.6 Significance of the Study ........................................................................................................... 13
1.7 Assumption ................................................................................................................................. 14
1.8 Limitations ............................................................................................................. 14
1.9 Delimitation ........................................................................................................... 14
1.10 Theoretical Framework ....................................................................................... 15
1.11 Conceptual framework ......................................................................................... 19
1.1.2 Operational Definition of Terms ...................................................................... 23
CHAPTER TWO ........................................................................................................... 24
LITERATURE REVIEW ............................................................................................ 24
2.0 Introduction ........................................................................................................... 24
2.1 The Role of Physics in Society ............................................................................. 24
2.2 Challenges of teaching and learning Physics ..................................................... 26
2.3 Nature of ICT ....................................................................................................... 28
2.4 ICTs in Developing Countries ............................................................................. 28
2.5 Development of ICT in Kenya ............................................................................. 31
2.6 ICT in Education .................................................................................................. 33
2.7 ICTs in schools ..................................................................................................... 35
2.8 ICT Tools for Teaching Physics ........................................................................... 37
2.9 Learning theories in support of ICT use ............................................................ 38
2.9.1 Behaviorism ..................................................................................................... 38
2.9.2 Cognitive .......................................................................................................... 39
2.9.3 Constructivism .................................................................................................. 39
2.9.4 Experimentalist ................................................................................................ 40
2.10 ICT Competency Skills ....................................................................................... 40
2.11 Computer Competence ....................................................................................... 40
2.12 Teacher Beliefs and Practices in the Use of ICTs .............................................. 44
2.13 Students Attitude towards the Use of ICTs ............................................. 27
2.14 Accessibility to the ICT Infrastructure .................................................. 49
2.15 Factors Affecting Teachers’ Use of ICT ............................................... 51
2.16 Teachers’ Characteristics .................................................................... 52
2.17 Availability of a strategic plan for ICT integration ............................... 55
2.18 Computer Attributes .......................................................................... 57
2.19 Effective Training Program ................................................................ 58
2.20 Models for Integrating Technology into Teacher Training Programs .... 59
2.21 Preparedness in Integration of ICT in Classroom .................................. 62
2.22 Related Studies .................................................................................. 64
2.23 Conclusion .......................................................................................... 67

CHAPTER THREE ......................................................................................... 69

RESEARCH METHODOLOGY .................................................................... 69

3.0 Introduction .......................................................................................... 69
3.1 Research Design .................................................................................. 69
3.2 Location ............................................................................................... 70
3.3 Variables ............................................................................................... 71
3.4 Target Population ................................................................................ 71
3.5 Sample Procedure and Sampling Grid .................................................. 72
3.6 Data collection Method ....................................................................... 74
3.6.1 Questionnaires ................................................................................ 74
3.6.2 Questionnaire Construction and Organization of Items ................... 75
3.6.3 Interview Guide ............................................................................... 76
3.6.45 Observation Guide ......................................................................... 77
3.7.0 Pilot Study ............................................................................................ 78
3.7.1 Validity .................................................................................................. 78
3.7.2 Reliability ............................................................................................... 79
3.8 Data Collection Techniques ................................................................. 80
3.9 Research Procedure ............................................................................... 81
3.10 Logistical and Ethical Consideration ............................................... 82
3.11 Conclusion .............................................................................................. 83
CHAPTER FOUR ............................................................................................ 84
DATA ANALYSIS, RESULTS OF FINDINGS AND DISCUSSION ...................... 84
4.0 Introduction ............................................................................................. 84
4.1 Biographical data .................................................................................... 85
4.1.1 Biographical data by Sex .................................................................... 85
4.1.2 Teachers Age distribution ................................................................. 86
4.1.3 Academic Qualification .................................................................... 87
4.1.4 Teaching Experience ......................................................................... 87
4.2 Teachers level of ICT expertise ............................................................ 89
4.4 Attitude of use of ICT by respondents ............................................... 93
4.5 Availability of ICT Resources ............................................................... 97
4.5.1 Type of computer available ............................................................. 98
4.5.2 Processor speed ................................................................................ 99
4.5.3 Storage capacity .............................................................................. 100
4.5.4 Peripheral devices ........................................................................... 101
4.5.6 Software and CD resources ............................................................. 102
4.6.1 Accessibility ...................................................................................... 103
List of Tables

Table 3.1 Demographic Information of Tigania West ......................................................... 70
Table 3.2 Sampling Grid.....................................................................................................73
Table3.3 Students Percentage per school ............................................................................74
Table 3.4 Questionnaire Organisation..................................................................................75
Table 3.5 Validitors rating ..................................................................................................79
Table 4.1 Respondents Participation by Gender .................................................................84
Table 4.2 Distribution of Participants Age by Gender .........................................................85
Table 4.3 Level of Education ..............................................................................................86
Table 4.4 Years of Experience .........................................................................................87
Table 4.5 Level of ICT Skills ..............................................................................................88
Table 4.6 Students ICT skills ............................................................................................89
Table 4.7 Percent of Students Computer skills by Gender ..................................................92
Table 4.8 Availability of Computers in Schools .................................................................98
Table 4.9 Computer Processor Type ..................................................................................98
Table 4.10 Peripheral Devices ..........................................................................................101
Table 4.11 Available software for Teaching Physics ..........................................................103
Table 4.12 Accessibility of ICT Facilities by Teachers ......................................................105
Table 4.13 Location and Frequency of Computer use by Teachers ....................................106
Table 4.14 Teachers use of Computers .............................................................................108
Table 4.15 Students use of Computers .............................................................................109
Table 4.16 Quantity of Computer use by Teachers .............................................................110
Table 4.17 Frequency of Computer use by Teachers .........................................................112
Table 4.18 Focus of use of Internet by Teachers .................................................................113
Table 4.19 Factors that Hinder ICT Integration .................................................................114
Table of Figures

Figure 1.1 Interrelationship of Learning Theories........................................... 16
Figure 1.2 The Relationship between Independent and Dependent Variables ....... 20
Figure 4.1 ICT enhances learning of Physics...................................................... 94
Figure 4.2 ICT helps to Meet Various Needs of the Students............................ 95
Figure 4.3 ICT Helpss in lesson Planning and Development................................. 95
Figure 4.4 Use of ICT makes the Lesson Enjoyable........................................... 96
Figure 4.5 Processor Speed................................................................................ 99
Figure 4.6 The Storagy capacities ................................................................. 100
Figure 4.7 Percent of Computers Per Location.................................................. 104
Figure 4.8 Focus of CIT use in schoools ....................................................... 108
Figure 4.9 Computer use by both Teachers and Students................................. 111
**LIST OF ABBREVIATIONS**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>CAS</td>
<td>Computer Assisted Scale</td>
</tr>
<tr>
<td>CD</td>
<td>Compact Disc</td>
</tr>
<tr>
<td>CD-ROM</td>
<td>Compact Disk Read Only Memory</td>
</tr>
<tr>
<td>CFSK</td>
<td>Computer for Schools Kenya</td>
</tr>
<tr>
<td>CLDS</td>
<td>Computer Laboratories Design Standards</td>
</tr>
<tr>
<td>CS</td>
<td>Computer Specialist</td>
</tr>
<tr>
<td>DEO</td>
<td>District Education Officer</td>
</tr>
<tr>
<td>DVD</td>
<td>Digital Versatile Disk</td>
</tr>
<tr>
<td>DVD-ROM</td>
<td>Digital Versatile Disk Read Only Memory</td>
</tr>
<tr>
<td>GB</td>
<td>Giga Byte</td>
</tr>
<tr>
<td>GoK</td>
<td>Government of Kenya</td>
</tr>
<tr>
<td>HIV</td>
<td>Human Immunodeficiency Virus</td>
</tr>
<tr>
<td>HOD</td>
<td>Head of Department</td>
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<tr>
<td>ICTB</td>
<td>Information Communication and Technology Board</td>
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<tr>
<td>ICT</td>
<td>Information Communication and Technology</td>
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<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>KICD</td>
<td>Kenya institute of Curriculum Development</td>
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<tr>
<td>KIE</td>
<td>Kenya Institute of Education</td>
</tr>
<tr>
<td>KCSE</td>
<td>Kenya Certificate of Secondary Education</td>
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<tr>
<td>KNEC</td>
<td>Kenya National Examination Council</td>
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<tr>
<td>MBL</td>
<td>Microcomputer Based Laboratories</td>
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<tr>
<td>MDG</td>
<td>Millennium Development Goals</td>
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<tr>
<td>Abbreviation</td>
<td>Description</td>
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<td>--------------</td>
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<tr>
<td>MOE</td>
<td>Ministry of Education</td>
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<tr>
<td>MHZ</td>
<td>Mega Hertz</td>
</tr>
<tr>
<td>MS</td>
<td>Microsoft Software</td>
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<tr>
<td>NGO</td>
<td>Non-Governmental Organization</td>
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<tr>
<td>OLPC</td>
<td>One Laptop per Child</td>
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<tr>
<td>PC</td>
<td>Personal Computer</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical Software for the Social Sciences</td>
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<tr>
<td>TLP</td>
<td>Teaching and Learning Process</td>
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<tr>
<td>TPB</td>
<td>Theory Planned Behaviour</td>
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<tr>
<td>TTI</td>
<td>Teachers Training Institute</td>
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<tr>
<td>USB</td>
<td>Universal Serial Bus</td>
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<tr>
<td>XP</td>
<td>Extended Programming</td>
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### LIST OF ACRONYMS

<table>
<thead>
<tr>
<th>Acronym</th>
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<tbody>
<tr>
<td>AIDS</td>
<td>Acquired Immune Deficiency Syndrome</td>
</tr>
<tr>
<td>EFA</td>
<td>Education for All</td>
</tr>
<tr>
<td>Modem</td>
<td>Modulator Demodulator</td>
</tr>
<tr>
<td>NEPAD</td>
<td>New Partnership for African Development</td>
</tr>
<tr>
<td>RAM</td>
<td>Random Access Memory</td>
</tr>
<tr>
<td>SMASSE</td>
<td>Strengthening Mathematics, Science Subjects Education</td>
</tr>
<tr>
<td>UNESCO</td>
<td>United Nations Educational, Scientific and Cultural Organization</td>
</tr>
<tr>
<td>MOEST</td>
<td>Ministry of Education Science and Technology</td>
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ABSTRACT

This research investigates the extent to which teachers and students of physics utilize ICT as a pedagogical tool in secondary schools in Tigania West District. The development of this study was influenced by various concerns of educational stakeholders about the ICT integration in schools and the competence on the use of ICT as a pedagogical tool. Using constructive theory as a theoretical eye, a survey was carried out in twelve schools that were purposively selected from 40 schools in the district. In total, 152 participants were involved; 120 students, 20 teachers, six computer specialists/computer teachers and six principals. The data collection methods involved were questionnaires, observation and interview schedules. The data was analyzed using simple percentages and presented using charts, graphs, maps and tables. It was found that ICT has a positive impact on teaching and learning of physics. Further, it was revealed that, despite the fact that the schools are well equipped with ICT facilities and that teachers have positive attitudes towards the use of ICT as a pedagogical tool, they did not integrate ICT in teaching and learning effectively. The researcher concluded that availability, accessibility and user-ability of ICT resources significantly affect the integration of ICT in curriculum. Besides, ICT use as a pedagogical tool among teachers and students was found to be a problem that was attributed to lack of ICT integration skills and strategies in schools. Therefore, based on the above findings, the researcher recommends that the schools to design an ICT strategy that aims at equipping teachers and students with knowledge and skills required for ICT integration. Secondly, there is need for the schools to invest more in computers and related technology so that the access to ICT tools cannot be limited only in labs and library but expand through establishment of ICT resource centre’s and availing at least one computer in each classroom. In addition, ICT training should not be limited to Ms Office suites but rather aim at training students with the appropriate skills to use ICT for their learning. Finally, there is a need for further in-depth investigation on teachers’ willingness, confidence, motivation, feeling, thinking, belief and the actual practices through classroom observations. The study findings are thought to be of eminence importance to teachers, students, school administrators and the educational policy-makers in Kenya.
CHAPTER ONE

INTRODUCTION

1.0 Introduction
This chapter begins with the context of the study, which includes the background to the problem, the statement of the problem, the significance of the study, research questions, objectives, limitations, assumptions, theoretical, conceptual framework and operational definition of terms.

1.1 Background to the Study
The purpose of this study was to provide a deep understanding about ICT as a pedagogical tool. Within this broad aim, the study intended to explore the extent to which computers are utilized by teachers’ and students as a pedagogical tool. The study was triggered by various concerns from educational shareholders that teacher are not aware of the potentials that technology offers in pedagogy (Mselle, 2012).

1.1.1 ICT Infrastructure
The use of modern technological tools such as computers and internet is still in its infancy stage in most developing countries including Kenya. It is argued that less has been done to integrate Computers in education. Most developing countries are currently developing ICT policies (Hare, 2007; Moonen, 2008; Tilya, 2008) which in most educational practices, their impacts are found to be inconsequential (Ottevanger, Van den Akker & Feiter, 2007). These policies seem to place a great deal of emphasis on providing ICT infrastructure to secondary and primary schools (Gaible and Burns, 2005) rather than their use in pedagogy (Unwin,
In the light of the discussion about stakeholders concerns, ICT refers to the applications found on most thin client computers, internet and other electronic delivery systems such as radios, digital televisions and projectors among others, that secondary school teachers can use as pedagogical tools. ICT as a pedagogical tool is regarded as the use of ICT facilities in teaching and learning process which involves the use of software application to solve problems, to provoke student capabilities, to create products or communicate and share their perspectives with each other (Jonassen, 2008). In the context of the present study, it is the ability of teachers to access information, create solutions, analyze and apply knowledge in teaching and learning process.

1.1.2 ICT Pedagogy
A number of international studies have shown that secondary school teachers lack competencies on the use of ICT as a pedagogical tool in teaching and learning process (Nihuka, 2011). In many schools, students are still being taught what students were taught in the 1950’s and in the same ways because of ineffective use of ICT as a pedagogical tool (Tapscott, 1998; Knight et al, 2006). The study by Condie and Livingston (2007) found that while some teachers continue to display a reluctance to engage with new technology, others remain fearful of trying new approaches which they perceive might have a negative impact on examination results. Making use of technology to support learning and teaching and using more constructivist approaches appear to be perceived as risky strategies for some teachers and they prefer to stick with tried and tested methods which they believe enable them to predict and control outcomes more easily. The
research study by Mlambo (2007) on ICT in A-level physics teaching and learning at secondary schools in Manicaland Zimbabwe found the absence of good examples of the best practice in the use of ICT in teaching physics as there were few teachers even remembered to when they typed notes for students or searched for old examination papers. He found physics teachers using traditional instructional methods mainly the lecture method and note dictation. This implies that ICT is not effectively used as a pedagogical tool in teaching. In the other study by Wong et al (2008) on insights into innovative classroom practices with ICT in China, it was found that ICT was not a critical tool to transform teaching and learning. It should be noted that ICT as pedagogical tool involves the use of software application to solve problems, to extend student capabilities, to create products or communicate and share their perspectives with each other (Jonnassen et al., 2008). There are various evidences which indicate that some teacher in secondary schools use ICT as a pedagogical tool while others are reluctant to use it. The study by Almadhour (2010) on the integration of ICT in pedagogy by secondary school teachers in teaching in New Zealand, identified tools such as Internet, Digital Cameras, video, video cameras and video players as pedagogical tools. The study found that these tools were used in teaching but the most tool used was the Internet. Cameras were used only to make photo and video of researched activities. The study by Afamasaga-Wright (2008) on teacher perceptions of ICT in secondary school in Samoa reveals the similar findings that the internet was mostly used by teachers to search information for teaching. The
study shows that videos were used too as a history teacher used it to present “conflict of the world”.

1.1.3 ICT Integration Barriers
A study in Singapore by Teo (2006), on the observations of ICT-mediated lessons identified several barriers to teacher ICT-integration in the classroom. These barriers involves inadequate appointment of technical support staff, inadequate appointment and training of student ICT helpers, lack of sufficient time for teachers to prepare for ICT-mediated lessons, insufficient collaboration among teachers in preparing ICT-mediated lessons, lack of support provided by school leaders in addressing teachers’ ICT concerns, and insufficient training and demonstrations or advice for teachers on how to incorporate ICT into classroom instruction. The study in Cyprus by Dirckinck-Holmfeld, Hodgson, Jones, de Laat, McConnell and Ryberg, (2010) shows that curriculum and school manuals do not include ICT integration; there is lack of supporting materials for each learning unit. Teachers, therefore, need to spend excessive amounts of time to find, assess, revise and adjust learning materials, activities and tools to fit to the needs of their students and the curriculum. Peeraer and Van Petegem (2009), assert that important barriers to use of ICT in teaching and learning are the teacher educators’ computer skills and confidence in using ICT. However lack of exposure to lessons fully-designed with ICT tools, lack of opportunities to try ICT, the need to practice in a technology laboratory, lack of educational technology teachers, an exam-driven educational system and studying to learn only what is to be tested were some of the underlying reasons for the prospective
teachers’ negative perceptions of ICT use in the teaching process (Hismanoglu, 2012).

1.1.4 ICT Competencies

Nowadays, there is an enormous pressure on the schools from the society, and from the media to ensure that students are competent in the area of learning technologies. The majority of the teachers tend to change their attitude and introduce new ICT tools and technologies into their Physics classes. Currently, in most countries ICT is conceived to be a facilitator of development. Many of the productivity gains in the developed world economies are attributed to the impact of ICT. UNESCO Bangkok (2003). Similarly, the ability to utilize and integrate ICT in education has become the norm of the 21st century teacher, as ICT is already an obvious in every sphere of life. The vast amount of information, communication and collaboration available through ICT has given teachers the opportunity in becoming experts in their fields that would satisfy the demands of educational challenges for the 21st century. On the same note, using ICT in education cannot be avoided as it is a high intensity tool that empowers teachers and learners to do new things and existing things and more efficiently.

Even though many countries are struggling to embrace ICT in teaching, in the developing countries, there are no enough evidences of how successful this integration is. The available studies show poor applications of ICT as a pedagogical tool among secondary school teachers. For instance, the study in Kenya by Nyarusy (2006) focused on the application of ICT in teaching and learning in private secondary schools. It was found that lack of financial resources
was the major problem facing most of these schools. The problem was found to have caused a series of other problems in schools such as inadequate IT facilities, lack of IT teachers, lack of internet connectivity and unsatisfactory teachers’ remuneration. It was further found that power fluctuation, uncompleted syllabi and some schools using old syllabus were the problems that hindered IT effectiveness in schools. Mselle (2012) outlines some obstacles which need to be addressed in order to initiate a meaningful move towards the use of ICT in teaching in Kenya. These obstacles include inadequate national ICT and electricity infrastructure especially in the rural areas. The telecommunication network is limited to the main cities and internet access costs are still high; making it difficult for schools to access and afford ICT infrastructure which not an exemption in Kenya. These capacity constraints include lack of coordination of ICT activities, limited information sharing, limited skills for integration of ICT; lack of scheme of services for ICT trained personnel and ineffective organizational structures. These obstacles affect teachers’ training as well as the use of ICT as a pedagogical tool in the classroom by teachers. In South Africa (one of the developed countries in Africa), the potential that ICT can have on enhancing and improving the quality of education have been acknowledged. Various ICT initiatives have seen the light trying to integrate and maintain the use of ICT (Gauteng online; 2003 Intel E- Education, 2003). Correspondingly, the Government of Kenya (G o K) appreciates and recognizes the potential contribution of ICT towards national development. For instance, it has initiated the use of ICT through the education policies such as session paper No.1
(2005:67) that contends, “Technology is a critical form of wealth to any nation… innovation, research development and science and technology will form one of the key pillars of education and training”. (MOEST session paper No.1 2005).

1.1.5 Use of ICT in Teaching Physics

The study of Physics involves the pursuit of truth; hence, it inculcates intellectual honesty, diligence, perseverance and observation in the learners (Das, 1985). The teaching of Physics provides the learners with understanding, skills and scientific knowledge needed for scientific research, fostering technological and economic growth in the society, where they live thus improving the standards of living (Kenya Institute of Education K.I.E., 2002 currently Kenya Institute of Curriculum Development KICD). Although, science is essential for industrialization, there has been a decline in academic achievement scores of secondary school students as well as low enrolment in the subjects in Kenya (Kenya National Examination Council (KNEC, 2009). Students shun Sciences particularly Physics when given an option girls (Aduda, 2003). That is, given a choice a student would rather drop Physics in favor of other Science subjects. For a long time, Physics has been mystified as difficult and hence, some schools do not offer it to form three and four. This situation does not support Kenya’s move towards attainment of Millennium Development Goals (MDG) and vision 2030 (session paper 1 of 2005). The concern is that the performance in Physics is poor and the subject is less popular among students in Kenyan secondary schools as compared to other science subjects. The persistent complain heard every time the National examinations are released is that performance in science is low. Since
2003, the government has been implementing a new curriculum in both primary and secondary schools, and has a new examination format (KNEC, 2005). This new format makes a deliberate attempt to lure students to take Physics (Orende & Chesos, 2005). Although the government has done its part, the role of the teacher in the classroom is important. The Teaching approach that a teacher adopts is one factor that may affect students’ achievement (Mills, 1991). Therefore, use of appropriate teaching method merged with appropriate technology is critical to the successful teaching and learning of Physics. It was thought that, incorporation of ICT in teaching and learning Physics would probably make the subject more popular. That is why in schools, universities, and in work life, the question of how to utilize modern ICT for learning purposes is an important question for anyone with a stake in education since new technologies are spreading rapidly. In Africa, most of the countries have embraced use of ICT in every sector. Rwanda for example, is envisioned to become a middle-income country by the year 2020. To achieve this, the government has identified the use of ICTs as the key tool in transforming the economy. As a result, promoting ICT in all sectors is well articulated in policy documents starting with Vision 2020. The Vision plan centers on creating a prosperous knowledge-based economy’ based on information and communication technologies thus hoping to make Rwanda the ICT hub of Africa, among other things. In the plan it is, however acknowledged that, there is a low rate of adoption and integration of science and technology in the socio-economic life of the country. Equally highlighted is the shortage of technically qualified professionals at all levels. In order to revolutionize this, the
education sector is expected to play a key role of developing and training required human resources, (Centre for commonwealth Education; 2010). Rwanda has introduced, the one laptop Per Child (OLPC) project, which was officially launched in October 2008 and has supplied over 5000 laptops to primary schools in three districts. These low-power and low-cost laptops are supplied free of charge to public primary schools whilst privately owned schools can purchase the same at a subsidized fee. The overall aim is to equip every child at primary school level with a laptop in the future to make it computer literate. (Centre for commonwealth Education; 2010). In Kenya, the government has introduced rural electrification program that has enhanced access to electricity by educational institutions thus facilitating wide use of ICT in marginalized rural areas (National ICT strategy for Education and Training 2006). In addition, MOEST has developed a national capacity for curricula design in all education and training sub-sectors to facilitate the use of ICT in service delivery so that access to quality educational services for learners at all levels of the education system is broadened (National ICT strategy for Education and Training 2006). Moreover, it has developed a capacity for computer assembly, and development of hardware and software instructional materials to support e-learning through Kenya Institute of Education (KIE) currently known as Kenya institute of Curriculum Development (KICD) . Teachers Service commission in partnership with Safaricom and Equity bank have introduced a special package for teachers to acquire laptops at affordable rates through check off (hire purchase). Besides, the Information Communication and Technology Board (ICTB) introduced a program to enable
college and university students to acquire quality laptops that are subsidized by the government (National ICT strategy for Education and Training 2006). Consequently, ICT has made deep inroad to teaching and learning among Kenyan schools. It has a direct role to play in education and if appropriately used, ICT can bring many benefits to the classroom and the education process in general. The commitment to the use of computers in schools was recently made concrete when the MOEST offered funds to 213 secondary schools, to equip their ICT facilities nationwide. Three schools in Tigania west district benefited from this initiative (National ICT strategy for Education and Training 2006). What is not known is how these computers are being used in these selected schools, and more particularly if they are being used for teaching and learning of Physics.

1.2 Statement of the Problem
Students learning remain central in any academic achievement debate. ICTs provide a window of opportunity for educational institutions and other organizations to harness and use technology to complement and support the teaching and learning process. However, despite the enormous advocacy of ICT aided teaching and learning, investment and donation of ICT equipment to schools within Tigania West sub-county still faces the challenge of how to transform students learning process to provide students with the skills to function effectively in this dynamic, information-rich, and continuously changing environment. The cause of concern is that unless this problem is addressed, investment in the development of ICT in the schools is going to be put to waste and improvement in the quality of teaching and learning is going to be sluggish.
This may make the schools fail to achieve its mission and to produce learners who are ready for the world of work which is increasingly reliant on ICT aided generation and dissemination of knowledge. In view of this discrepancy, there is need to examine the particularly how ICT has been integrated in teaching and learning of Physics in Tigania west sub-county secondary schools.

1.3 Purpose of the Study
The main purpose of this study is to evaluate the overall use of ICTs in the teaching and learning of Physics in Tigania West District of Meru County, Kenya. It takes into account the reference to the following; the level of ICT use by students, teachers and administrators, determine perceived competency and perception of ICTs, describe the challenges faced by teachers in ICT use and identify Physics teachers’ and students training and support needs. Furthermore, an effort will be made to gather information on levels of access, provision and use of ICT by teachers, school managers and students within and out of schools, as well as their attitudes towards its use in learning of Physics.

1.4 Objectives of the Study
This study seeks to fulfill the following objectives:

I. To assess the ICT skills of Physics teachers in Tigania west district

II. To assess ICT skills of students in Tigania west district

III. To find out teachers’ and students’ attitude towards the use of ICT in teaching and learning Physics

IV. To determine availability of ICT resources for teaching and learning Physics in secondary school
V. To determine, the accessibility of ICT resources to both Teachers of Physics and students

VI. To establish the extent of computer use by teachers and students in teaching and learning of physics

VII. To find out, the challenges facing Teachers of Physics in integration of ICT in their respective schools

1.5 Research Questions
The study was guided by the following research questions

II. What training levels in ICT do Teachers of Physics in Tigania West District possess?

III. Are the Physics students’ possessing adequate ICT skills to enable them in learning?

IV. What ICT hardware and software equipment’s are available in the schools?

V. What is the focus of computer use by the schools, teachers and students?

VI. How often do teachers use ICT in teaching and learning of Physics in a week, a month and a term?

VII. What challenges are teachers and students of Physics face while using ICT in classroom?

VIII. To what extent do the teachers of Physics use ICT in teaching and learning purposes?

IX. To what extent do the students use ICT in learning Physics?
1.6 Significance of the Study
This study is of significance to the field of education and technology as it expands
the ICT knowledge base. The concept of ICT as a pedagogical tool is new to most
teachers and students in secondary schools in Kenya. The findings of this research
study have the following benefits: Firstly, the study investigated teachers’ use of
ICT as pedagogical tool in teaching physics secondary schools, looking at the
attitudes. The findings impacted the way ICT is used as a pedagogical tool in
schools in Kenya. Therefore, the study is significant to educators who want to
learn more about the use of ICT. Secondly, the findings of the present study are
expected to create awareness among teachers on the importance ICT as a
pedagogical tool and change their attitudes and practices by improving their
professional practices in teaching. Thirdly, the findings add new knowledge to the
existing literature in Kenya since there are little ICT related researches. Fourthly,
the findings may serve as reference points for educational stakeholders in other
parts of the world that would lead to improvement of provisions of education
among secondary school teachers.
In addition, introduction of ICTs in schools is very costly in terms of installation
and maintenance of both the hardware and software. With this rise in the cost of
implementation and demand, there is a need to evaluate the effectiveness of
technology in education. Therefore, a proper evaluation of the use of the ICTs in
teaching and learning will help us to learn from the experiences, improve on the
current programs, plan and allocate adequate facilities, evaluate policies and
demonstrate results as a part of accountability to key education stakeholders.
Moreover, the funds that the donors, partners and stakeholders provide would like to know through the performance indicators whether they targeted goals and objectives have been achieved.

1.7 Assumption
This study is dependent on the assumption that, computers available in the schools are used for ICT integration in teaching and learning process.

1.8 Limitations
This study limits itself to the following. First, it limits the participants to the Physics teachers, Physics students and computer specialists in each school. On the same note, it is apparent that school heads will be involved since they are the schools policy supervisors. Secondly, it will involve form two only. It excludes form one, form three and four because the former are very new in school they might have not learnt enough ICT skills that are worthy to use in learning of Physics in most schools and the latter, in most of the schools as cited in the background information and the related studies, have few Physics students and others none at all because it is optional, for that reason form three and four were not included in this study.

1.9 Delimitation
This study aims at investigating how teachers of physics are utilizing ICT as a pedagogical tool. The research is carried out in public secondary schools in Tigania West District, Kenya.
1.10 Theoretical Framework
One way of understanding how ICT influences the teaching and learning environment is to use theoretical tools such as constructivism (Resnick, 1987). Constructivists believe that learning is construction of knowledge obtained from one's experiences rather than directly receiving information from the outside world (Resnick, 1987). Constructivism therefore, refers to a learning approach that emphasizes on the importance of experiential exploratory learning. It is evolved from the writings of Piaget and Bruner who focused on the relevance of direct meaningful knowledge construction through experience of the world (Collins & Green, 1992). Well-established scholars such as, Dewey (1916), Piaget (1972), Vygotsky (1978) and Bruner (1990), defines constructivism-learning theory as an active construction of new knowledge based on a learner’s prior experience. Further, Bruner (1990) expounds it as a learning process in which the learner is able to build on present and previous information. Constructivist emphasizes on critical thinking, problem solving, authentic learning experiences, social negotiation of knowledge, and collaboration pedagogical methods that change the role of teacher from disseminator of information to learning facilitator, helping students as they actively engage with information and materials to construct their own understandings Forman and Pufall (1988). Both the knowledge frameworks of students (prior knowledge) and of the knowledge domains relevant to the learning activities must be considered in the integration of ICT. Many educators have argued that the appropriate use of ICT by students can assist teachers in determining and catering for the prior knowledge of students.
Further, it is argued that ICT can assist students in engaging cognitively to a greater depth with knowledge domains. That is students are supported in employing the full range of thinking skills within authentic contexts. This is often discussed in terms of cognitive taxonomies such as that provided by Bloom (1964). The educator who believes in constructivism should be concerned with personal conceptual frameworks, prior knowledge, students understandings, the relationship of formal knowledge to spontaneous frameworks, and the attitude of the learner to formal knowledge (Osborne and Wittrock, 1985; von Glasersfeld, 1991). Vosniadou (1994) argues that a belief in constructivism will determine the type of computer software used in classrooms and the manner in which computer-use is integrated with the curriculum and implemented in the classroom. However, this may be a little overstated, as the fundamental focus for a constructivist starts with the individual student within the context of the environment in which that student is placed. Skinner believed that people could learn more effectively if their environment is carefully controlled.

Figure 1.1 Interrelationships of Learning Theories
He developed the principles of operant (behavior) conditioning. In the constructivist, view the learner as an active participant is involved in structuring his or her own learning experiences. Papert worked with Piaget who emphasized the way in which knowledge is structured and organized as well as how the learner’s own perceptions of their prior experiences pre-form the knowledge structure.

The importance of how the learner relates new experiences to existing knowledge becomes paramount. Snowman and Biehler (2003) describe constructivism in terms of four facets. The first facet of constructivism is that “meaningful learning is the active creation of knowledge structures from personal experiences” (Snowman and Biehler 2003, 303). This suggests that learning occurs when people use their existing knowledge to understand and explain new ideas. The second facet of constructivism is that it rejects standardization of curriculum and promotes customization based on the student’s prior knowledge. Constructivism does not speculate a total transfer of knowledge from one person to another since individuals interpret and make meaning for them. It advocates the principles of multiple realities. Constructivism disputes assessment based on standard tests, and promotes testing which is part of the learning process. The third principle of constructivism maintains that the truth is “in the mind of the beholder” (Snowman and Biehler 2003, 304). In other words, though people may generally agree on an issue, since they interpret their own meaning, which is influenced by their environment, they can have their own specific explanations for any issue. The
final facet of constructivism, “has to do with the formation and changing of knowledge structures” (Snowman and Biehler 2003, 304) Constructivist principles involve an open-ended environment, where learners get greater control of the learning process. According to social constructivism, learning generally is a socially mediated activity (Snowman and Biehler 2003). Thus, applying Vygotsky’s theory of cognitive apprenticeship to the use of computers, Snowman and Biehler (2000) argue that computers can play a crucial role in facilitating learning for children. A computer can be used to link the learner to more knowledgeable peers and experts. Such a relationship mediated through ICT based modes of communication is referred to as ‘Tele-apprenticeship’ (Snowman and Biehler 2000). ICT-based modes of communication help learners create strong relationships with mentors, experts and peers. Constructivism is the assimilation of experimentalist, humanistic, behaviorist and cognitive ideals and theory (figure 1.1). The “constructivist stance maintains that learning is a process of constructing meaning; it is how people make sense of their experience” (Merriam and Caffarella, 1999. 260). When applying this theory in teaching and learning of Physics, it is essential to understand that we need to consider the cultural environment in which this learning takes place. Moreover, constructivist-learning approach involves educators building school curriculum around the experience of their students. Constructivists believe learner-centric instructional classroom methods will strengthen the commitment and involvement of self-motivated learners because of their high level of interaction
1.11 Conceptual frame work

The focus of this study is based on what happens in the classroom and how ICT is used in teaching and learning of Physics. It responds to the reasons why and the ways in which teachers use ICT in the classroom and how they are determined by their overall teaching attitude and competence of teachers and students. The presence and use of the ICT resources by physics students and teachers provides an avenue of interaction. These interactions provide feedback which acts as and reinforce towards the learning process. Multimedia applications like games, drills, animation and other graphical applications provides practices that take the form of problem to be solved and answer frames which exposes the students to the subject in steady steps consequently generating more interest in the subject matter which in the long run affects their academic performance and gives them the desire to try and use these acquired knowledge in a different setting. The emphasis on equipping schools with ICT facilities has influenced the use of computers in schools? Pelgrum (2001) lists some of these as: personal ideas about the contribution that technology can make to the processes of teaching and learning and classroom management; Teachers” characteristics such as knowledge and skills; the number of computers and ICT infrastructure; and difficulty in integrating ICTs instruction in classrooms. Mooij and Smeets (2001) explain that if teachers are not confident in their ability or competence to handle computers this may influence their willingness to introduce technology in their classrooms. This ICT competence factor is the same that Zhao and Cziko (2001) refer to as Control Principle. Other factors significantly influencing ICT use in schools
according to Mooij and Smeets (2001) are school manager’s policy and budgetary decisions. Figure 1.2 presents the general conceptual framework for the study as well as the interactions of various variables.

![Figure 1.2: Relationship of Variables](source: Owner 2014)

According to figure 2.2 above, the main independent variables are, National ICT policy, School ICT policy, Availability of ICT, ICT Infrastructure (Power, computers, Internet connectivity), funds for acquisition and maintenance, ICT competency among teachers and students greatly affect effective integration of ICT programs in learning institutions.

Availability of Funds. The availability of funds in schools determines the number and quality of computers in a school. Further, they determines the learning software that are installed in the computers for ICT integration.

Availability of power. Availability of reliable power supply (from Kenya Power), is a very significant in determining of whether the school undertakes to purchase and implement ICT programmes. It has been noted in the literature review that use of generators regularly to power computers is very expensive, while use solar power may be undependable, (Jhuree, 2006).
Internet connectivity. Availability of internet connectivity in schools enables teachers and students to search for new teaching and learning resources from different sources. The high cost of connectivity has been observed to hamper ICT usage in Kenya. This is especially so for the poor schools, which cannot afford the high cost of Telecommunication and Internet used for academic purposes.

The National ICT Policy

The Ministry of Education policy document (2006) guides schools on the integration of ICT in education. It further, emphasizes integrating ICTs in teaching curriculum at all levels of education from primary school to universities.

Individual’s characteristics

According Schofield, (1997), the teacher is the key to the usage of educational integration. Teacher’s knowledge, skill, and philosophy determine their instructional methods (Staub & Stern, 2002) and have significant effects on the students that they teach (Brophy & Good, 1986). Educators ultimately determine whether and how computers will be used. Therefore teacher training in ICT and computer use is of paramount importance, if successful usage of ICT into the curriculum is to be achieved. Untrained or inadequately trained teachers might be disinterested and may therefore develop a resistance to using the computers in the classroom (Anderson, 2002). McFarlane emphasizes that: teachers who are uncomfortable with computers, and who fail to see how they can be used to enhance learning, simply do not use them.

Teacher’s motivation and student’s attitude towards learning using the ICT will affect its integration, if teachers are not motivated, they will not encourage its use.
Therefore, these are seen as the intervening variables. Teacher’s attitudes and beliefs in ICTs use affects the way technological innovation is applied in education. Bullock (2004) found that teachers’ attitudes are a major enabling or disabling factor in the adoption of technology. Similarly, Kersaint, Horton, Stohl, and Garofalo (2003) found that teachers who have positive attitudes toward technology feel more comfortable using it and usually incorporate it into their teaching. Woodrow (1992) asserts that any successful transformation in educational practice requires the development of positive user attitudes toward the new technology. The development of teachers’ positive attitudes toward ICT is a key factor not only for enhancing computer usage but also for avoiding teachers’ resistance to computer use (Watson, 1998). The teachers' attitudes and beliefs also influence what they themselves learn from education and training programs and what didactic practices they make use of in their classrooms (Clark & Peterson, 1986; Fang, 1996; Pajares, 1992; Zeichner et al, 1987).

Research has shown that many educational reform initiatives have failed precisely because they did not influence the beliefs or the practices of the teachers (Cohen & Ball). However, significant positive correlations exist between teachers’ attitudes towards ICTs and five independent variables namely cultural perceptions, computer competence, computer access and computer training (Albirini & Abdulkafi, 2006). The intervening variables enhances or dismay the use of ICT in teaching and learning. Finally, the dependent variable is the integration of ICT in teaching and learning.
1.12 Operational Definition of Terms

Distance Education  Distance education describes a set of teaching and learning strategies (or education methods) that can be used to overcome spatial and temporal separation between educators and learners.

Information, Communication and Technology. These are electronic devices for collecting, storing, processing, and communicating information.

Integration  use of ICT resources as a pedagogical tool

Resource-Based Learning  involves communication of curriculum between learners and educators through the use of resources (instructionally designed and otherwise) that harness different media as necessary.

Resources  These are the hardware and software facilities that in combination constitute an ICT centre
CHAPTER TWO
LITERATURE REVIEW

2.0 Introduction
This chapter describes literature relevant to the research purposes of this study. It is organized into sub-sections. Each section has different features though related to the study that cover diverse aspect of ICT use in the teaching and learning of Physics.

2.1 The Role of Physics in Society
Science is recognized widely as being of great importance internationally both for economic well-being of nations and because of the need for scientifically literate citizenry (Fraser & Walberg, 1995). Knowledge of science and technology is therefore a requirement in all countries and all people globally due to the many challenges that are facing them. These challenges include emergence of new drug resistant diseases, effects of genetic experimentation and engineering, ecological impact of modern technology, dangers of nuclear war and explosions, tsunamis, earthquakes and global warming among others (Alsop & Hicks, 2001). As a result, there are rapid changes taking place in industry, communication, agriculture, and medicine. Science as an instrument of development plays a dominant role in bringing about these changes by advancing technological development, promoting national wealth, improving health and industrialization (Republic of Kenya, 1999; Validya, 2003). Taylor (1984) emphasized that Physics is and will remain the fundamental science. This suggests that other sciences depend upon the knowledge obtained through the study of Physics.
Physics is therefore an important base in science and technology since it studies the essence of natural phenomena and helps people understand the increasingly technological changing society (Zhaoyao, 2002). Physics as a branch of Science has many applications for example in medicine; where throughout this century advances in Physics and medicine have gone hand in hand. Medical community to devise new techniques for diagnosing and treating a variety of illness has rapidly exploited the most fundamental discoveries in Physics. Even in the continuing research necessitated by the challenges posed by diseases such as Ebola, and HIV/AIDS, the development of high precision equipment employing principles of Physics remain necessary (Minishi et.al, 2004). In information technology, which has reduced the world into a global village through use of satellites and computers, the use of principles of Physics has been very useful. A wide range of application of Physics is used in industrial development for improvement of materials useful to the wellbeing of human race. The study of Physics involves the pursuit of truth; hence, it inculcates intellectual honesty, diligence, perseverance and observation in the learners (Das, 1985). Physics education therefore enables the learner to acquire problem-solving and decision-making skills that provides ways of thinking and inquiry, which help them to respond to widespread and radical changes in industry, health, climatic changes, information technology and economic development. These changes are demanding knowledge of scientific principles in order to tackle them (Mohanty, 2003). The teaching of Physics provides the learners with understanding, skills and scientific knowledge needed for scientific research, fostering technological and economic growth in the
society, where they live thus improving the standards of living (Kenya Institute of Education (K.I.E., 2002), currently called Kenya Institute of Curriculum Development (KICD)).

In spite of the recognitions given to the Physics subject as one of the essential sciences at the secondary school level as contained in the National Policy of Education, the achievement of students and the number of candidates who choose Physics have become worrisome to the generality of the people, most especially Physics educators and researchers (Akinlaye, 1998). Many researchers have identified different solutions among which is the use of different Instructional methods such as guided discovery, concept mapping, field trip, demonstration method and use of ICT. Okebukola (1992) confirmed that the use of appropriate instructional strategies can influence the performances of low achieving students as well as making the lesson interesting.

2.2 Challenges of Teaching and Learning Physics
According to the Ministry of Education, Science and Technology, 2008 (MoEST)
The Physics curriculum poses vast challenges to both the learner and the teacher. The learner has to struggle with the abstract concepts concerning the universe that ranges from the determination of the size atoms in matter Physics to the mass of large bodies such as the earth and the sun in the universe. In school laboratory experiments, students have to deal with numerous measurements and values mainly in figures. Measuring instruments and related apparatus, calculators, graph paper and pencil are some of the traditional tools in practical work. Often students struggle to strike a balance between data collection processes where measurement
values of fast moving objects are required with repeated readings and at the same time maintaining a record of results, drawing graphs and analyzing the results. ICT may not be the solution to all these challenges, but can be a resourceful tool for dealing with both the content and process of Physics. Moreover, research as reviewed that, teaching Physics is challenging enough. Teaching reluctant students is even more challenging, Steinberg R. (2008). According to Steinberg, (2008) the common challenges in teaching and learning of Physics can be summarized as: Student are not motivated or interested in taking Physics, Challenges with student’s attitude and expectation, Lack of basic mathematical skills, Students don’t think Physics is important, Lack of enough trained teachers, Lack of laboratories and Equipment, Ability of the teachers to influence the subject to the student s, which might be due to the problem of teacher’s qualification and effectiveness, The overloading of curriculum and Physics syllabus, The lack of engagement in debate and quiz in this subject, The limitations on practical and fieldwork, Non-implementation of ICT in science teaching, Insufficient account taken of pupils' previous learning and attainment, including what they had already learned in primary school.

Thus teaching this subject means not only classroom lectures but also laboratory-based practical classes where students learn about the subject matter by carrying out experiments or by teachers demonstrating experiments or by use of computers simulation of experiments and demonstration that could be difficult to carry out in the laboratories. It is argued by various scholars that, with ICT integration
students may view physics in a different dimension that may foster positive attitude towards physics.

2.3 Nature of ICT
The ICT stands for Information and Communication Technologies and is defined as a “Diverse set of Technological tools and resources used to communicate, and to create, disseminate, store and manage information” (Blurton C, 2010). He further notes that ICT has become a very important part of the educational delivery and management process because it is changing methods of teaching and learning by adding elements of vitality to learning environments including virtual environments for the purpose. New technologies make it possible for complicated collaborative activities of teaching and learning by dividing it in space and time, with seamless connectivity between them. Due to its capability to offer anytime and anywhere, access to remote learning resources, ICT is a potentially powerful tool for offering educational opportunities.

2.4 ICTs in Developing Countries
The idea that IT can help developing countries is fascinating to many, because of the benefits that have apparently been realized in the West (Avgerou, 1990). Motivated by the prospect of greater economic, social, educational and technological gains, both developing and developed countries, are bringing about education reforms, with a clear focus on ICT integration in education (Jhurree, V., 2005). Although ICT is now at the centre of education reform efforts, not all countries are currently able to benefit from the developments and advances that
technology can offer (Kozma, R., Anderson R., 2002). There are significant barriers often referred to as “the Digital Divide” that limit the ability of some countries to take advantage of technological developments (Kozma, R., Anderson, R.E., 2002). Thus, developing countries are faced with challenges related to access, pedagogy or assessment when using ICT to improve and reform education (Kozma, R., Anderson, R.E., 2002). Because much research in the area of technology integration in education has been conducted in technologically advanced countries, but little in the developing countries, few statistics are available from developing countries (Jhurree, V., 2005). According to Jhurree (2005), this might imply that the former countries now possess a wealth of knowledge, skills, expertise, and the competitive edge that most of the latter countries do not possess. On the other hand, as Jhurree (2005) suggests, the latter countries can gain a lot from the expertise of their advanced counterparts. According to a study undertaken by Kozma and Anderson (2002), both developed and developing countries are beginning to use their investment in ICTs to reform education. Moreover, Hepp, et al. (2004) claim that, developing countries have become anxious about the widening gap between their reality and the aggressive ICT policies of some developed countries. Consequently, there is a more urgent need to improve the quality and equity of education to bridge the gap between developed and developing nations, and ICTs are perceived as necessary tools for this purpose. Wachira (2005) states that, in developing countries less than 1% of the population has access to ICTs, the digital discrepancy is largely a rural-urban divide, in the urban areas being on the vantage point (Wachira, E., 2005).
Compaine (2001) claims in his book “The Digital Divide: Facing A Crisis or Creating A Myth?” that today’s digital divide was yesterday’s computers-in-the-schools divide, the television divide of 1955, the radio divide of 1930, or the book divide of the previous half-millennium. The difference between then and now is that both technologies seem to eliminate most of these gaps at much faster rates. Wijewardena (2002) suggests that there are six key underlying causes of the digital divide. These are: the disparities in access to non ICT resources, the impact of the digital divide being a driver of the digital divide, cultural features, language issues, level of urbanization and the level of concentration of ownership in ICTs infrastructure and services (Wijewardena, M., 2002). Also Adeya (2002) quotes in his paper “ICTs and Poverty” from Barlow (1998) “Common perceptions of the potential of the digital age are limited by the habits of mind one develops in an industrial society”. These habits are different for those who have grown up in poverty with no television sets for instance to shape their worldview. Nevertheless, Adeya (2002) also notes that the basis of this argument is weak however since Barlow has no empirical evidence to support his assertion, apart from his experiences in the countryside of a developed country. Moreover, Pelgrum and Law (2003) argue that while technology has the potential of bringing educational opportunities to more remote areas, the introduction of IT into schools becomes confined for developing countries due to the demands on infrastructure investment. Thus, the divide between urban and rural areas might be widened and consequently it might introduce a digital divide to the existing economic and educational divides (Pelgrum, W.J., Law, N., 2003).
Finally, Bracey (2005) puts forward that it is critical to ensure that the digital divide between developing and developed countries is bridged through the introduction of ICTs into elementary school systems where early learning begins. In his point of view, the challenge for all is to make use of new technologies in meaningful ways to maximize their value to learners, teachers and others involved in the dissemination of the uses of technology.

2.5 Development of ICT in Kenya
The earliest attempt at ICT policy formulation in Kenya dates back to the 1980s, but the process remained incomplete by 2000 (Nduati & Bowman, 2005). The formation of ICT policy in Kenyan education has its roots in the Ministry of Research of the time. The motivation was to develop national policy guidelines for the development of ICTs in the country in order to address the then prevailing haphazard growth of the sector. This was complemented by the readiness of government launching one laptop per child program in primary schools donor agencies including. Reports by both Waema (2005) and Farrell (2007) seem to agree with the idea that fast and haphazard growth of information technology lacking direction and regulation provided an impetus for ICT policies as mentioned earlier. In the process of reducing the haphazard development of ICT in schools, the government has made education the avenue for equipping the nation with ICT skills in order to create a vibrant and sustainable economic growth. The National ICT policy was launched in 2006 in response to issues raised in Session Paper No. 1 of 2005 according to MOE (2006). It was also meant to assist the nation to achieve part of the Millennium Development Goals.
Its principal objective was to facilitate sustainable economic growth and development, and poverty eradication through productive and effective technologies. It further aims at pursuing progress towards full socio-economic inclusion of citizens through universal access (e-learning). It was on this background that New Partnership for Africa Development (NEPAD) was initiated to address challenges facing African countries like Kenya. ICT infrastructure was identified as a priority action area for inducement of conditions for sustainable development. In 2003, NEPAD prioritized efforts towards bridging of the digital divide between Africa and the developed world. One of the six high priority areas identified was the NEPAD e-school initiative. Its main aim was to integrate ICT in the delivery of education curriculum at secondary and primary school levels in order to improve access, quality and equity in education among member states. Presently, less than ten percent of secondary schools offer computer studies despite its perceived role in the nation’s socio-economic development Okuogo (2006). The ideal situation would be where ICT was mainstreamed in all school subjects such that it would be seen in Geography, History, Business Studies, and Physics and so on. This could be done more easily if schools had access to e-materials and the relevant ICT infrastructure including the internet. This is what made it necessary for these schools to be fitted with the necessary ICT infrastructure. The main ones are; computers, e-materials, internet appliances and trained personnel. To justify the investment of computers in schools, it is necessary therefore to survey their effectiveness to the school and surrounding
community in terms of their e-learning programs against the contribution of the already existing ones.

2.6 ICT in Education
Considerable resources have been invested to justify the place of technology in education, and many research studies have revealed the benefits and gains that can be achieved by students, teachers and administrators (Jhurree, V., 2005). Many authors have cited some of the ICTs benefits, to start with; Hepp, et al, (2004) state the following reasons for the application of ICTs in education. First, a new society requires new skills because ICTs are the paramount tools for information processing, new generations need to become experienced in their use, should acquire the necessary skills, and therefore must have access to computers and networks during their school life. This is supported by the World Bank report of 1998 that stated, “ICTs greatly facilitate the acquisition and absorption of knowledge, offering developing countries unprecedented opportunities to enhance educational systems, improve policy formulation and execution, and widen the range of opportunities for business and the poor.

One of the greatest hardships endured by the poor, and by many others, who live in the poorest countries, is their sense of isolation. The new communications technologies promise to reduce that sense of isolation and to open access to knowledge in ways unimaginable not long ago”. (World Bank (1998:82). Secondly, Schools are knowledge-handling institutions; therefore, ICTs should be fundamental management tools on all levels of an educational system, from classrooms to ministries thus ICT should be used as a productivity enhancement.
Finally, Schools should profoundly revise present teaching practices and resources to create more effective learning environments and improve life-long learning skills and habits in their students. In order to deal with the questions of “How can ICTs be applied to support education change?” and “How can its application in education in turn support sustained economic development and community transformation?” Kozma (2005) in an attempt to show how ICTs can be applied to support education change and how its application in turn support sustained economic development, suggests the following four types of approaches in general; first, ICTs are used to improve the delivery of and access to education. This approach can improve education on the margin by increasing the efficiency by which instruction is disseminated. Secondly, ICTs are the focus of learning. By learning ICT skills, students become better prepared for work that increasingly involve the use of ICTs. Thirdly, ICTs can be used to improve student understanding and increase the quality of education. Lastly, Knowledge creation, technology, technological innovativeness, and knowledge sharing can contribute to the transformation of the education system and to sustained economic growth and social development. Moreover, Papert (1997) recognized the following positive impacts of ICTs in education: first student’s motivation and creativity is enhanced when confronted by the new learning environments. Second, ICTs open for a greater disposition to research and problem-solving opportunities focused on real social situations. Third ICT offers a more comprehensive assimilation of knowledge in the interdisciplinary ICT environment, fourth ICT has the ability to generate knowledge and capacity to cope with rapidly changing, complex, and
uncertain environments, finally new skills and abilities are fostered through technological literacy.

ICTs provide a new framework that can foster a revision and an improvement of teaching and learning practices such as collaborative, project-based and self-paced learning. The cultural, social and professional roles of ICTs are exercised primarily through an effective use of the vast amount of information sources and services available today via Internet and CD-based content for the entire educational community; students, teachers, administrators and parents. ICTs have important roles to play in making school administration less burdensome and more effectively integrated to the official information flow about students, curricula, teachers, budgets and activities through the educational system information pipelines or by use of school management programs.

2.7 ICTs in schools

ICT infrastructure in a school is understood to comprise a basic computer system configuration with a systems unit, monitor, keyboard and mouse together with operating system and application software. Some schools have gone beyond the basic configuration and have added connectivity and additional peripheral devices such as multimedia speakers, CD-ROM drives, scanners, and data view projectors, etc. These have been and are being used variously by teachers and students. Schools should offer conditions needed to optimize learning and promote the transfer of knowledge and skills. Learning environments need to reflect the potential uses of knowledge that pupils are expected to master, in order to prevent the acquired knowledge from becoming inert (Bransford, 1990).
(Collins, 1996) argue that rich contexts and tasks that are as authentic as possible should be provided by presenting links to the world outside school. In addition, teachers should stimulate pupils to engage in active knowledge construction. This calls for open-ended learning environments instead of learning environments which focus on a mere transmission of facts. Co-operation and interaction in the classroom environment are important in order to foster the acquisition of learning skills, problem solving skills, and social relations (Bennett & Dunne, 1994; Slavin, 1995; Susman, 1998). Finally, since classes are of mixed ability, segregation is considered to be one of the key criteria for effective classroom practice (Bearne, 1996; Kerry & Kerry, 1997; Wang, 1990). Teachers are expected to adapt the educational setting to the needs and capabilities of the individual pupils. ICT may contribute to creating powerful learning environments in numerous ways. ICT provides opportunities to access an abundance of information using multiple information resources and viewing information from multiple perspectives, thus fostering the authenticity of learning environments. ICT may also make complex processes easier to understand through simulations that, again, contribute to authentic learning environments. Thus, ICT may function as a facilitator of active learning and higher-order thinking (Alexander, 1999; Jonassen, 1999). The use of ICT may foster co-operative learning and reflection about the content (Susman, 1998). Furthermore, ICT may serve as a tool to curriculum differentiation, providing opportunities for adapting the learning of Physics content and tasks to the needs and capabilities of each
individual pupil and by providing tailored feedback (Mooij, 1999; Smeets & Mooij, 2001).

2. 8 ICT Tools for Teaching Physics
The new digital ICT is not single technology but combination of hardware, software, multimedia, and delivery systems (Mooij, 1999). In connection, Farrell, 2007 points out that, ICT in education encompasses a great range of rapidly evolving technologies such as desktop, notebook, and handheld computers, digital cameras, local area networking, Bluetooth, the Internet, cloud computing, the World Wide Web, streaming, and DVDs; and applications such as word processors, spreadsheets, tutorials, simulations, email, digital libraries, computer-mediated conferencing, videoconferencing, virtual environment, simulator, emulator, mobile apps etc. It is further noted that the use of newer ICT is being integrated with use of older technologies, enabling the existing resources and services to be of continuous use in teaching and learning physics. Today ICT is being used as a tool for improving the quality of life by improved efficiency and enhanced effectiveness in teaching of physics. Different types of ICT tools assist the teachers and students of physics by providing them with learning opportunities, capabilities and also increase potential of the exposure. ICT makes them capable by providing the ability to access knowledge with the help of suitable digital media. ICT is playing very important role in communicating with peers, thereby promoting collaborative and social learning environment (Blurko, 2000). According to the teachers of physics website column (2004-2006), a number of physics teaching resources and tools have been listed in append XIII.
These tools range from learning objects, multimedia, mobile learning, internet and social media, interactive white boards and slides presentations to modelling and simulations. According to the University of Sydney Faculty of education and social work, the teacher requires very basic ICT skills for integration of ICT in teaching physics such as; internet browsing, word processor, PowerPoint, excel, publisher, online classes windows explorer and navigation. The use of the ICT tools and skills needed is supported by the constructivism theories which is a learning theory found in psychology which explains how people might acquire knowledge and learn. It therefore has direct application in education. The theory suggests that humans construct knowledge and meanings from their experiences. Piaget’s theory of constructivist learning has had a wide ranging impact on learning theories and teaching methods in education and is underlying theme of many educations reform movements.

2.9 Learning Theories in Support of ICT Use

The use of ICT in the teaching and learning of Physics adopts a range of learning theories. From among many models of ICT use, the educational models for computer assisted learning (CAL) developed by Kemmis, Atkin and Wright (1977 in Skaife and Wellington 1993) date back to the advent of computers in education. Their framework is a set of four models of learning theory: Behaviorism, Cognitive, Constructivism and Social constructivism.

2.9.1 Behaviorism

Behaviorism was the primary function of Plato. Behaviorists produced a rich environment in which trainers could create and deliver high quality interactive
courseware to students in classrooms, homes and offices with or without the presence of an instructor (Szabo, 1992:7). In the past, behaviorism has had the greatest influence on the design and use of ICT (Simonson & Thompson, 1997). Based on Skinner’s operant conditioning and Pavlov’s classical conditioning, the essence of behaviorism is to have instruction that produces behavioral change (Simonson, 1997). In this model, the role of the computer is to present the content, test and give the student feedback that will engender learning.

2.9.2 Cognitive Theory

While the behaviorists focus on the content as the object of learning, the cognitivists pay attention to the student as subject (Simonson & Thompson, 1997) and the computer as a mediator (Skaife & Wellington, 1993). The student is guided to learn through discovery. The learner is also given opportunity to learn through concrete operations, and then graphical representations of reality before engaging with abstract numerical symbols. The role of ICT is to provide a rich learning environment. Software programs that fulfill this include simulations, multimedia encyclopedia, Encarta and electronic books (Williams, 2000).

2.9.3 Constructivism

Since Physics is both a domain of knowledge and process of investigation. Constructivism elevates the importance of processes especially the knowledge construction process. Advocates of constructivism, Piaget (1981) and Bruner (1990) in Williams (2000), stress that individual constructs are developed through discovery. Students are therefore given opportunity to manipulate ideas, generate and test hypothesis (Skaife & Wellington, 1993). ICT, in this case assumes the
role of a tool especially for model building. Students can build their own models or use generic ones.

Going a step further to Vygotskian social constructivism, which pays attention to context of knowledge construction, ICT is particularly useful as a tool mediating among other learners, parents and teachers. The teacher’s main role is to provide gallows in the learning process, to guide the student who actively engages in constructing knowledge individually and socially. ICT plays the mediation role, providing informative tools, communication tools, constructive tools, and co-constructive tools (Williams, 2000).

2.9.4 Experimentalist
This paradigm involves using ICT as sweat saving tool, reducing inauthentic labour (Skaife & Wellington 1993; Twining, 2001). In Physics, examples of tasks that students may use the computer are many and may include difficult calculations, data capturing in selected experiments and difficult drawing of graphs. This reduces time for higher-level cognitive tasks such as the interpretation and comparison of experiments. Barnett sums up by saying that, “In a way ICT helps us to address one of the greatest challenges in the 21st century: how to harness ICTs to help us prepare for “an unknown future” (Barnett 2004).

2.10 ICT Competency Skills
Professional development of teachers sits at the heart of any successful technology and education program. Baylor and Ritchie (2002) carried out a quantitative study that looked at the factors facilitating teacher skill, teacher morale, and perceived student learning in technology-using classrooms. They
found that professional development has a significant influence on how well ICT is embraced in the classroom. Also, they added that teachers’ training programmes often focus more on basic literacy skills and less on the integrated use of ICT in teaching. Despite the numerous plans to use technology in schools, however, teachers have received little training in this area in their teacher education programs (Varsidas & Mc Isaac, 2001). According to Schaffer and Richardson (2004), when technology is introduced into teacher education programs, the emphasis is often on teaching about technology instead of teaching with technology. Hence, inadequate preparation to use technology is one of the reasons that teachers do not systematically use computers in their classes. Teachers need to be given opportunities to practice using technology during their teacher training programs so that they can see ways in which technology can be used to augment their classroom activities (Rosenthal, 1999).

Teachers are more likely to integrate ICT in their courses, when professional training in the use of ICT provides them time to practice with the technology and to learn, share and collaborate with colleagues. On the other hand, training school students to serve as technology experts may aid the integration of computers into the classroom setting (Hruskocy et al, 2000). He carried out a study on training students to become technology experts for teachers and peers. Hruskocy and his colleagues concluded that not only teachers’ expertise and dedication are necessary for technology integration but also students’ enthusiasm and talent prompt the process.
2.11 Computer Competence
According to Pelgrum (2001), the success of educational innovations depends largely on the skills and knowledge of teachers. Also, he found that teachers’ lack of knowledge and skills was the second most inhibiting obstacle to the use of computers in schools. Similarly, in the United States, Knezek and Christensen (2000) hypothesized that high levels of (attitude), skill and knowledge (proficiency), and tools (level of access) would produce higher levels of technology integration that will reflect on student achievements positively. Their model postulated that educators with higher levels of skill, knowledge, and tools would exhibit higher levels of technology integration in the classroom. Moreover, Berner (2003) studied the relationship between computer use in the classroom and seven independent variables: perceived relevance; desire to learn; emotional reaction to technology; beliefs about computer competence; beliefs about technology; administrative support; and peer support. He found that the faculty’s belief in their computer competence was the greatest predictor of their use of computers in the classroom. Therefore, teachers should develop their competence based on the educational goals they want to accomplish with the help of ICT.

In addition to the factors mentioned above, there are other factors that influence teachers’ decision to use ICT. They are collegiality among computer using teachers, self image, student- oriented educational philosophy of the teacher, positive views about the impact ICT has on teachers’ work, perceived changes, student-oriented pedagogical approach, personal entrepreneurship, professional engagement, self confidence, and willingness to change. However, the research
literature on factors influence the implementation of ICT in education has a relatively long history and is international in nature (Becta, 2003). If one is aware of these factors ‘teacher level factor’ and ‘school level factor’ steps can be taken to gain success in technology integration process. Most of the articles reviewed focus either upon the individual teacher or upon the school as a whole as the unit of analysis. However other issues emerge about the innovation tasks facing both if they are viewed together. The study by Ertmer and her colleagues (1999) offers one useful framework for making this connection. They identified three levels of teachers’ computer use, varying in their relationship to the existing curricula. These involve using ICT as: first as, supplement to the curriculum, secondly, as a reinforcement or enrichment of the curriculum, or and finally as a facilitator for an emerging curriculum. However, these three categories help us to distinguish the positions of whole schools as well as individual teachers. This enables us to speculate about what the implications might be of various kinds of match and mismatch between a schools’ position and that of an individual teacher within it. The position is different again in schools where both teacher and school favor using ICT to promote an emerging curriculum. Many of the sources, such as Evans (2002) and Richardson (2000) show such schools as learning organizations that are continually looking for ways of improving teaching and learning. These schools train their teachers to use technology as a tool, and to transform their classrooms into interactive, inquisitive learning environments. Therefore, teachers need support, examples of good practice, and leadership from their school
principal to receive the necessary time for professional development, in order to truly transform teaching and learning in the classroom.

2.12 Teacher Beliefs and Practices in the Use of ICTs

Teacher beliefs are defined broadly as “unstated, often unconsciously held assumptions about students, classrooms, and the academic material to be taught” (Kagan, 1992; 65). Pajares (1992) has indicated that teacher beliefs have more influence on teacher practice than teacher knowledge. According to Clark and Peterson, the professional decisions teachers make on a daily basis are based on their beliefs. Teacher beliefs play a critical role in general instructional practices (Pajares, 1992; Richardson, 1996) as well as specific technology integration practices (Ryba & Brown, 2000; Yocum, 1996). Typically, teachers with student-centered beliefs are more likely to integrate technology in student-centered ways (Cope & Ward, 2002). However, there is not always a direct relationship between beliefs and practices. Even though teachers may promote student-centered technology beliefs, their practices may not necessarily follow those beliefs (Ertmer, Golapkrishnan, & Ross, 2001; Judson, 2006), based on observations of 32 teachers who self-reported student-centered beliefs, Judson concluded “there was no significant correlation between teachers’ reported beliefs about instruction and their actual practice of integrating technology”. Perhaps these inconsistencies are due to the difficulty in measuring teacher beliefs. Pajares (1992) stated that, “it is the context specific nature of beliefs and their connections to other beliefs that make them especially difficult to infer and measure. It is this same feature that often makes them appear more inconsistent than they perhaps are.” (Pajares
Because beliefs are typically inferred from what teachers say, intend, or do, it is important to examine all three aspects in order to gain an accurate representation of beliefs (Rokeach, 1968). Another explanation for the apparent contradictions between beliefs and practice may stem from the existence of conflicting beliefs. Rokeach (1968) proposed that beliefs are ranked in order of importance. When a situation produces two conflicting beliefs, the belief with the higher ranked importance will override the other. For example, a teacher may believe that students should use technology as a tool for learning, but also believe that students need to learn specific technology skills in order to be prepared for the future. The second belief may be ranked higher; thus, the teacher gives her students lots of time to learn how to use specific technology skills or programs.

Beliefs have a tendency to influence practice (Pajares, 1992; Richardson, 1996), especially beliefs attributed to value (Ertmer & Ottenbreit, 2008). Value beliefs (or beliefs about the value of something) encompass the perceived importance of particular goals and choices (Anderson & Maninger, 2007). In other words, teachers’ value beliefs with regards to technology are based on whether or not they think technology can help them achieve the instructional goals they perceive to be most important (Watson, 2006). When a new pedagogical approach or tool is presented, teachers make value judgments about whether that approach or tool is relevant to their goals. The more valuable they judge an approach or tool to be, the more likely they are to use it. This is particularly true of technology (Zhao et al., 2002). When teachers learn how to use technology within their specific content areas and/or grade levels, they can more readily transfer that knowledge.
to their own classrooms (Hughes, 2005; Snoeyink & Ertmer, 2001/2002). When learning experiences are focused solely on the technology itself, with no specific connections to grade or content areas, teachers are unlikely the example, the more likely the teacher will see value and learn it”. Although teachers may possess positive attitudes toward technology, it is unclear which specific value beliefs drive or motivate their uses of technology (Smarkola, 2008). Similar to other innovations, teachers will not spend precious time, energy, and resources learning about a new technology tool and incorporating it into current pedagogical practices if it is not valued. Coppola (2004) found that the five teachers she studied would only use technology, when they truly believe in its value. Technology integration “requires so much work that only a teacher who already sees its value will carry it out. Teacher has to be sold on the idea that computers could be instructionally worthwhile before he or she would dig into the hard work of integrating them with instruction”. Snoeyink and Ertmer (2001/2002) found similar results, indicating that when teachers saw value in using technology for specific educational purposes, they were more likely to use technology even when barriers existed. Therefore, it seems reasonable to assume that teachers need to assign value to a specific use of technology before incorporating it into their teaching practices (Zhao & Cziko, 2001). According to Yildrim (2000) a study examining the changes in pre-service and in-service attitudes of teachers toward computers indicated that teacher’ attitudes, levels of confidence, and job satisfaction significantly improved after completing a computer literacy course.
The follow-up study indicated that previous computer experience had a very positive influence upon teachers’ expectations of the course.

2.13 Students Attitude towards the Use of ICTs
Although the term ICT implies far more than simply access to personal computers, students generally perceive using computers as having a positive effect on their learning. Lui, Macmillan, and Timmons (1999) points out that “On average, students who used computer-based instruction scored at the 64th percentile on tests of achievement, compared to students in controlled conditions without computers who scored at the 50th percentile”. Kulik (1994) reinforces the claims of earlier empirical studies, it has been found that using computer technologies in developmental classrooms positively influenced students’ attitudes toward writing and improved both the appearance and quantity of student writing. Attitudes affect teachers’ behaviours. Additionally, they have a considerable effect on openness to new experiences, as well as on reflecting and implementing change. Positive attitudes towards ICT, though too limited, support their use in classes. The effectiveness of ICT investments can be achieved with their effective application in the classroom as a part of the curriculum. By this way, learner-based learning environments can be created. As Kozma and Wagner (2003) claim, ICTs can affect the pace at which the learning gap is bridged in developing countries, both domestically and in relation to other nations. The great challenge is to harness the advantages of these technologies, in order to improve the delivery and quality of educational services, as well as to accelerate the rate at which knowledge is distributed and learning chances and outcomes are equalized
throughout society (Wagner, and Kozma, 2003). Drent and Meelissen (2007) conducted a study about factors which stimulate or limit the innovative use of ICT by teacher educators in the Netherlands. The study used questionnaires for 210 teachers and interviews for 4 of those teachers who had responded. Their findings showed that several factors such as a student–oriented pedagogical approach, a positive ICT attitude, computer experience, and personal entrepreneurship of the teacher educator have a direct positive influence on the innovative use of ICT by the teacher. Also, comparison between these factors in predicting computer use identified that attitude toward computer contributed more in explaining ICT use by teachers. In addition, educational theorists and researchers have realized that an important factor in the implementation of computers is users’ acceptance, which is in turn influenced by their attitudes towards these media (Koohang, 1989). Teachers’ attitudes have been found to be major predictors of the use of new technologies in instructional settings (Almusalam, 2001). The successful use of technology in the classroom depends to a large extent on the teachers’ attitudes toward these tools (Lawton & Gerschner, 1982). In fact, it has been suggested that attitudes towards computers affect teachers’ use of computers in the classroom and the likelihood of their benefiting from training (Kluever, Lam, Hoffman, Green & Swearinges, 1994). Positive attitudes often encourage less technologically capable teachers to learn the skills necessary for the implementation of technology-based activities in the classroom. Harrison and Rainer (1992) found that participants with negative computer attitudes were less skilled in computer use and were therefore less likely to accept and adapt to
technology than those with positive attitudes. They concluded that changing individuals’ negative attitudes is essential for increasing their computer skills. Therefore, if teachers want to successfully use technology in their classes, they need to possess positive attitude to use technology. Such attitude is developed when teachers are sufficiently comfortable with technology and are knowledgeable on its use.

2.14 Accessibility to the ICT Infrastructure
Using up-to-date hardware and software resources is a key feature to diffusion of technology (Gulbahar, 2005). In recent years, most of the schools are equipped with different kinds of technological infrastructure and electronic resources available. For instance one Australian school has reported that this school has provided personal notebook computers and their own web spaces, email access and workspace for all staff, and students from Year 5 onwards. Video conferencing is available and the school has established its own intranet, placing all its resources on-line. These are accessible via radio connections from school and home. In this college the use of radio is seen as an innovation that has completely changed the nature of teaching and learning (Richardson, 2000). Also, Richardson (2000) reported that many teachers integrated technology into their teaching and learning process in this school. This awareness appeared when they saw the potential of on-line lessons and the possibility of creating shared, net-based teaching materials. Therefore, hardware, software and network infrastructure must be available to integrate ICT in education.
Appropriate resourcing and flexible, forward-looking planning, linked closely to what teachers actually want and need at any given stage, will be essential. Furthermore, Albirini (2006) carried out a study examining the factors relating to the teachers’ attitudes toward information and communication technologies. A questionnaire was designed to collect evidence from high school English teachers about their perceptions of computer attributes, cultural perceptions, computer competence, computer access, and personal characteristics (including computer training background). The sample consisted of 63 male and 251 female teachers. The results showed that a relatively high percentage of the respondents (57%) had computers at home while only 33.4% of the respondents had access to computers at school. This percentage gives a clear indication of the insufficiency of computers at Syrian schools, particularly for teacher use. Thus, Albirini’s findings substantiated this globally felt barrier that computer access has often been one of the most important obstacles to technology adoption and integration worldwide (Pelgrum, 2001). On the other hand, Mumtaz (2000) stated that many scholars proposed that the lack of funds to obtain the necessary hardware and software is one of the reasons teachers do not use technology in their classes. Also, a report on teachers’ use of technology by the National Center for Education Statistics (September, 2000) indicates a correlation between availability of computers and computer use. In general, teachers who had computers in their classes were more likely to use them in instruction than teachers who did not; more than 50% of teachers who had computers in their schools used them for research and activities related to lesson preparation. A total of 78% of teachers surveyed cited limited
access to computers as a barrier to effectively using computers in their classes. Of this total, 38% thought “not enough computers” was a “great barrier” to using technology in their classes. Therefore, efficient and effective use of technology depends on the availability of hardware and software and the equity of access to resources by teachers, students an administrative staff.

2.15 Factors Affecting Teachers’ Use of ICT
As a classroom tool, the computer has captured the attention of the education community. This versatile instrument can store, manipulate, and retrieve information, and it has the capability not only of engaging students in instructional activities to increase their learning, but of helping them to solve complex problems to enhance their cognitive skills (Jonassen & Reeves, 1996). Generally, three objectives are distinguished for the use of ICT in education (Plomp and Rapmund, 1996): the use of ICT as object of study, the use of ICT as aspect of a discipline or profession; and the use of ICT as medium for teaching and learning. The use of ICT in education as object refers to learning about ICT, which enables students to use ICT in their daily life. The use of ICT as aspect refers to the development of ICT skills for professional or vocational purposes. The use of ICT as medium focuses on the use of ICT for the enhancement of the teaching and learning process (Drent, Meelissen, 2007). It is a fact that teachers are at the center of curriculum change and they control the teaching and learning process. Therefore, they must be able to prepare young people for the knowledge society in which the competency to use ICT to acquire and process information is very important (Plomp et al., 1996). In general, the research literature on the
implementation of ICT shows that it involves a large number of influencing factors (e.g., Mumtaz, 2000). We can make a distinction between non-manipulative and manipulative school and teacher factors by reviewing several studies on factors that influence teachers’ decisions to use ICT. Non-manipulative factors are factors that cannot be influenced directly by the school, such as age, teaching experience, computer experience of the teacher or governmental policy and the availability of external support for schools (Ten Brummelhuis, 1995). On the other hand, manipulative factors refer to the attitudes of teachers towards teaching and ICT, ICT knowledge and skills of teachers, commitment of the school towards the implementation process and availability of ICT support (Ten Brummelhuis, 1995).

2.16 Teachers’ Characteristics
Teachers’ characteristics (e.g. individual’s educational level, age, gender, educational experience, experience with the computer for educational purposes and financial position) can influence the adoption of an innovation (Rogers, 1995, Schiller, 2003). The report by the National Center for Education Statistics (2000) indicated that teachers with fewer years of experience were more likely to use computers in their classes than teachers with more years of experience. More specifically, teachers with three years or less teaching experience reported using computers 48% of the time; teachers with 4-9 years, 45% of the time; those with 10-19 years, 47% of the time, while teachers with 20 years or more reportedly used computers only 33% of the time. This may be due, in part, to the fact that new teachers have been exposed to computers during their training and therefore,
have more experience using this tool. Then, one of the factors that determine the extent to which teachers use computers in their classes may be the number of years they have been teaching. Moreover, Venkatesh and Morris (2000) investigated about age and gender differences in the overlooked context of individual adoption and sustained usage of technology in the workplace using the Theory of Planned Behavior (TPB). They studied on user reactions and technology usage behavior over a 5-month period among 355 workers being introduced to a new software technology application. The results showed that the decisions of men and younger worker were more strongly influenced by their attitude toward using the new technology. In contrast, women and older worker were more strongly influenced by subjective norm and perceived behavioral control. Then, these groups of people adopt very different decision processes in evaluating new technologies. On the other hand, Albirini (2006) found that age was not a significant factor in relation to teachers’ attitudes towards ICT. However, it was revealed in another study that age correlated negatively with the Jordanian teachers’ attitudes towards ICT in Jordan ($r = -.13, p <.01$). This result demonstrated that as the age of the teachers decreased, their attitudes towards ICT increased. This finding confirms the results of Roberts, Hutchinson and Little’s study (2003) that the probability that teachers would use ICT in the classroom was limited by the reality that teachers who were educated 20 years ago were trained by people who themselves were trained before the arrival of computers in schools.
In addition, Bauer and Kenton (2005) carried out a study about technology integration in the schools. They used a qualitative study to examine the classroom practice of 30 "tech-savvy" teachers who used computer technology in their instruction. They found that the teachers were highly educated and skilled with technology, were innovative and adept at overcoming obstacles, but that they did not integrate technology on a consistent basis as both a teaching and learning tool. They stated two reasons regarding these findings: students did not have enough time at computers, and teachers needed extra planning time for technology lessons. Other concerns were out-dated hardware, lack of appropriate software, technical difficulties, and student skill levels.

Furthermore, there are other personal characteristics that may influence how teachers use computer applications in their classrooms. The teacher’s own learning style is certainly one such factor. For example, if a teacher is a creative thinker who likes the idea of constructing knowledge, is a life-long learner, a social learner, and a decision maker, he may be more likely to use computers in more integrative and transformational ways that are useful and valuable to students instead of ways that promote and support traditional classroom practices (Bielaczyc & Collins, 1999; Carvin, 1999). Therefore, personal characteristics of teachers are an important influence on how easily they take up an innovation. Support for this is provided by a classic American study of the diffusion of innovations. Rogers (1995) found that innovators are divided into five categories, depending on the stage at which they take up an innovation. The initial innovators typically form the first 2-3 % to take up an innovation, while early adopters make
up the next 13-14%. These two groups together might be called the earlier adopters. This is important when looking for ways to encourage further take-up, because Rogers identifies a tendency for there to be distinctive differences in the personality characteristics of earlier and later adopters. As he summarizes it, earlier adopters differ from later ones in tending to show greater empathy, less dogmatism, a greater ability to deal with abstractions, greater rationality, a more favorable attitude towards change, a better ability to cope with uncertainty and risk, a more favorable attitude toward science, less fatalism and higher aspirations. This characterization implies a distinctly unfavorable perception of later adopters. However a positive description of later adopters is not hard to provide. Compared to earlier adopters, later adopters could equally well be described as more realistic, steadier in their judgments, with a concrete grip on problems, having a dislike for fads, being less willing to take unnecessary chances, having a preference for being guided by experience and with a more realistic appreciation of possibilities than earlier adopters.

2.17 Availability of a Strategic Plan for ICT Integration

Teachers need to know exactly how ICT is used as a teaching and learning tool. Many researchers have pointed out that a school’s ICT vision is essential to effective ICT integration (Anderson & Dexter, 2000). Bennett (1996, p. 60) stressed the importance of a “well-defined mission that describes technology’s place in education”. In line with this idea, Ertmer (1999) wrote, “A vision gives us a place to start, a goal to reach for, as well as a guidepost along the way” (p. 54). Also, Olson (1997) recommends that teachers and schools must develop a
vision before they make substantial investments in hardware and software. In other words, users of technology must have a fundamental belief in the value of innovation or the innovation is doomed to failure. Teachers must have opportunities to study, observe, reflect, and discuss their practice, including their use of ICT, in order to develop a sound pedagogy that incorporates technology (Kearsley & Lynch, 1992). Hence, the vision should not be created by a single person or through a top-down process starting from the MOE. It is crucial to involve those who have a stake in the outcomes, including teachers, parents, students, and the community, and allow them to assist in the creation of the vision by contributing their knowledge, skills, and positive attitudes. Therefore, a clear vision of ICT integration in schools that is shared by all members of the school community promotes effective use of ICT in the classroom. Once the vision has been successfully created and accepted, the next step is to articulate an ICT integration plan, spelling out how the teachers are expected to integrate technology in their lessons (Strudler & Wetzel, 1999). In fact, an ICT master plan that is formulated according to a school’s vision and its socio-cultural setting assures effective integration of ICT (Bangkok, 2004). Gulbahar (2005) conducted a study to illustrate how technology planning process was carried out in a private K-12 school in Turkey. Data were collected from 105 teachers, 25 administrative staff, and 376 students. Findings of this study indicated that educational institutions must develop a technology plan in order to use technology in an effective and efficient manner for teaching, learning and administrative purposes. Also, some issues that should be considered include staff and student
development in ICT-related skills, curriculum and assessment, ICT facilities and resources and support teams (both technical, administrative and pedagogical). Therefore, an ICT integration plan provides a detailed blueprint of the steps and methods needed to translate the school ICT vision into reality. Developing ICT integration plans is no doubt a complex and time consuming task, but they are usually well worth the time required to put them together.

2.18 Computer Attributes
According to past research, Rogers (1995) stated that characteristic of an innovation as perceived by individual in a social system affect on the rate of adoption. Also, he identified five innovation attributes that may contribute to the adoption or acceptance of an innovation: relative advantage, compatibility, complexity and observable. The relationship between an innovation’s attributes and adoption has been examined in a number of diffusion studies. For example, Albirini (2006) found that the computer attributes were significantly correlated to teachers’ attitudes towards computer. Albirini’s study accentuated the importance of computer attributes in the process of computer adoption in developing countries. Also, Dillon and Morris (1996) stated that “innovations that offer advantages, compatibility with existing practices and beliefs, low complexity and potentiality will have a more widespread and rapid rate of diffusion” (p. 6). Therefore, if teachers perceive ICT as a beneficial tool, compatible with their current activities, easy to use and have observable outcomes, they will demonstrate positive attitudes towards ICT.
2.19 Effective Training Program
The teacher has an important role to play in the teaching/learning paradigm shift, with ICT facilitating the development of a higher level of cognitive skills in evaluating arguments, analyzing problems and applying what is learnt. Although teachers play an important role in the learning environment, they are often not consulted regarding changes to teaching learning procedures (Bangkok, 2004). In fact, the teachers’ needs under changing conditions have to be continuously assessed and activities to satisfy these have to be developed. So, professional development is necessary for teachers to enable them to effectively use technology to improve student learning. Staff development should be collaboratively created, based on faculty input and school needs. It must prepare teachers to use technology effectively in their teaching.

According to Spillane (1999), teachers who have a strong engagement towards their own professional development are more motivated to undertake activities, which lead to a better understanding of the goals of an innovation. Similarly, Fullan (1992) pointed out that teachers who are actively involved in their own professional development are more able to implement changes in their teaching. Hence, having a recognition system for innovative and effective use of ICT integration in schools will motivate teachers to use ICT in teaching. For example, formal certification of in-service professional development that leads to diplomas or degrees could provide an incentive for teachers to upgrade and update their skills in and knowledge of ICT integration. In line with this idea, Fullan (1992) suggested that training should not be one shot workshops, but rather ongoing
experiences so that learners can be kept up-to date with ever changing technologies. Teachers need follow-up training sessions to ensure that they keep abreast with current technologies. Hence, teacher training is crucial and these programmes must adequately prepare teachers with skills necessary to integrate technology in their classes. Moreover, they must learn to work smarter and have a vision to implement ICT in their classes. Having vision requires strategic planning, risk-taking and decision making, imagination and commitment. In addition, teachers need to have a clear understanding of what to change as well as how to change (Bennis, 1990). Therefore, they need to become lifelong learners and develop their skills and abilities to overcome their fear of being the captain and focus on leading the ship. In other words the teachers must work to become transformational leaders.

The following section reviews some literature on teacher training to identify models or strategies that are effective for preparing teachers to integrate technology.

2.20 Models for Integrating Technology into Teacher Training Programs

Schmidt (1998) stated that two approaches have been primarily used in teacher education programs which are “offering an instructional technology course” or “integrating technology throughout all courses”. In the first approach, a complete instructional technology course is offered to teachers as one of the courses in their program of study. According to Parker (1997), this approach is not effective because technology classes are usually focused on teaching students about using technology at the expense of exposing them to practical ways of applying it in
their classroom practices (Parker, 1997). In fact, teachers need to understand what computers can do, what learners can do with computers and ways of using them in their classes (Brownell, 1997). Hence, in order for technology to be effectively incorporated into teacher preparation programs, teachers should complete a well-planned sequence of courses and experiences that will help them understand and apply technology in education. In other words, technology must be infused into their instructional practices and that college faculty use technology in their courses as learning and teaching tool. Kortecamp and Croninger (1996) proposed a model that was successfully implemented in a teacher education program at New England University (UNE). This model consisted of five interrelated components which were familiarization with hardware and software, partnering with mentors, developing personal projects, becoming mentors, keeping current. At the first phase of this model, teachers became familiar with hardware and software and then aggressive professional development was introduced to equip them with the knowledge and skills necessary to use the technology. At the second phase, partnering with mentors, teachers were motivated to collaborate with other faculty members who had experience using technology. The main reason for doing this was so teachers get exposed to ways of using technology in their professional activity as well as to provide ongoing support for faculty who were less familiar with technology. In the third stage, teachers were involved in designing projects that help their students to use technology in meaningful ways. For example, teachers designed projects to model technology use in their teaching activities, and to facilitate, place students in technology-rich field practices. At the
final stage, becoming mentor and keeping current, teachers became mentors and guide their students in using technology. Technologies are constantly being developed to decrease the educator’s workload and increase student learning, motivation, and knowledge of tools and skills necessary to become lifelong learners in the age of technology. Therefore, keeping abreast with new technologies is critical if technology is to be effectively used in teaching. Another model was proposed by McKenzie and his colleagues in 1996. They called it the “systematic design model”. This model was applied at West George College to facilitate staff development. The model consisted of three distinct stages: planning, implementation phase, evaluation. This model seems to provide a good explanation of the teachers’ training program because it was designed based on a written technology plan. This plan identified what should be taught, how it should be taught, and which technology should be used in teachers’ training program. Also, a technology planning team was responsible to determine the school's current level of technology use, and to conduct both informal and formal needs assessments in order to identify priorities for professional development activities. In this way, they could get information to establish professional development goals for using technology to promote engaged learning.

Another important feature of the McKenzie’s model is evaluation. In fact, effective professional development uses evaluation to ensure that each activity meets the needs of the participants and provides them with new learning experiences.
2.21 Preparedness in Integration of ICT in Classroom

The challenge for teachers to more effectively harness the educational implications and possibilities of ICT learning resources and tools is not simply a problem of finding sufficient time to develop appropriate computer skills or even think about potential applications but a careful planning. Planning depends largely on how well policy makers understand and appreciate the dynamics of such integration (Jhurree, 2005). Integration of ICTs in education has been a contentious issue (Jhurree, 2005). As Jhurree (2005) claims some people argue that technology will change the educational landscape forever and in ways that will engender a dramatic increase in the performance of learners (Papert, 1997). Unlike these extreme advocates, there are others who adopt a balanced approach (Jhurree, 2005). They are convinced that ICTs, if properly integrated, have the potential to enhance the teaching and learning process (Rehbein, 2004; Kozma, Wagner, 2003). Hinostroza, et al. (2004) note that in order to have long lasting effects, an ICT policy should preferably not be designed in isolation. Rather, it should be part of a more comprehensive effort towards improving the equity and quality of an educational system. Similarly, Levine (1998) emphasizes the importance of having a plan that is based on real school needs and one that is realistic, achievable, and effective. The plan should be produced, not for the sole purpose of putting technology in the classroom but to reflect the real needs of schools in order to make effective technology deployment and to produce enhanced learning environments.
Finally, Hepp, Hinostroza, Laval and Rehbein (2004) have been cautious to emphasize that there is no universal truth when it comes to applying ICTs in education, and that there is no advice that can be directly applied without considering each school’s reality, priorities and long-term budgetary prospects and commitment. While ICT investments for educational innovations and developments have an important potential, it is neglected that there are teachers who will use it in the classrooms as a part of the curriculum (Cohen & Ball, 1990; Vacc & Bright, 1999; Niederhauser & Stoddart, 2001). However, how these teachers perceive these reform efforts is closely related to certain variables such as experience, level of knowledge, attitude toward ICT, educational applications, achievement expectations and learning-teaching approaches (Kozma, 2003).

One of the factors that determine educational development and innovation in general is teachers as they are the ones to use the ICT investments for educational development. Technology does not have an educational value in itself. It becomes important when teachers use it in learning-teaching process. Although there are some who claim that the presence of technology in the classroom creates a pressure and requires effective use (Kozma, 2003), research results show that these are also related to teachers’ levels of knowledge. (Pelgrum, 2001; Garland & Noyes, 2004) wonder why is it that relatively little is known about what motivates a teacher to adopt ICTs in a classroom? The answer lies on the positive approach of use of ICT in Education that should be emulated in the developing world, more so Kenya in order to realize the objectives of vision 2030.
2.22 Related Studies
In an attempt to achieve the objectives of secondary school education and improve on performance, various strategies of teaching have been researched in Kenya though in other subjects. Wachanga and Mwangi (2004) found out that cooperative class experiment teaching method facilitated students’ chemistry learning. This method, increased student’s motivation to learn. The cooperative concept mapping approach teaching method enhanced the teaching of secondary school biology in Gucha district (Orora, Wachanga & Keraro, 2005). A research done in the teaching of agriculture by Kibett and Kathuri (2005) revealed that students who were taught using project based learning outperformed their counterparts in regular teaching approach. Research carried at past revealed that, although Physics is essential for industrialization, there has been a decline in academic achievement scores of secondary school students as well as low enrolment in the subject in Kenya (Kenya National Examination Council KNEC, 2003). Despite the fact that Physics is an important subject in economic, scientific and technological development most schools have made it optional in Forms Three and Four and others do not offer it at all due to students’ poor performance in the subject and lack of enough trained Physics teachers. The mean at KCSE has continued to be low over the years. Often the teacher is blamed for the poor performance among other factors such as availability of teaching facilities and the attitude of the students towards the subject. Teaching methods therefore, are a crucial factor that affects the academic achievement of students (Mills, 1991). Students shun Sciences particularly Physics when given an option and this
especially applies to girls (Aduda, 2003). That is, given a choice a student would rather drop Physics in favor of other Science subjects. For a long time, Physics has been mystified as difficult and hence, some schools have not offered it in the last two years of secondary school education. Recent findings show that students who hold negative stereotype images of scientists, science and technology in society are easily discouraged from pursuing scientific disciplines and usually performed poorly in science subjects (Changeiywo, 2000). This situation does not favor Kenya’s move towards developing a scientific and technological nation more so, when she hopes to achieve vision 2030. The concern is that the performance in Physics is poor and the subject is less popular among students in Kenyan secondary schools as compared to other science subjects. The recurrent complain aired every time the National examinations are released is that performance in science is low. Even if the government has done its part by equipping the schools with modern computers and other ICT facilities, the role of the teacher in the classroom is important. The teaching approach that a teacher adopts is one factor that may affect student’s achievement (Mills, 1991). Consequently, use of ICT in teaching and learning of Physics hoped to be the remedy. According to Huffman, Goldberg and Michlin (2003), computers can be used to create constructivist-learning environments with science teachers’ methods significantly improving from the traditional teacher-centered to pupil-centered. Likewise Redish (1993), in his paper, “What can a Physics teacher do with a computer?” identified three types of capabilities of computers relevant for constructivist approaches in Physics instruction programs: first, computers can
capture and display data from the real world quickly and accurately. The student can link both the concrete elements of the real world and abstract representation of Physics, secondly, computers can perform and display complex simulations, making abstract and inferred concepts real for the student; and finally, Computers avail modeling tools for students. He further describes the use of microcomputer-based laboratories (MBL) where the computer can control, capture and display video images and allow students to take data from the screen for example in pendulum, circular motion, waves, optics and projectile motion.

The use of computer programs that include a collection of tools such as graphing software, spreadsheets, lab tools, video tools and data collecting tools and simulator are all used to actively engage the student in the Physics learning process. These approaches towards the use of ICT in the Physics laboratory reveal the need for the teachers, in the first instance, to be aware of how ICT can be used to enhance constructive learning of Physics by their students. Since teachers are the ones who formulate lesson objectives drawn from the Physics syllabus and plan the learning outcomes, there is need to focus on the teachers, their IT skills, their training, and their understanding of integrating ICT into the Physics curriculum and how the use of ICT influences the teaching and learning environment. There are number of studies that have attempted to categorize teachers’ varying levels of use of computers. For instance, in 1990, Dwyer, Ringstaff and Sandholtz proposed the five-phase teacher development model as follows: Entry, Adoption, Adaptation, Appropriation and Invention. After a decade, UNESCO (2002) put forward a similar four-level conceptual framework.
to describe the stages of ICT use, which are emerging, Applying, Infusing and Transforming. Moreover, Bialobrzeska and Cohen (2005) suggested that there are three levels of integrating ICT into learning, namely through functional practice, integrative practice and transformational practice. While these are helpful categories for the initial classification of how computers are being used, they tend to focus on the teacher (Dwyer, 1990). What is needed is a clear understanding of ICT use in teaching and learning environments.

2.23 Conclusion
The chapter opens by first recognizing the role that Physics in the society. It reviews that Physics interrelates with other disciplines such as medicines, engineering, modern communication and technology. The discoveries of Physics have been important base in science and technology since Physics studies is the essence of natural phenomenon. Secondly, challenges that teachers and students of Physics encounter are highlighted. The major one being the negative attitude towards the subject, abstract concept of Physics content and laboratory experiments that requires collection and processing of data of first moving objects like atoms and electrons. These experiments require reading, recording of values, drawing graphs and analysis. The available literature has observed that ICT may not be the solution of these challenges but it is said to be a resourceful tool that can be able to deal with both the content and process of teaching Physics. This leaves a gap to be filled because scholars have not shown how the ICT can be a resourceful tool in teaching and learning. Therefore, this study is suggested to find out how ICT is utilized in teaching and learning of Physics. It will further come
out with a framework to suggest on the best way these ICTs can be used as a teaching tool. Finally, the chapter is broken down into subsections that address the related concept and gaps in the literature reviewed.
CHAPTER THREE  
RESEARCH METHODOLOGY

3.0 Introduction  
In this section, reintegration of the research questions is made; methodology and design of the study are designed to address the issues of designing, implementation, integration and utilization of ICT in teaching and learning of Physics. It covers the description of the area of study, population identification, study sample, sample size, research approach, research instruments, the pilot study, methods of data collection and methods of data analysis.

3.1 Research Design  
In this research, both the descriptive and explorative research designs were employed. The study is descriptive in nature because, the data interpretation is followed by explanation on responses. The study is also explorative for the reason that, it explores more information on ICT and its benefit to students, teachers and administrators. It uses structured questionnaires to collect quantitative information and interviews. Similar questionnaires were developed for teachers, students and ICT coordinators. The questionnaires issued to teachers, students and coordinators contained basic common items with additional cohort of specific questions. Teachers of Physics and students responded to questions on the use of ICT in teaching and learning of Physics. The present state of ICT facilities in secondary schools was investigated, particularly how ICTs are utilized and their impact on instruction of Physics. The data gathered was subjected into two main analytical approaches: a qualitative analysis, collating the evidence from the various
sources, at school level, class level, student level, and utility category level. Quantitative analyzed data from the various sources, quantifying all the aspects of ICT usage in schools. The choice of this design was dependent on the nature of the data to collect and the variables.

3.2 Location
The study was taken in Tigania west sub-county which is one of the nine sub-counties that constitute Meru County. It is on the Eastern side of Mt. Kenya highlands about three hundred and ninety kilometers (390km) from Nairobi, the capital city of Kenya. Its attitude ranges from 2145 meters above the sea level in the highest regions to as low as 600 meters above the sea level in the lower parts which cover the greatest part of the sub-county. It comprises of Akiithi, Kianjai, Mituntu divisions of Western zones; Uringu, Mbeu and Kitheo location of Tigania Central division. The population of Tigania west according to 2009 national census was reported as shown in the table 3.1.

<table>
<thead>
<tr>
<th>Demographic characteristic</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Pop. Below18 years</td>
<td>36,239</td>
<td>42,751</td>
<td>78,990</td>
</tr>
<tr>
<td>Total Pop. 18 years and above</td>
<td>43,631</td>
<td>52,136</td>
<td>95,767</td>
</tr>
<tr>
<td>Total</td>
<td>79,870</td>
<td>94,887</td>
<td>174,757</td>
</tr>
</tbody>
</table>

**Source:** Tigania west District registrar: Pop. Index (persons per Km²) =239.4

Tigania west sub-county covers an approximate area of 730 square kilometers, it boarders Isiolo county to the west, Tigania East to the north, Tharaka to the East and Imenti central to the south. Tigania west is on a semi-arid region with its main
economic activity being peasant and pastoral farming (see Appendix XIV). The schools are not evenly distributed because most of the schools are found on the western zone. Tigania west has primary school enrollment rate of 19.9%, it is ranked tenth in the province. Secondary school enrollment rate is 61.2% it is ranked 8th in the province (Ministry of Education DEO’s office). The sample schools cover different geographical regions; (upper, lower, eastern and western zones of Tigania west sub-county), categories; (provincial, sub-county), status; (Boarding and day schools) and management; (government, private, missionaries).

3.3 Variables
As mentioned in the previous section, teachers’ classroom use of ICT depends on a variety of internal and external variables. Considering the research and the literature reviewed the variables are classified into three categories below:

i. Independent variables: Availability of funds, National ICT policy, School ICT policy, availability of ICT, ICT competency, availability of power, Internet connectivity.

ii. Intervening Variables: Teacher’s attitude and beliefs, individual characteristics, Student’s attitude, management style, teacher’s motivation

iii. Dependent variables: ICT integration in teaching and learning

3.3 Target Population
The research was carried out in schools in Tigania west sub-county. Currently there are four (4) provincial boarding secondary schools; 12 provincial day secondary schools, 10sub-county boarding and 14-day schools. Of these schools,
18 schools are boarding, while 22 are day schools. The target respondent comprises school’s principal, form two Physics teacher(s), ICT coordinators and form two students. The sample locale and sample size were selected purposely. It was based on qualitative as well as quantitative information. The study focused on the schools within Tigania west sub-county, Meru County, Kenya. The rationale being that, Tigania west has many schools that the Ministry of Education has granted funds for installation of ICT resource centers such as; Miathene boys (provincial school), Kanjalu girls (provincial school), Akithii girls (provincial school) and Athwana Boys (district school). These and other schools in the sub-county have been using ICT since 2004 for instruction purposes hence there is a need to carry a study to find out how ICT and related technologies have been integrated in teaching and learning in the schools. The study will involve physics teachers, form two physics students, principals and computer teachers.

3.5 Sample Procedure and Sample size
The sample of the study was made of 152 respondents which comprised six principals, six computer teachers, 20 teachers of physics and 120 students. At first, all the schools in the sub-county were listed. Secondly, through consultation and liaison with the sub-county education’s office, purposively picked the schools that have started ICT integration. This formed 30% of the total schools in Tigania West Sub County.
Two schools were randomly selected for pilot study, the table 3.1 shows the sample size in each category.

**Table 3.2 Sample size**

<table>
<thead>
<tr>
<th>Respondents</th>
<th>Target population</th>
<th>Sample size</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of schools</td>
<td>40</td>
<td>12</td>
<td>30</td>
</tr>
<tr>
<td>Principals</td>
<td>12</td>
<td>6</td>
<td>50</td>
</tr>
<tr>
<td>Physics Teachers</td>
<td>48</td>
<td>20</td>
<td>41.2</td>
</tr>
<tr>
<td>Computer Specialists/Teachers</td>
<td>18</td>
<td>6</td>
<td>33</td>
</tr>
<tr>
<td>Physics Students</td>
<td>480</td>
<td>120</td>
<td>25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>558</strong></td>
<td><strong>152</strong></td>
<td></td>
</tr>
</tbody>
</table>

The following non-probability sampling procedure guideline was applied to select the participating schools.

i. The sampling procedure was purposive because the schools are to be known to have computers, although the exact number of computers was not important to this study.

ii. The specific schools were coded S1 to S12. Teachers were coded T1.1 to T12.2 where T1.1 is the first teacher in the first school and T12.2 is the second teacher in the twelfth school and so on. Similarly, names of participating students were converted to L1.1 to L12.10, while those of the computer specialists or teachers and principal were coded as CS1 to CS12 and P1 to P12 respectively.
3.6 Data collection Procedures
Secondary data was collected by the method of analysis of documents. Such documents included official records, newspaper accounts, reports, as well as the published data used in the review of outstanding literature. Primary data on the other hand was obtained directly from the field and collected through observation, self-administered questionnaires, and interviews.

3.6.1 Questionnaires
Three questionnaires were prepared targeting the Physics teacher, ICT specialist and students. The data from students give the best verification on the consistency of Physics teacher’s data on use of ICT in classroom practice. Besides, it also compared teachers report on ICT skills of their students with what the students reported. Moreover, the student questionnaire focused on skills that student have, their confidence using ICT, level of ICT use with teachers in class, outside formal teaching hours, and at home. The teacher’s questionnaire focused on most core variables. These include; the professional level of training of the teacher, experience, teacher competencies, ICT access issues, and presence of ICT artifacts and their use. The computer specialist’s questionnaire mainly concentrated on the ICT infrastructure, presence of hardware and software, connectivity and school ICT policy issues. There was an overlap on questions that sought to establish Physics resources that are available and which were used by Physics students and teachers. These questionnaires were designed such that each question was related to a given research question and the topic. Both closed and open ended questions were used. Open ended questions were to help supplement
the information given in the closed ended questions and helped in obtaining more complete data. The questionnaires were preferred because they give clear and specific responses and enable the respondent to express themselves freely especially teachers who may not have enough time to attend to personal interview. In general, students questionnaires included items that investigated; their attitudes toward ICT educational experiences; self-assessment of competence and confidence in ICT; access to a range of facilities and resources (both at home and in school); their ICT interests, hopes and expectations for the future. Teachers of Physics and ICT Coordinators items required responses on their attitudes, ICT preferences and actual uses of ICT. Their expectations and aspirations for the future, current levels of skills, access and level of use of ICT was noted. Moreover, changes in pedagogy, staff development experiences, including strengths and weaknesses of training, and future needs, and responses to the ‘digital gap’ between home and school were established.

3.6.2 Questionnaire Construction and Organization of Items

The questionnaires were structured to incorporate both closed and open-ended questions. The distribution of the questions in all questionnaires is given in the table 3.3 below.
Table 3.4 Questionnaire Arrangement

<table>
<thead>
<tr>
<th>Main Part</th>
<th>Question Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bio-data</td>
<td>1,2,3 and 4</td>
</tr>
<tr>
<td>Computer accessibility and usage</td>
<td>5,6,7 and 8</td>
</tr>
<tr>
<td>ICT Training and Skills</td>
<td>9 (i, ii, and iii)</td>
</tr>
<tr>
<td>Software used and Skills</td>
<td>13 and 14</td>
</tr>
<tr>
<td>Views / personal opinion on ICT use</td>
<td>15</td>
</tr>
<tr>
<td>Challenges face in ICT integration</td>
<td>16, 17 and 18</td>
</tr>
</tbody>
</table>

The Items that asked for the respondent’s reason for their answers often followed questions that required yes or no responses.

3.6.3 Interview Guide

Interview guide was used to collect primary data. Semi-structured face-to-face interview guide (Appendix IV) were set up with sets of outlined questions about issues to be explored. The outlined questions were meant to guide and make sure that all the relevant topics are covered. Interview guides permitted the researcher to probe and guide the respondents for detailed information and help keep interaction focused. Interviews were suitable for administrators since they had limited time to respond to questionnaires and verbal interaction with them helped in detecting biased answers. Moreover, the informal nature of the interview with the teachers and students facilitated building of good rapport with interviewees. School Principals interview items among others included the following: their awareness of and involvement in the initiatives, existence of a school policy on ICT, awareness of and support for changes in pedagogy. Also their perceived priorities with respect to ICT and resource allocation, development planning, the
impact of staff development; their intentions and aspirations for the future; responses to the ‘digital gap’ between home and school. The interview schedule items were based on eighteen (18) guide questions that follow the order of the questionnaires.

3.6.4 Observation Guide
Observation of participants in the context of a natural scene was made especially when they were in computer labs. Observation provided knowledge of the context in which events occurred, and enabled the researcher to see the utilization of the available resources and the things that participants themselves were not aware of.

The school visits give a chance to carry out on site observations. The computer specialist (CS) inspected the ICT infrastructure to confirm accuracy of the report. As it proved to be the case, there were instances where the CS was not sure about some computer specifications such as network switch specifications and server software in use, processor speed, memory and hard drive size. In some schools where the classes were ongoing in the computer, laboratories were observed for between 20 minutes to 40 minutes. Physics laboratories, preparation rooms and storerooms were also checked to determine other equipment that were available and whether they included ICT tools.

Although, the observation check list give an opportunity to carry on site observation it was possible in only six schools. The other schools had no class scheduled for Physics and those who had the lessons were scheduled for practical and theory in the classrooms. The ICT infrastructure was examined to confirm
accuracy of the responses given by the computer specialist (CS). Some photographs were taken of exemplars of computer laboratories and display screens with the consent from the principal (see Appendix VIII). Field notes were made with a column for observations where insights and suggestions were recorded (see Appendix V and VI).

3.7.0 Piloting

To determine the validity of the research instruments, a pilot study was conducted prior to the actual research where two schools were involved. The pilot study helped the researcher to adjust the questionnaires.

3.7.1 Validity

To establish the validity, the instruments (Appendix I, II and III) were subjected to the scrutiny of two experts who evaluated the relevance of each item in the instruments to the objectives. The experts rated each item on a scale. Their recommendations were used to finally modify questions and the format of the tools that had the ability to solicit the expected data. The physics students, teachers and computer specialists were the relevant subjects that were given questionnaires, observed and or interviewed to obtain data. Once the questionnaires were designed and rated, the content validity index (CVI) was then computed as follows;
CVI = \frac{\text{Agreed Items by both validators}}{\text{Total number of items being validated}}

<table>
<thead>
<tr>
<th>Table 3.5: Rater opinions</th>
<th>Relevant Items</th>
<th>Not relevant Items</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rater 1</td>
<td>40</td>
<td>6</td>
<td>46</td>
</tr>
<tr>
<td>Rater 2</td>
<td>39</td>
<td>7</td>
<td>46</td>
</tr>
<tr>
<td>Total</td>
<td>79</td>
<td>13</td>
<td>96</td>
</tr>
</tbody>
</table>

\[
\text{CVI} = \frac{79}{92} = 0.86
\]

Since the established CVI was 0.86 (CVI < 1) it is an indicator that the instrument was valid.

3.7.2 Reliability

A pre-test was conducted after establishing the validity. Thirty respondents from two schools were used in the pre-test to answer the questionnaire. Their responses were subjected to a Cronbach’s Alpha Coefficient reliability test using the following formula:

\[
\alpha = \frac{K}{K-1} \left( 1 - \frac{\sum_{i=1}^{K} \sigma^2_{Y_i}}{\sigma^2_X} \right)
\]

Where \( K \) is the number of components (\( K - \) Items

\( \sigma^2_X \) Represents the variance of the observed total scores

\( \sigma^2_{Y_i} \) Represents the variance of components \( i^{th} \) for the current sample of persons

The cronbach’s \( \alpha \) was equal to 0.76 which indicated that the questionnaire was very reliable. Further reliability of the instrument was established using computer program of SPSS deploying Cronbach Alpha method of internal consistency to measure instruments consistency.

In conclusion, this study used three main triangulation methods;
i. The data triangulation – four main sources of data was used namely the principal, Physics teacher, the ICT teacher and the students.

ii. The methodological triangulation – three data gathering methods were used. These were; observation, interviews (informal and formal) and questionnaires.

iii. Use of the internal consistency technique (Cronbach formula)

3.8 Data Collection Techniques and Procedures
This research entirely used two main data collection approaches; quantitative and qualitative. Both secondary and primary sources of data were used. Secondary sources provided existing information about the schools such as their ICT status. Most of this information was found in the sub-county Education’s Office (DEO), Ministry of Education Science and Technology (MOEST) and United Nations Educations, Social and Cultural Organization (UNESCO) publications. Primary data was collected through use of questionnaires, interview and observation schedules. During the visits, questionnaires were distributed by researcher for completion by the Physics teacher (Appendix I), Physics students (Appendix II) and computer specialist (Appendix III). Within the limits of the time that was available at each school, interviews were carried out with the school principals (Appendix IV).

With permission from the Ministry of Education Science and Technology (MoEST) at district level, the DEO wrote a letter of introduction to all principals granting permission to conduct the research in the schools in the district for
 academic purpose. The schools were visited during the period of 13\textsuperscript{th} February-24\textsuperscript{th} February 2012. Most of the principals after introduction made elaborated remarks on the use of ICT that some of them were used in the data analysis. In other cases, the researcher was referred to the deputy head and in one case to the teacher on duty who acted as a guide to the Physics laboratory and computer room where the Teachers of Physics and computer specialists were located. The Teachers of Physics helped to locate Physics students. In two schools Physics student were met in the science lab and computer lab respectively. On average, a school visit lasted two hours during which the first 20 minutes was spent at reception and the principal’s office. However at one school, despite having made an appointment over the phone, the Principal was not available and he was the only one who processed computer lab keys I could not access the ICT facilities in that school, although others participated. Effort to contact this principal over the phone and emails later had no results since the phone calls and emails were not answered.

3.9 Data Analysis Techniques

After collection of the data, data cleansing was done in order to determine erroneous, partial or irrational data and then develop the quality through corrections of detected errors and/or omissions. After cleaning, the data collected was coded and entered in the computer for analysis. Data analysis procedures that were employed involved both quantitative and qualitative procedures. Quantitative data derived from the demographic section and other closed
questions were analyzed using descriptive, cross tabulation and referential statistics. Qualitative data generated from the open-ended questions in research instruments was organized according to objectives and categorized through content scrutiny. The data analysis required the use of computer spreadsheet, therefore, the statistical package for social sciences (SPSS) was used.

3.10 Logistical and Ethical Consideration
Since qualitative research is conversational, researcher maintained clear boundaries between what the participants said and what they were told. In summary, the following were observed during the study:

i. Before involving the participants, permission from the head of the institutions (principals) was sought first.

ii. Participants were informed fully about the purpose, methods and intended possible use of the research findings and what their participation in the research entails.

iii. The confidentiality of information supplied by research subjects and the anonymity of respondents was respected by giving the schools and participants codes.

iv. Research participants participated in a voluntary way, free from any coercion.

v. The research was conducted competently and with due concern for the dignity and welfare of the participants and in a manner consistent with
Kenyan laws and school rules and regulations, as well as professional standards and ethics governing the conduct of research.

vi. Prompt opportunity for participants to obtain appropriate information about the nature, results, recommendations and conclusions of the research, after carrying out the study was provided.

vii. Finally, reasonable measures to honor and appreciate all commitments made by research participants and the institution head was made.

3.11 Conclusion
This chapter has provided a description of the research design decisions taken to carry out the study. A survey study approach was taken as a choice of what is to be studied. A combination of non-statistical and statistical sampling procedures was used that lead to site and participant selection were highlighted. Use of different sources of data and use of different methods to collect the data through questionnaires, observation and informal interviews are explained as three ways of triangulation. The use SPSS was described under data analysis with emphasis on use of the inductive method of qualitative data analysis and ends with a vivid illustration of the ethical principles that was observed.
CHAPTER FOUR

REPORTING AND DISCUSSION OF FINDINGS

4.0 Introduction

This chapter presents findings of the study, which have been discussed under the thematic areas and sub sections in line with the study objectives. The thematic areas were questionnaire return rate, demographic characteristics of the respondents. The analysis of data collected and interpretation was in relation to the objectives and research questions.

Table 4.1 Questionnaires Return Rate

<table>
<thead>
<tr>
<th>Category of Respondents</th>
<th>Administered</th>
<th>Returned</th>
<th>Return Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics Teachers</td>
<td>20</td>
<td>18</td>
<td>90%</td>
</tr>
<tr>
<td>Computer specialists/ Teachers</td>
<td>6</td>
<td>6</td>
<td>100%</td>
</tr>
<tr>
<td>Physics Students</td>
<td>120</td>
<td>120</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>146</strong></td>
<td><strong>144</strong></td>
<td><strong>98.6%</strong></td>
</tr>
</tbody>
</table>

In this study, a total number of 120 students, 20 teachers, six computer teachers and six Principals were sampled giving a total of 152 participants. A total of 144 questionnaires (98.6%) were fully completed and returned of which 120, were filled by students, 18 were filled by teachers and six were filled by computer teachers respectively. Data was collected using questionnaires, interview guide and observation checklist and the responses were statistically analyzed.

The response rate was made possible as the researcher administered the questionnaires in-person and waited for them to be filled-in. In few cases, the questionnaires were dropped and respondents reminded continuously to fill them
in. The results are presented in this chapter in form of frequencies, distribution tables, percentages, charts and graphs.

4.1.0 Biographical Data

In order to establish the type and various characteristics of the participants, their background information was captured under the following sub endings:

4.1.1 Sex

The respondents were asked to indicate their sex. The findings show that 64.5% of the respondents were male while 35.5% were female. In all categories the male overcame the female with the biggest discrepancy on the side of students table 4.2.

Table 4.2 Category of Participants by Sex

<table>
<thead>
<tr>
<th>Sex</th>
<th>Principals</th>
<th>Teachers of Physics</th>
<th>Computer Teachers</th>
<th>Students</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Freq</td>
<td>%</td>
<td>Freq</td>
<td>%</td>
<td>Freq</td>
</tr>
<tr>
<td>Male</td>
<td>4</td>
<td>66.7</td>
<td>14</td>
<td>70</td>
<td>4</td>
</tr>
<tr>
<td>Female</td>
<td>2</td>
<td>33.3</td>
<td>6</td>
<td>30</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>6</td>
<td>100</td>
<td>20</td>
<td>100</td>
<td>6</td>
</tr>
</tbody>
</table>

The finding concurs with the literature review that indicated there are a few female students taking Physics. This shows that the Physics subjects in Tigania West, is mostly dominated by male which underscores that Physics field, just as most scientific and technical disciplines, is predominated by male. Similarly, most of the schools are headed by male principals since there are 66.7% of the principals being male against 33.3% for the female counterparts. The same was observed for the computer specialists. Therefore, unless explicit measures are
taken to address the constraints girls and women face, any attempt to formulate ICT as a tool for knowledge and information indulgence for the underprivileged may increase gender disparities and lessen the potential impact of ICT in education.

4.1.2 Age

Only teachers who were asked to indicate their age since students are regarded to be of the same age cohort. Teachers who filled the questionnaire, their ages ranged from 30 to 50 years. Table 4.3 gives the range of teacher’s age by schools.

**Table 4.3 Teachers Age**

<table>
<thead>
<tr>
<th>Age</th>
<th>Male</th>
<th>Male %</th>
<th>Female</th>
<th>Female %</th>
<th>Total</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 30</td>
<td>3</td>
<td>15</td>
<td>2</td>
<td>10</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>31-40</td>
<td>5</td>
<td>20</td>
<td>3</td>
<td>15</td>
<td>8</td>
<td>40</td>
</tr>
<tr>
<td>41-50</td>
<td>6</td>
<td>30</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>30</td>
</tr>
<tr>
<td>Over 50</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>15</td>
<td>5</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

n=20

It was found out that 15% of the teachers are age 30 years or below. Majority of teachers are aged between 41-50. Amazingly, there was no Physics lady teacher who was above the age of 41 years. Analysis of literature revealed some areas in which there were significant differences by age group for access to different forms of ICT and confidence in using some applications by teachers. However, the effect sizes were small. Although it would not be appropriate to assume age-related differences as a basis for program planning, it would be important to recognize that such differences in access, related experience, and confidence do
exist between and within age groups and to ensure that any teacher preparation program offers opportunities for access that will assist teachers to extend their experience of ICT and build their confidence with a wider range of applications.

### 4.1.3 Academic Qualification

When teachers were further to indicate their higher academic qualifications, 60% of the students had bachelors’ degree as their highest qualification. Only 10% had other qualification but they did not specify.

**Table 4.4 Level of Education**

<table>
<thead>
<tr>
<th>Level of Education</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Masters Degree</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Bachelor’s Degree</td>
<td>12</td>
<td>60</td>
</tr>
<tr>
<td>Diploma</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Others</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>20</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

n*=20

The findings indicate that most of the teachers in Physics department have good academic credentials (Masters and Bachelor’s degree). However, it was revealed that, the teachers who indicated others, untrained to teach Physics. They reported having KCSE certificate a waiting to join university for other carriers other than education.

### 4.1.4 Teaching Experience

Though some research reported that teachers’ experience in teaching did not influence their use of computer technology in teaching (Niederhauser & Stoddart, 2001), most research showed that teaching experience influence the successful
use of ICT in classrooms (Wong & Li, 2008; Giordano, 2007; Hernandez-Ramos, 2005). Gorder (2008) reported that teacher experience is

Factors influencing teachers’ adoption and integration of ICT significantly correlated with the actual use of technology. Similarly, in United States, the (U.S National Centre for Education Statistics, 2000) reported that teachers with less experience in teaching were more likely to integrate computers in their teaching than teachers with more experience in teaching.

When teachers were further asked to state the number of years in teaching, the responses was as shown in table 4.5.

Table: 4.5 Years of Experience

<table>
<thead>
<tr>
<th>No. of Years Worked</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 2 years</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>3 to 5</td>
<td>12</td>
<td>60</td>
</tr>
<tr>
<td>6 to 10</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>11 to 15</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Above 15 years</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

\[ n^* = 20 \]

Table 4.5 illustrates the findings on the number of years the respondents had taught Physics. It was found out that 60 % of the teachers had the experience between 3 to 5 years. There was only one teacher who had an experience of more than 15 %. This indicates that teachers of Physics had a vast of experience and knowledge.
4.2 Teachers Level of ICT Expertise

Computer competence is defined as being able to handle a wide range of varying computer applications for various purposes (van Braak et al., 2004). This subsection explores the first objective, teacher’s skills in the use of ICT in teaching of Physics. The teachers rated themselves depending on their ability to use computer in teaching and learning.

Table: 4.6 Level of ICT Skills

<table>
<thead>
<tr>
<th>Level of Expertise</th>
<th>No. of Teachers</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Expertise – Cannot use computer applications</td>
<td>8</td>
<td>40</td>
</tr>
<tr>
<td>Fair - Operates basic functions</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>Good – Can use office applications</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Very-Good - Use office applications and Internet</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Excellent – Can use office applications, web, internet, blogs and emails</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>100</td>
</tr>
</tbody>
</table>

The teachers level of computer skills was very low, 40% of teachers could not use computers, compared to the 10% of the teachers that claimed to use computer with confidence. The study reviewed that most teachers could not effectively use computers to support curriculum implementation due to lack of computer skills and therefore could not operate the basic functions such as typing and printing. However, 20% had fair skills for performing the basic tasks though they said the relied so much from the computer teacher. Teachers who claimed to have good
skills in ICT were 15%; they could do most of the office application without any difficulties. Similarly, those who could perfectly carry out with confidence the office applications and internets were 15% they required minimal technical assistance from the computer specialist. Conversely, only five per cent of the teachers were experts, indeed one teacher only who claimed could carry out office application web and internet activities without any assistance from the computer teacher. This supports further the reason that makes teachers of Physics to shy away from use of ICT in teaching, though the administration has offered good ICT working environment. The level of expertise was determined by use of a five level of Likert scale ranging from “NO expertise to Excellent”. It can be deduced that, some teachers not only lack ICT related training but also lack professional training because 10% of teachers of Physics were untrained to teach Physics and 40% lacked basic computer skills. Teachers with no IT training seemed to shy off from the use of any ICT resource. Teachers’ computer competence is a major predictor of integrating ICT in teaching. Because it was found out that majority of teachers who reported negative or neutral attitude towards the integration of ICT into teaching and of Physics processes lacked knowledge and skills that would allow them to make “informed decision. The findings concurs with a qualitative multiple case-study research on primary school competence and confidence level regarding the use of ICT in teaching practice conducted in five European countries, Peralta & Costa (2007) found that technical competence influenced Italian teacher’s use of ICT in teaching. However, the teachers cited pedagogical
and didactic competences as significant factors if effective and efficient educational interventions are likely to be implemented.

4.3 Students Computer Skills

The present-day students are essentially in a different situation from previous generations, with the large majority of students having ICT skills that are of a different type from their teachers’ (and parents’), often better and wider; even the time spent using a computer efficiently supports the improvement of ICT skills. It is obvious that for the younger generation using ICT is easy and ordinary, characterizing a life-style consisting of the functions of both working and learning, as well as functions of leisure time, like social media, gaming or uploading and listening to music, Pederson (2006). There is a cultural gap between students and teachers in terms of the digital world, and, as mentioned in Pedersen et al. (2006), very few teachers know what is going on in the digital world of a 13-year-old student. This differentiation and students’ ICT competence are challenges for teachers because the digital skills are nowadays basic skills, such as reading and writing. Student’s computer skills were captured by rating themselves using a four-tier scale from None- Expert. Most Physics students had no ICT skills from their previous schools. This is an indicator that students in secondary school have little knowledge of computers in their lower classes.
The majority of students, of both genders, had the skills for performing simple activities, such as using a file and communicating via the Internet. Although the majority of students also managed more complex file management activities, girls more often had problems, and, further, girls had fewer skills in “complex communication” e-mail messaging and advanced applications desktop publishing software. There are, however, some results that show that the difference between boys and girls in ICT use and competence is diminishing, e.g. Lahtinen (2007) argues for this in his study of 14-year-old Finnish students. Anyway, the difference between boys and girls is not simple and straightforward, and it is changing rapidly because of the extensive use of the Internet. Table 4.4 shows the responses of basic skills such as the use of the mouse, keyboard and general navigation within windows environment. It seen that, half of the students (50%) have no computer skills while 39% and 16% of the students had basic and

<table>
<thead>
<tr>
<th>Skills</th>
<th>None</th>
<th></th>
<th>None</th>
<th></th>
<th>None</th>
<th></th>
<th>None</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Freq</td>
<td>%</td>
<td>Freq</td>
<td>%</td>
<td>Freq</td>
<td>%</td>
<td>Freq</td>
<td>%</td>
</tr>
<tr>
<td>Word processing</td>
<td>38</td>
<td>36</td>
<td>30</td>
<td>28</td>
<td>29</td>
<td>27</td>
<td>23</td>
<td>26</td>
</tr>
<tr>
<td>Spreadsheets</td>
<td>45</td>
<td>42</td>
<td>41</td>
<td>38</td>
<td>28</td>
<td>26</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Presentation tools</td>
<td>67</td>
<td>63</td>
<td>45</td>
<td>42</td>
<td>8</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Databases</td>
<td>87</td>
<td>81</td>
<td>33</td>
<td>31</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Internet</td>
<td>24</td>
<td>22</td>
<td>54</td>
<td>51</td>
<td>30</td>
<td>28</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>Basic maintenance</td>
<td>50</td>
<td>47</td>
<td>43</td>
<td>40</td>
<td>27</td>
<td>25</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Publishing software</td>
<td>72</td>
<td>67</td>
<td>48</td>
<td>45</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
average computer skills respectively, therefore they had indicated they could carry out some of the computer operations with minimal assistance from either the teacher, computer teachers or other students. Moreover, 7% of the students claimed to have expert skills, they could perform most of the computer operations without relying form the teacher or computer specialists. However, they had no skills in basic maintenance, databases, presentations tool and publishing software such as, MS-publisher, Corel draw and adobe page maker. In contrary, there is an even distribution of students across the categories ranging from no skills to those claiming expertise on the use of internet.

4.4 Attitude of Use of ICT by Respondents

Physics teachers presented the belief that ICT tools can provide students the opportunity to explore in-depth different abstract topics by using specific tools (eg, simulations), which cannot be investigated in the laboratory for different reasons like inadequate equipment and lack of time. They have also indicated that ICT is perhaps a way of promoting investigative practical work, which might offer much more opportunities compared to illustrative practical work. In such a case, the students will have the opportunity of exploring a topic in-depth by actual experimental activity together with an abstract investigation while using ICT tools in learning Physics. Consequently, students’ understanding is expected to be improved. However, it was clearly well-defined that teachers believe that laboratory and practical work cannot be replaced by virtual experiments and by the use of ICT, as the students are required to develop different investigative skills. Thus, they concluded that the use of ICT in Physics teaching should be an
additional element in laboratory activities aiming to support and enhance practical work not to replace it. Teachers were asked to rate themselves using a Likert scale of five ranging from strongly agrees to strongly disagree; the following figures illustrate the perceptions of teachers in the use of ICT in teaching and learning of Physics.

**Figure 4.1 Teachers views on how ICT enhances learning of Physics**

In general, most of the teachers agreed that use of ICTs makes them more effective in their teaching, i.e. ICT enhances effective teaching by making them more organized in their lesson planning and meeting various needs of students. Teachers largely agreed that with the use of internet and technology, their lesson plans are better off and enjoyable, 56% of the teachers agreed while 24% strongly agreeing. Only a small percent, (4.5%) disagreed with 13.5% not sure because they had not used ICT in teaching.
When teachers were asked whether ICT helps in lesson planning and development, 35% of the teachers agreed that ICT helps in lesson planning with 14% strongly agreeing. There was 18% of the teachers who strongly disagreed and 27%, who disagreed that the ICT does not help in lesson planning.

**Figure 4.2: ICT helps in lesson planning and development**

It seems that only 6% of the teachers were not sure of the effect of ICT. Their opinions were pegged on their capability to access and use the ICT facilities in teaching.

Further, teachers were asked if the use of ICT helps to meet various needs of the Physics students. Their responses are illustrated by the figure 4.3.

**Figure 4.3: ICT helps to meet various needs of students**
There were no much differences when we consider their responses on how ICT helps in lesson planning and how it meets various needs of the students. There were 33% of the teachers who agreed, 19% disagreed, while 16 % disagreed strongly as compared to the 29 % who strongly agreed. Therefore, most teachers agreed that the ICT is able to meet various needs of the student in teaching and learning of Physics.

Finally, teachers were asked to state whether ICT makes the Physics lesson enjoyable, their responses were as shown in the figure 4.4

![Use of ICT makes the lesson enjoyable](chart.png)

**Figure 4.4: Use of ICT makes the lesson enjoyable**

Most teachers acknowledged that ICT makes Physics lesson interesting and enjoyable, in total 60% agreed and 34% strongly agreed. A very small percent of teachers that disagreed and one per cent were undecided. It was observed that majority of teachers indicated that they would like to integrate more computer applications into their teaching. Therefore, it appears that teachers’ perceptions toward ICTs in teaching Physics are encouraging, where most of them showed positive perception on computer use in teaching and instruction. It is believed
that, teachers can see the value of the ICTs in enhancing teaching and learning, and they are positive towards further integration of technologies into classroom instruction. The general feeling was that Physics teachers believe there are tools which motivate students and enhance their scientific understanding by improving investigative practical work. Physics teachers pointed out that a successful Physics teaching requires the use of laboratory work during which the students are able to link theoretical understanding and a practical activity. Thus, the students and their teachers as well have the opportunity to evaluate and identify possible misconceptions or enhanced conceptual understanding. Thus, Physics teachers concluded that different ICT tools (eg, data loggers and simulations) could augment current practical activities and consequently offer the students additional supporting instruments regarding their understanding. However, the teachers were aware that the use of technology is not always beneficial for students and that on its own cannot solve existing problems regarding Physics teaching.

4.5 Availability of ICT Resources

This section entails identification of the presence of ICT resources and key features of the computers that are used in schools. The schools were categorized into various levels for easier analysis according to the school type. One of the major factors affecting integration of ICT in education is the availability and adequacy of the ICT tools. If the available ICT resources are not adequate enough for both the students and teachers, full utilization of these tools may never be realized. In view of this, respondents were requested to rate the adequacy of ICT resources and the findings are presented in Table 4.8:
There were 300 computers available in the 12 schools that were involved in the study. Out of the available computers, 92% of them were working therefore only 8% that were grounded.

It was noted that, PBS and PDS had the highest number of computers although most of them were not working. Surprisingly, the DDS despite having the lowest number of computers they were all in working condition. Since there were 300 computer systems in 12 schools, it can be averaged that, in Tigania west district there is an average of 25 computers per school.

4.5.1 Type of computer available
Schools had different types and models of computers. In this study they were clustered in terms of the processor type, processor speed and storage capacity.

From the table 4.9, it shows the numbers of schools that had the computers with Pentium I, II, III, IV and Celerons or clone that are classified as others.

<table>
<thead>
<tr>
<th>Processor Type</th>
<th>No. of Schools</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intel Pentium 4</td>
<td>5</td>
<td>41.7</td>
</tr>
<tr>
<td>Intel Pentium 3</td>
<td>6</td>
<td>33.3</td>
</tr>
<tr>
<td>Intel Pentium 2</td>
<td>2</td>
<td>16.7</td>
</tr>
<tr>
<td>Others</td>
<td>1</td>
<td>8.3</td>
</tr>
</tbody>
</table>
About 41.7% of the schools had computer systems that had Pentium 4 (P4) type of processor. Most of the computers were said to have been upgraded to P

There was only one school (1%) that had computers that were P1. There was CS in this school for guidance; they were waiting for the technician to arrive repairs and maintenance. From the table 4.7 it shows that 33.3% and 16.7% of the schools had P4 and P2 processor types respectively. These systems were reported to be working though they were slow because of the low processor speeds (figure4.3) show the processors speeds available in schools.

4.5.2 Processor speed
Processor speed is important because it determines how fast a computer is able to perform a task. High speed computer are able to multitask which makes the user to have many programs running at the same time without the computer hanging up. Low computers are not able to run heavy learning software such as Exam Vista. Computers specialist or teachers give the following responses as shown on figure 4.5.

![Figure 4.5 Computer Speeds In Mhz](image)
It was revealed that half of the schools had computers with 2.4 Ghz processor speed and 8.3% had the processor speeds that was below 1Ghz. Figure 4.5, illustrates that half of the schools have computers that have the processor speed of 1.2GHz. CS from the schools was recommending the management to purchase computers that had the processor speed above 1.2 GHz. There was 25% of the schools that had computers with the processor speed of 2.4GHz and 16.7% respectively. The lowest processor speed was 512MHz. These computers were used by students to learn basic skills in computer packages and not for integration in teaching and learning.

4.5.3 Storage capacity

Computer storage capacity in a computer is essential since it’s the one that determines the amount of data that can be stored in a computer and the software to be installed. Computers with low storage capacity are said not to be installed the modern windows such as window vista, windows 7, windows 8 and other learning programs such as Encarta suite for students. The computer specialist were asked to indicate the storage capacities of the available computers and responses was tabulated as shown by the figure 4.6

![Figure 4.6: the storage capacities computers in GB-Gigabytes](image)
The highest percentage of computers (50%) were having 40GB and were found in half of the schools, 25% had 80GB. The highest storage capacity was found in two schools (16.7%) and was 120 GB while the lowest was in one school (8.3%). The school secretaries use these computers with the lowest storage capacity to type and print office work and exams. Teachers and students had a limited access to these computers because they were intended to be used by the school management.

4.5.4 Peripheral devices

Most of the computers in the schools were fitted with CD ROM or DVD ROM drives while a few schools had some computers fitted with CD-writers and DVD-writers. Other peripheral devices common in the schools were printers. Digital cameras were available in 25% of the schools while projectors in 42% schools. Modems were available in 58% schools. Although the computers in all schools were fully multimedia, not all computers had headphones or computers.

Table 4.10: Summary of the Peripheral Devices

<table>
<thead>
<tr>
<th>Peripherals</th>
<th>No. of Schools</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Printers</td>
<td>12</td>
<td>100</td>
</tr>
<tr>
<td>Scanners</td>
<td>8</td>
<td>67</td>
</tr>
<tr>
<td>Photocopies</td>
<td>7</td>
<td>58</td>
</tr>
<tr>
<td>DVD Rom</td>
<td>9</td>
<td>75</td>
</tr>
<tr>
<td>CD Rom</td>
<td>6</td>
<td>50</td>
</tr>
<tr>
<td>Writers</td>
<td>6</td>
<td>50</td>
</tr>
<tr>
<td>Speakers</td>
<td>11</td>
<td>92</td>
</tr>
<tr>
<td>Projectors</td>
<td>5</td>
<td>42</td>
</tr>
<tr>
<td>Digital Cameras</td>
<td>4</td>
<td>33</td>
</tr>
<tr>
<td>Modem</td>
<td>7</td>
<td>58</td>
</tr>
</tbody>
</table>

\[ n=12 \]
All schools had printers installed (100%), moreover, there were few schools that had scanners and photocopiers. The 33% of the schools that had digital cameras were intended for the registration of form fours during national examination therefore they were not used in any way to enhance teaching and learning of Physics. Other peripherals devices were as shown by the table Teachers pointed out that, the most important devices such as the projectors, modem, CD/DVD-ROM were lacking and where they existed, they were not adequate. Speakers were termed to be vital during stimulated lessons for audio sensation. This could be the reason why 92% of the schools had speakers in their computer laboratories. The available photocopiers (50%), scanners (67%) and printers (100%) were mostly kept in the administration offices and were used by the secretary to do office work, production of examinations and results.

4.5.6 Software and CD resources
The software and other education programs installed, was analyzed and it was discovered that computers in many schools were installed extended programming (XP). One school had two laptops for teachers that were installed windows 7-ultimate. Teachers reported that in the staffroom used to download teaching resources from the internet for students and teachers to use them offline when the internet is not available. All the computers were fitted with Microsoft office that contained the basic packages such as word, excel, access and PowerPoint and publisher. Most of the schools relied on internet to download teaching materials for students to use offline. Schools had the following resources as shown in the table 4.11.
Table 4.11: Physics software and resource available in schools

<table>
<thead>
<tr>
<th>Type of Resource</th>
<th>Schools</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encarta suite</td>
<td>4</td>
<td>33.3</td>
</tr>
<tr>
<td>Learning Things Africa</td>
<td>4</td>
<td>33.3</td>
</tr>
<tr>
<td>Exam Vista</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>KCSE Topical CDs</td>
<td>5</td>
<td>41.7</td>
</tr>
<tr>
<td>KCSE Physics Papers CD</td>
<td>9</td>
<td>33.3</td>
</tr>
<tr>
<td>Physics Schemes of Work CD</td>
<td>2</td>
<td>3.5</td>
</tr>
<tr>
<td>Physics Practical and Projects CD</td>
<td>6</td>
<td>50</td>
</tr>
<tr>
<td>No Resources Available</td>
<td>2</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Most of the schools 41.67% had CD resources for teaching and learning of Physics. There were 3.45% of the schools that had no any form of ICT teaching resource. These schools used their computers for teaching students basic computer skills only. The schools that installed Encarta student’s suite learning software had also installed learning things Africa which contained simulated projects and illustrations in three dimensions for learning Physics.

4.6.1 Accessibility

Access to ICT infrastructure and resources in schools is a necessary condition to the integration of ICT in education (Plomp, Anderson, Law, & Quale, 2009). Effective adoption and integration of ICT into teaching in schools depends mainly on the availability and accessibility of ICT resources such as hardware and software.
Obviously, if teachers cannot access ICT resources, then they will not use them. Therefore, access to computers, updated software and hardware are key elements to successful adoption and integration of technology. This study found out that the accessibility of Computers depends on their location. Most of the computers were located in computer laboratories, with a few in administration offices. The location was important since it determines who is to use the computer at a particular moment figure 4.7.

![Bar chart showing availability of computers in various locations in school](image)

**Figure 4.7 Availability of computers in various Locations in school**

In most of the schools, 80% of computers were kept in the computer laboratories and the Principal’s was 5%. The second place that the highest number of computers recorded with 10% was the staffroom. Other areas such as library, HODs offices, classrooms, and study rooms had one computer but in most schools, there were none. Since the location of computers affected the
accessibility by both teachers and students, the study in the following section analyzes the accessibility of computers by teachers and students separately.

### 4.6.2 Teachers Accessibility to Computers
Accessibility to computer is the use of computers by teachers at appropriate time without restrictions or inconveniences. The accessibility of computers depends on the location. The schools that had computers in the principals or secretaries office marked the lowest accessibility.

<table>
<thead>
<tr>
<th>Location</th>
<th>No. of Teachers</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal’s office</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>HODS</td>
<td>7</td>
<td>35</td>
</tr>
<tr>
<td>Staffroom</td>
<td>9</td>
<td>75</td>
</tr>
<tr>
<td>Computer Lab</td>
<td>15</td>
<td>45</td>
</tr>
<tr>
<td>Study Room</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>Library</td>
<td>5</td>
<td>20</td>
</tr>
</tbody>
</table>

Most of the teachers had access to computers at school more than any other place especially in the staffroom. The computers that were in the staffroom were used by teachers to update student’s records and for typing of exams. Computers in the computer lab had 45% accessibility teachers of Physics. These teachers were likely to have access to ICT when they needed it for teaching Physics.

### 4.6.3 Student Access to Computers
This section discusses the places that student’s frequency of access to computers in school and outside school. This was important in identifying the student’s capabilities in the use of computers in learning Physics. Student’s access to computers was based on a three–tier nominal scale ranging from never to always.
This scale was used to gauge student’s accessibility to computers at school, home and cyber. An analysis of the accessibility is given in the table 4.11 below.

**Table 4.13: Location and frequency of Computer use by Students**

<table>
<thead>
<tr>
<th>Place of access</th>
<th>Frequency</th>
<th>Total frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>School</td>
<td>Always</td>
<td>20</td>
<td>20.8</td>
</tr>
<tr>
<td></td>
<td>Sometimes</td>
<td>82</td>
<td>68.3</td>
</tr>
<tr>
<td></td>
<td>Never</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Home</td>
<td>Always</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Sometimes</td>
<td>14</td>
<td>11.7</td>
</tr>
<tr>
<td></td>
<td>Never</td>
<td>92</td>
<td>76.7</td>
</tr>
<tr>
<td>Cyber</td>
<td>Yes</td>
<td>5</td>
<td>4.1</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>114</td>
<td>95</td>
</tr>
</tbody>
</table>

It implies that, only 21% of students indicated that they have access to school computers always, 68% sometimes and 5% have never accessed computer. The students always had access to computer were from the schools that have computers in the computer laboratories and have timetables. Moreover, these students were determined that they were taking computer as a subject therefore they had more time in the computer laboratory than others. Students who had access to computers at cyber were only 4.1% and those who had never had access to computers were 95%. This shows that, apart from the school students have limited access to computers elsewhere. There were very few students who had access to computers at home and cyber. It is clear that only a small percentage of students that have no access to computers.

**4.7 The Extent of use of ICT in the schools**

The study concerned itself with the impact of computers use has on curriculum but excluding computer studies as a discipline. It includes both content and the
processes of the curriculum. The focus of use of ICT in most of the schools (100%) was mainly administrative and teaching, computer skills.

![Figure 4.8 Focus of the ICT use in schools](image)

This study revealed that, computers in schools are at support stage, where they are used to support school programs. The schools that focused on the ICT integration were 41.7%, they had timetables indicating when certain subjects are to be carried out in the computer laboratory.

### 4.7.1 Focus of computer use by teachers
Teachers were asked to tick what they use computers for in school, at home and elsewhere. Their responses were analyzed in the table 4.14
Many teachers (90%) use computer for communication through email and Facebook. Social networking was placed second (80%) by teachers. Entertainment was the third with 75%. Teachers listened music, watched video and browsed for media from the internet which they later listen or watch offline. The academic focus was rated position four with 60%. Teachers used computer to type exams, keep students’ progress reports and progress. Practicing of computer skills was fifth while sixth was the focus on their own study. The study revealed that use of ICT in education was not among top priority in many schools.

### 4.7.2 Focus of Computer use by Students

Most of the students reported that sometimes they play games in the computer lab and at home. They pointed out that they use the excuse of practicing computer skills to gain access to the computer lab so that they can play games and listen to the music especially when not accompanied by the teacher.
Table: 4.15 student’s use of computer

<table>
<thead>
<tr>
<th>Focus</th>
<th>NO. of Students</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doing Assignments</td>
<td>20</td>
<td>17</td>
</tr>
<tr>
<td>Typing my Projects</td>
<td>36</td>
<td>30</td>
</tr>
<tr>
<td>Learning More about Physics</td>
<td>24</td>
<td>20</td>
</tr>
<tr>
<td>Communicating (emails)</td>
<td>56</td>
<td>47</td>
</tr>
<tr>
<td>Playing Games</td>
<td>80</td>
<td>67</td>
</tr>
<tr>
<td>Facebook</td>
<td>68</td>
<td>57</td>
</tr>
<tr>
<td>Entertainment (music and movies)</td>
<td>74</td>
<td>62</td>
</tr>
<tr>
<td>Practicing Computer Skills</td>
<td>102</td>
<td>85</td>
</tr>
</tbody>
</table>

About 67% of the students spend their time playing games and 57% on Face book when connected to the internet. The students taking computer as an examinable subject their focus was mainly doing assignments, projects and practicing computer skills. One of the purposes of this study was to establish the overall ICT use in teaching and learning of Physics yet, only 20% of the students use computers to learn Physics. These students use ICT specifically to learn more about Physics as a supplement to classroom and practical learning. Some students exposed their saved research work from the internet and Encarta from one of the computers. One student had her own flask disk that contained the researched work and other materials for learning.

4.7.3 Quantity of Computer use
To ascertain the quantity of computer use in schools teacher and students were asked to point out the number of hours which they have access to computers in a week. The study assumed that:
i. Access to computers is having computers at their disposal for use irrespective of the purpose of use.

ii. The computers could only be available for use 8 hours a day for 5 days in a week, resulting to 40 hours per week.

iii. Quantity of computer use focused was restricted to use within the school. Any access to computers elsewhere was not necessary.

Table 4.16 displays 14 teachers out of 20 who filled the questionnaires responded to this question by indicating the number of hours they use computers in their schools.

<table>
<thead>
<tr>
<th>No. of Teachers (f)</th>
<th>No. of Hours in Use per week</th>
<th>Total hours in use per week</th>
<th>Percent in Use (T=40 hrs)</th>
<th>Percent Not in Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>8</td>
<td>16</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>24</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>4</td>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>6</td>
<td>15</td>
<td>85</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>4</td>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

n=14

It is evidence that the computer use by teachers in all schools is relatively low such that in some school teachers recorded not having used computer at all. The highest number of hours in use was recorded as 24 hours per week which is 60% in the whole district. This is an indication that most of the computers in the school lie unutilized in the rooms. Putting into consideration the eminence of ICT in teaching and learning of Physics in the literature review the ICT is not yet fully
recognized as a tool to aid in teaching but a subject to be taken by students and teachers.

4.7.4 Students Quantity of Computer use.
Out of 120 students who were selected 104 responded to this question. The study revealed that computer is in use by students for 12 hours (30%). The student’s quantity use was slightly higher than that of the teachers because they had included the time they undergo computers study lessons in the computer room otherwise the data collected was analyzed as shown by the figure 4.9 below.

![Graphical Presentation of Computers use by Teachers and Students](image)

**Figure 4.9 The Graphical Presentation of Computers use by Teachers and Students**
The analyses done shows there is no significance difference between the teachers and students quantity of computer use. The slight difference could be attributed to the fact that teachers have some free time during the day. However, there are other factors that are discussed later in the next section. The quantity of computer
use indicates the number of hours that computers are available for use by teachers and students; to get the extent of use of the computers the next subsections cover how frequent do the teachers and students use the computers.

4.7.5 Frequency of Computer use by Teachers
Teachers were asked to indicate their computer use on four tier Likert scale ranging from very often to never. The total number of respondents is indicated against the percentage of those responded to this item. The table 4.17 shows the frequency of computer use and the purpose that a teacher as ever used computer for in school.

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Very often</th>
<th>%</th>
<th>Often</th>
<th>%</th>
<th>Rarely</th>
<th>%</th>
<th>Never</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching specific subject</td>
<td>3</td>
<td>15</td>
<td>2</td>
<td>10</td>
<td>9</td>
<td>45</td>
<td>6</td>
<td>30</td>
</tr>
<tr>
<td>Learning specific subject</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>20</td>
<td>5</td>
<td>25</td>
<td>9</td>
<td>45</td>
</tr>
<tr>
<td>Teaching computer skills</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>15</td>
<td>11</td>
<td>55</td>
</tr>
<tr>
<td>Making presentations</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>25</td>
<td>15</td>
<td>75</td>
</tr>
<tr>
<td>Preparing lessons</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>15</td>
<td>16</td>
<td>80</td>
</tr>
<tr>
<td>Finding education materials</td>
<td>8</td>
<td>40</td>
<td>4</td>
<td>20</td>
<td>6</td>
<td>30</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Communication e-mails and face</td>
<td>6</td>
<td>60</td>
<td>0</td>
<td>10</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>book</td>
<td>12</td>
<td>2</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Keeping students records</td>
<td>4</td>
<td>20</td>
<td>6</td>
<td>35</td>
<td>2</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preparing students report forms</td>
<td>10</td>
<td>50</td>
<td>3</td>
<td>15</td>
<td>6</td>
<td>30</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Registration of candidates</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>8</td>
<td>40</td>
<td>7</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Playing games and entertainment</td>
<td>15</td>
<td>75</td>
<td>3</td>
<td>15</td>
<td>2</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Each of the use that the teachers indicated was analyzed basing the frequency use from Very often to Never. Computer games and entertainment was the major reason for teachers frequents access to computers. Similarly, communication (emails and social media) was the second with 60% of the teachers. However, Preparation of teaching materials was the third with 50% of teachers doing it very often.
4.7.6 Frequency of ICT use in Teaching of Physics

Teachers were asked to indicate how often they use ICT in teaching Physics and their responses were recorded as shown by the table 4.18.

**Table 4:18 Frequency of Teaching Physics using ICT**

<table>
<thead>
<tr>
<th>ICT use in Classroom</th>
<th>No. of Teachers</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>9</td>
<td>45</td>
</tr>
<tr>
<td>Rarely</td>
<td>6</td>
<td>30</td>
</tr>
<tr>
<td>Often</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>Very often</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N/A</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

\( n=20 \)

From table 4.16 majority of the Physics teachers did not embrace ICT in teaching where 45% of teachers taught without integrating ICT with only between 15% embracing the technology in their teaching often. Interestingly, there was none of teachers admitted having used ICT very often. One teacher had indicated use of ICT in teaching was not possible because most the computers were not accessible and the ones in the computer lab mostly are used by the students who are taking computer studies as an examinable subject. These two challenges came out strongly as it will be exposed in the next subsection.

4.8 Factors that Affect Teachers and Students' use of ICT Tools

The respondents were asked for the factors that affect student’s use of the various ICT tools and their responds are summarized in Table 4.19.
Table 4.19: Factors that affect the use of ICT in Teaching Physics

<table>
<thead>
<tr>
<th>Opinion</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inadequate power supply</td>
<td>13</td>
<td>8</td>
</tr>
<tr>
<td>Limited time to access the Lab</td>
<td>37</td>
<td>22</td>
</tr>
<tr>
<td>Inadequate infrastructure</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>Bureaucracy</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Limited ICT facilities</td>
<td>62</td>
<td>37</td>
</tr>
<tr>
<td>Inadequate internet services</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>Lack of hands on experience</td>
<td>25</td>
<td>15</td>
</tr>
<tr>
<td>Management of the lab equipment’s</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

From Table 4.19, responses from the open ended questions revealed that majority (37%) of the respondent’s emphasized limited ICT resources in the schools as the major factor affecting the use of ICT tools. This was evident where students accessed the computer laboratory to study in three different shifts on different days not for convenience but to share the few computers that were available. Student computer ratios were too high yet many computers were faulty. This view was further supported by 37 (22%) of the respondents who stressed that they have limited time to access the computer laboratory. Computer teachers raised the issue of lacking adequately equipped computer laboratory. Approximately 25 (15%) of the respondents indicated that they lack hands on experience and most instruction were theoretical with the students having very little time to practice since the
computer laboratory is always competed for. This suggests that the teachers and students are not equipped with the practical knowledge and skills that they may so much require during learning of Physics with computers. Nearly 13 (8%) respondents raised inadequate power supply, while at least 11 (7%) looked at limited infrastructures with the same number stressing inadequate internet connectivity as the factor affecting use of ICT resources. A smaller number of (2%) and (1%) of respondents, pointed at bureaucracy and mismanagement of laboratory equipment’s respectively as factors affecting their use of the ICT tools in the school. The data analyzed reveals a very low level of use of ICT by both teachers of Physics and students. Only a small number of teachers and students use ICT to enhance learning in a haphazard way considering the potential of ICT in teaching and learning of Physics.
CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter focuses on the summary of the study conclusions, recommendations and suggestions for further research.

5.2 Summary

The study investigated the extent to which ICT has been integrated in teaching of Physics in secondary schools in Tigania West Sub county. The study was guided by seven objectives. Literature was reviewed from different sources that revealed ICT resources availability and accessibility very important determinant in the integration of ICT in teaching of physics since it influences the frequency of ICT. In addition, it emerged that ICT skills level was still very low and this needs to be upgraded through in-servicing to enable them manipulate the ICT equipment. The literature further, revealed that inadequate ICT equipment’s have reduced the frequency of ICT enabled lessons in secondary school.

The study was guided by Vygosky’s social constructivism theory, which postulates that in the process of knowledge construction and cognitive development, of principal importance is the social context within which teaching and learning takes place. The methodology used for the study involved descriptive survey design which involves obtaining information concerning the current status of phenomena to help draw valid conclusions from discovered
facts. The study targeted 40 secondary schools in Tigania West sub-county. The researcher used a combination of a purposive sampling and simple random sampling to obtain the 12 schools. Three sets of questionnaires were used for the study, physics teachers, physics students and computer specialists. Data collection was done by physical administration of the questionnaires. The collected data was collated and analysis done using both qualitative and quantitative approaches. The results were presented using tables, figures, frequencies and percentages with brief explanation of the relevant interpretation.

The study pursued seven objectives and made seven major findings. The first objective was to determine the teachers ICT skills and competencies in use of ICT in teaching of Physics. The overall computer use by both teachers and students in the sampled schools was very low. It was attributed to teacher’s lack of adequate ICT skills to embrace integration. It was revealed that although teachers and students have a relative good access to computers, it appears that teachers of Physics across-the-board have limited basic computer skills for ICT integration. Therefore, it gives the reason why most teachers abstain from using computers in their teaching. In terms of training, 20% of teachers obtained their ICT skills at University or College as part of their qualification an indicator that most of the teachers are not competent in using computer in teaching of Physics. As far as use of ICT in teaching is concerned, the Physics teachers appear to be onlookers and unsure where to start using the technology in their teaching. In general, most of the teachers reported being beginners or armatures in ICT skills. When teachers were asked to rate themselves, 40% rated themselves as having no
expertise (cannot use computer at all), 20% fair (able to operate basic computer functions), 15% good (able to use office applications), 15% very good (office applications and internet) and 5% excellent (office applications, web, internet and e-mails).

The second objective was to find out students ICT skills for integration. It was evidenced that, students seemed to have more knowledge of the computer use than some of the teachers of Physics. It attributed to the fact that most schools teach computer skills as a subject from form ones. Therefore, at form two they are believed to have acquired the basic skills to enable them to perform simple tasks using computers such opening and saving documents and files, editing and formatting documents and internet browsing. It is amicably that there was only one girl (0.9%) who claimed was excellent in computer skills unlike the boys where there was none. However, more percentage of boys reported being fair, good and very good in computer compared to girls.

The third objective was to find out the teachers and students views on use of ICT in teaching and learning Physics. Teacher’s views regarding the use of ICT are critical factor for the successful introduction and use of ICT. In this perspective, teachers’ educational beliefs regarding the use of ICT are expected to influence their decision whether to use or not a range of ICT tools and therefore support the implementation of ICT. Nearly more than half of the teachers indicated that ICT is a way of promoting investigative practical work, which offer much more opportunities compared to illustrative practical work that students will have the opportunity of exploring a topic in-depth by actual experimental activity together
with an abstract investigation while using ICT tools. Consequently, students’ understanding is expected to be improved. However, it was clearly well-defined that teachers believe that laboratory and practical work cannot be replaced by virtual experiments and by the use of ICT, as the students are required to develop different investigative skills. Thus, they concluded that the use of ICT in Physics teaching should be an additional element in laboratory activities aiming to support and enhance practical work not to replace it. However, the opinions of the teachers were sought on this matter. Surprisingly, what surfaced was the fact that the same teachers ignoring use of ICT expressed a positive attitude towards use of ICT in teaching and learning of Physics. Thus, in as much as the teachers of Physics have a positive view appreciating ICT capabilities in teaching, they shy off using the technology. Nearly a quarter of the students indicated that they experienced feelings of anxiety and stress associated with engaging in the ICT interaction. These students openly acknowledged that they had little background in computer skills and that they did not enjoy working on problem solving using ICT. This contradicts the general data that indicated students viewed interacting with ICTs was ‘enjoyable’, ‘interesting’ and ‘easy’. In inference, most students agreed that use of ICT in teaching and learning of Physics increased their ability to understand complex and abstract ideas such as the movement of electrons, X-rays production, cathode ray oscilloscope and projectile motion.

The fourth objective was to determine the availability of ICT resources in schools for integration. On availability of ICT infrastructure, places where there were many computers in most schools was computer laboratories and staffroom. Some
schools had bought laptops for use by teachers which were connected with one modem to the internet. Even in the schools that had very well equipped ICT laboratories lacked adequate physics learning software. It was therefore concluded that, the schools had few ICT infrastructure whose use was mainly in the administration office and teaching computer studies as a subject.

The fifth objective was, to establish the accessibility of these ICT facilities in schools. Accessibility to computers was influenced by many factors such as; school ICT policy, location of the computers, the computer specialist and individual factors. Forty percent of the teachers stated that they were not able to access the computers in the computer lab because the computer lessons are always conducted in the laboratory. In addition, the teachers rarely accessed the computers in the principal’s office. They believed that they were to be used for management and administration purposes by the secretary accounts clerks and principals. The computers located in the staffroom were highly used by teachers to prepare notes and other teaching materials. Moreover, teachers frequently used them to enter marks and to practice computer skills such as typing and research. On the other hand, the accessibility of computer in many schools by students was reported as being restricted. Students were not allowed to use computers on his or her own unless accompanied with the subject teacher. This was attributed to two main reasons. First, some computer rooms contained other things such as textbooks and exercise books. Appendix N shows photographs of the computer labs that were taken with concert from the principals. This ICT Centre was turned into a bookstore to keep old and new books, both text and exercise books.
Secondly, most students had not acquired adequate ICT skills to enable them work on their own without the help of the teachers or computer specialists.

The sixth objective was to establish the extent of computer use by both teachers and students in teaching and learning of Physics. The study established that few physics teachers use ICT in their lessons preparation and delivery. Results showed that few teachers use computers on a regular basis to help them on their own work and occasionally for classroom management. It further, revealed that the teachers are not using software to create lessons nor to create lesson notes. However, it indicated that teachers are interested in learning new ways to integrate technology into their classrooms. Therefore, they have a desire to do more with computer technology than just daily administrative tasks because they believed it would be helpful with their instruction and student understanding of Physics. The data distinguished that teachers with 1-5 years of experience utilize the computer to access information sources for their work more than the teachers with over 10 years’ experience. On the same note, teachers who used computers utilized word processor to prepare lesson plans, class notes, student’s records and report cards. At the same time, however, there was a lack of computer use in actual lesson instruction, lesson research and individualized planning. General reasons for this non-use ranged from lack of proper equipment, in-service, and lack of administration support.

The seventh objective was find out the challenges faced by teacher and students when using ICT as a pedagogical tool. There were four main challenges that
emanated to be common to both teachers and students; to start with, the administrators were highlighted to be the main obstacle to the use of ICT in teaching and learning of Physics in most schools. Teachers shifted blame to authorities due bureaucracy. To some extent, it would seem that some school administrations were too strict on teachers’ access to computers, to the extent of locking away computers in storerooms under the pretext of security. Some principals were reported to attaching the laboratory key together with his car key; therefore, it meant that the computer lab could only be used when he was around otherwise it remains closed throughout. Secondly, lack of schools ICT guideline policy was the second challenge. Most of the schools had no policy at all and therefore they were unable to utilize the resources effectively. Thirdly, the computer studies lessons made computers to be mainly underutilized by teaching computer studies. In many schools, students taking computer as a subject spend almost the whole day in the computer. Finally, lack of computer skills by both teachers and students contributed so much in disuse of the ICT in teaching and learning process.

5.3 Conclusion

Considering Physics teachers and student’s responses and their expressed thoughts it is apparent that although there is an on-going plan for introduction and promotion of ICT, teachers feel that nothing has been achieved. The existing plan seems disorganized with no definite goals as it seems that there is no prior preparation grounded especially on teachers’ beliefs. Even though it is indicated
teachers’ beliefs as one of the critical catalysts for a successful implementation of ICT tools there is no evidence that they have been taken into account in Tigania west sub-county. Changes in education such as the introduction of ICT require the support of teachers as they are the individuals who will use or coordinate computers and technology in schools. An in-depth understanding of teachers’ beliefs will provide specialists the information about how to design ICT tools implementation and how to support teachers during these efforts. A failure to do so increase the chances of an ineffective implementation as the majority of teachers might resist using computers and technology in reality, as they will be unlikely to be supported as they would expect. Physics teachers feel that the use of ICT might be an additional tool, which could support practical activities and theoretical content teaching. Different ICT tools can increase students’ participation and transform them to active learners working towards the construction of their own understanding. As cited in Tondeur et al work (2008) indicated types of computer educational use, where computer is considered as a collaboration tool or a tool for high order skills. This type of computer use might fit better with constructivist teaching approach as the students are individual learners collaborating with others and working to acquire knowledge on their own. This process is likely to help student to develop analytical thinking skills and obtain high order skills. Thus, the study indicates two elements; incompetent teachers and teaching constraints, which both require governmental specialists’ attention and therefore an in-depth investigation so as to identify the actual factors resulting to teachers not using ICT. The use of ICT might overcome the limited
time as there are several technological tools (e.g., data loggers) with which teachers and students can work more effectively. From this viewpoint, the use of ICT can enable students to investigate and analyse in more depth, as they will not be stressed with the data collection. Thus, the students might have more chances to think rather to collect data and in this perspective the teacher will be able to support and encourage his students to predict, check and analyse their predictions. These features are few of the advantages of the use of ICT during practical work and it seems that Physics teachers should take advantage of such tools, which aim to develop students’ understanding.

The level of ICT infrastructure was revealed as wanting in most of the schools, therefore there is a need to be improved to ensure adequate access by students to ICT and schools should strive to reduce its student-computer ratio.

5.4 Recommendations

Considering the state of presence of ICT infrastructure in the schools and empirical evidence of scanty use of ICT in teaching and learning of Physics, the section proposes recommendations that may be adopted by various education stakeholders. Moreover, it provides the proposed framework and further research areas of immense significance to ICT integration. This study therefore recommends that;

i. Schools should move promptly in making use of any ICT grants they receive. Given the importance of technical support and maintenance in ensuring the continued operation of their ICT system, schools should
endeavor to allocate a separate budget annually for the maintenance and development of their ICT systems. Furthermore, schools need to manage their computer systems more effectively. Principals should help in formulation of the school’s ICT policy and strategic plan to enable easier access and effective utilization of ICT resources.

ii. It is recommended that, as resources permit, schools should work towards providing all teaching and learning spaces with ICT facilities. This should include general classrooms and should not be confined to specialized rooms, as tends to be the case at present. As an interim measure schools could consider setting up a mobile ICT facility, comprising, for example, a laptop computer (or computers), a printer, and a digital projector. Schools with computer rooms should ensure that they are as fully accessible as possible. This could be achieved by a combination of effective timetabling and the adoption of a system that allows teachers to book the room as necessary. Schools should also explore ways of facilitating students with access to ICT facilities outside lesson times. The setting up of a computer club, for example, could contribute to making computer facilities more accessible to students. Finally, for the able schools they can acquire two computer centre one for teaching computer as a discipline and the other to be used as a resource centre by the rest of the school fraternity.

iii. As opportunities arise, schools should develop the range of ICT peripherals and software available to facilitate teaching and learning. Furthermore, efforts should be made to promote awareness within schools,
particularly among staff members, of the availability of such resources.
Schools should also carry out a regular ICT needs analysis in the area of sciences especially Physics in order to identify the necessary ICT resources.

iv. Schools should endeavor to provide staff members with adequate access to ICT facilities for the purpose of planning and preparing for their teaching. Many schools have already done this by providing such facilities in their staff rooms or in work rooms. It should be remembered that the provision of facilities in individual classrooms could also provide teachers with access to ICT for planning and preparation purposes and not just for teaching purposes. Consideration could also be given to acquiring a small number of laptop computers, or other mobile facilities, that could be used by members of the staff at school or at home, as necessary.

5.5 Proposed framework
Taking into account the literature review and the findings, this study proposes Frame under which ICT can be integrated swiftly in schools.

Considering the findings from study and literature reviewed, there seems to a strong need for a structure on which teachers can rely on when using ICT in teaching. Therefore, there is a need for this framework that will be a guideline for the ICT educators, and act as an information gateway for stake holders in the field of ICT integration, while at the same time coordinating efforts on ICT in the District. This framework would comply with each schools strategic plans, as well as alignment with education national plans such as EFA (Education for All). The
proposed framework as shown by the figure 5.1 was formulated after discussion of the findings and collating with the recommendations.

Figure 5.1 proposed ICT framework

It is by no means a definitive framework, but future researchers may generate further discussions with time. Some guiding principles for the theoretical framework are:

a. Student learning is central

b. School ICT development – organizational holistic approach

c. ICT across the curriculum – relevant, dynamic, accessible
d. school-based ICT development – needs based, sustainable

Ministry of education provides the financial support, policy, logistical awareness and appreciation of ICT in education. They may further offer consultation and in-service training. KICD serves as curriculum content developers hence having a major role of carrying out a research to determine the learners’ needs and the way they can be met suing ICT resources. Teacher trains to acquire ICT integration skills that enhance effective curriculum implementation. The Donors give resources to school to equip their ICT centres and to upgrade the existing ones. Donor will work in collaboration with the ministry of education. The school administration formulates the ICT guidelines that teachers and students can follow in order to effectively be able to integrate ICT in teaching smoothly. It is at the administration that the role of the computer specialist or teacher will be defined clearly. Further, it was seen that availability, accessibility and utilization of ICT was dependent on the school principals who had a negative attitude towards the integration. Therefore, this frame proposes the principals to be the motivators by providing easy access to the ICT facilities. Students are the central of the framework where it is expected that after effective integration of ICT in teaching, there will be an overall improvement in performance of Physics because the lessons will be more interesting than before and students will be able to solve problems without strain.
5.6 Proposed Further Research

The study raised two main pathways for further research.

i. There is need to investigate the principals influence in the use of ICT in teaching and learning.

ii. There is a need to investigate the influence of the role of the computer specialists or computer teachers in ICT integration.
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Appendix I Teacher’s Questionnaire

This questionnaire is aimed at obtaining information about the use of ICT in teaching and learning of Physics in secondary school. Please answer the questions in the spaces provided and Tick where necessary.

Please indicate your gender? *(Tick the appropriate box)*  ☐ Male  ☐ Female

1. Indicate your age group
   ☐ Under 30 years  ☐ 31-40 years  ☐ 41-50 years  ☐ Over 50 years

2. What is your highest qualification?
   ☐ Diploma  ☐ Bachelors  ☐ Masters
   ☐ Others (Please specify)………………

3. How long have you been teaching Physics? ☐ Years

4. Did you receive any training on ICT before joining teaching profession? Yes  ☐  No  ☐

5. If NO, how did you get the training in ICT?
   ……………………………………………………………………………………………
   ……………………………………………………………………………………………

6. Have you received any ICT training during your teaching profession? Yes  ☐  No  ☐

7. How would you rate your level of expertise in computer use when teaching physics?

<table>
<thead>
<tr>
<th>LEVEL OF EXPERTISE</th>
<th>Tick that applies to you</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO EXPERTISE – cannot use computer at all.</td>
<td>☐</td>
</tr>
<tr>
<td>FAIR able to operate basic computer functions.</td>
<td>☐</td>
</tr>
<tr>
<td>GOOD- able to use office applications (power points, spreadsheets, word processor) for school assignment</td>
<td>☐</td>
</tr>
<tr>
<td>VERY GOOD- all the above skills including use of internet resources</td>
<td>☐</td>
</tr>
<tr>
<td>EXCELLENT- all of the above including use of e-mail</td>
<td>☐</td>
</tr>
</tbody>
</table>

8. How frequently do you use ICTs for your school work related to the following purpose?
   ……………………………………………………………………………………………
   ……………………………………………………………………………………………

9. List the common software/tools that you use for teaching physics?
   ……………………………………………………………………………………………
   ……………………………………………………………………………………………
10. In your own opinion how do you agree with the following statements?

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Agree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICT enhances learning of Physics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICT helps to meet various needs of the physics students</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICT helps in lesson planning</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICT use ICT makes the lesson enjoyable</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

11. How do you agree or disagree on the availability of the following ICT resources that is used teaching and learning of physics?

<table>
<thead>
<tr>
<th>ICT Resources</th>
<th>Not available</th>
<th>Fairly available</th>
<th>Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) Computers/PC in classroom</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ii) Internet &amp; E-mail</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iii) Television set</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iv) Projector</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>v) software</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vi) Computer laboratory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vii) Video conferencing equipments</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

12. In your own opinion, are the following ICT resources adequate in your school for use during teaching and learning of physics *(please rate them according to their adequacy)*

<table>
<thead>
<tr>
<th>ICT Resources</th>
<th>Inadequate</th>
<th>Fairly adequate</th>
<th>Adequate</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) Computers/PC in classroom</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ii) Internet &amp; E-mail</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iii) Television set</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iv) Projector</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>v) software</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vi) Computer laboratory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vii) Video conferencing equipments</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Others (specify)
13. How often do you access computer and other resources located in the following locations in the school?

<table>
<thead>
<tr>
<th>Location</th>
<th>Never</th>
<th>sometimes</th>
<th>always</th>
<th>Not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer lab</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classroom</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resource centre</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Library</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staffroom</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Principal’s office</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others (specify)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

14. According to you, which are the challenges that affect the use of ICT in teaching and learning of physics in your school? *(please Tick where applicable)*

<table>
<thead>
<tr>
<th>Opinion</th>
<th>Tick all that applies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of adequate ICT skills</td>
<td></td>
</tr>
<tr>
<td>Lack of motivation to use ICT</td>
<td></td>
</tr>
<tr>
<td>Inadequate power supply</td>
<td></td>
</tr>
<tr>
<td>Limited time to access the lab</td>
<td></td>
</tr>
<tr>
<td>Inadequate infrastructure</td>
<td></td>
</tr>
<tr>
<td>Bureaucracy in getting access</td>
<td></td>
</tr>
<tr>
<td>Limited ICT facilities</td>
<td></td>
</tr>
<tr>
<td>Inadequate internet services</td>
<td></td>
</tr>
<tr>
<td>Lack of hands on experience</td>
<td></td>
</tr>
<tr>
<td>Management of the lab equipment’s</td>
<td></td>
</tr>
<tr>
<td>Lack of ICT policy</td>
<td></td>
</tr>
<tr>
<td>Others (please specify)</td>
<td></td>
</tr>
</tbody>
</table>

The end

Thanks very much for your valuable time spent filling this questionnaire
Appendix II Student’s Questionnaire
This questionnaire is aimed at obtaining information about the use of ICT in teaching and
learning of Physics in secondary school. Please answer the questions in the spaces
provided and Tick where necessary.

1. Indicate your gender?  ☐ Boy  ☐ Girl

2. Where did you encounter with computer first?

☐ Here at school primary school  ☐ Computer training college

☐ Cyber café  ☐ Home

☐ Others  ………………………

3. How would rate your level of expertise in computer use?

<table>
<thead>
<tr>
<th>LEVEL OF EXPERTISE</th>
<th>Tick that applies to you</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO EXPERTISE – cannot use computer at all.</td>
<td>☐</td>
</tr>
<tr>
<td>FAIR- able to operate basic computer functions.</td>
<td>☐</td>
</tr>
<tr>
<td>GOOD- able to use office applications (power points, spread sheets, word processor) for school assignment.</td>
<td>☐</td>
</tr>
<tr>
<td>VERY GOOD- all the above skills including use of internet resources.</td>
<td>☐</td>
</tr>
<tr>
<td>EXCELLENT- all of the above including use of e-mail, internet surfing and searching; development of web pages; participation in e-learning and online classes</td>
<td>☐</td>
</tr>
</tbody>
</table>

4. How would you rate yourself on the following skills that are necessary for learning physics using computers?

<table>
<thead>
<tr>
<th>Skill</th>
<th>None</th>
<th>Basic</th>
<th>average</th>
<th>Expert</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word processing</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Spreadsheets</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Databases</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Presentation tools</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Internet</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Basic maintenance of computers</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Use of desktop publishing software</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
5. Where do you access computers in your school?
   - Computer lab
   - Library
   - Classroom
   - Study room
   - Others (specify) ……………………….

6. Apart from the school, where else do you have access to computers?
   - Home
   - Cybercafé
   - None
   - Others (specify) ……………………

7. How many hours per week are the computers available for you to use in learning Physics?
   - Hours

8. How often does your Physics teacher use computer for teaching Physics?
   - Never
   - Sometimes
   - Always

9. How many hours on average per week do you use computers outside the school?
   - Hours

10. How do you agree or disagree on the availability of the following ICT resources that is used teaching and learning of physics?

<table>
<thead>
<tr>
<th>Resource</th>
<th>Inadequate</th>
<th>Fairly adequate</th>
<th>Adequate</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) Computers/PC in classroom</td>
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<tr>
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<td></td>
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<td>iv) Projector</td>
<td></td>
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<tr>
<td>v) Software</td>
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<tr>
<td>vii) Video conferencing equipments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others (specify)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

11. How do you agree or disagree with the following statements?

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Agree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICT enhances learning of Physics</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>ICT helps to meet various needs of the physics students</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICT helps in research and problem solving</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICT use ICT makes the lesson enjoyable</td>
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</tr>
</tbody>
</table>
12. How often do you access computer and other resources located in the following locations in the school?

<table>
<thead>
<tr>
<th>Location</th>
<th>Never</th>
<th>Sometimes</th>
<th>always</th>
<th>Not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer lab</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classroom</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resource centre</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Library</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staffroom</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Principal’s office</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others (specify)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

13. What would you think could be the main challenges that may make you not to access computers often in school when learning physics?

<table>
<thead>
<tr>
<th>Opinion</th>
<th>Tick all that applies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of adequate ICT skills</td>
<td></td>
</tr>
<tr>
<td>Lack of motivation to use ICT</td>
<td></td>
</tr>
<tr>
<td>Inadequate power supply</td>
<td></td>
</tr>
<tr>
<td>Limited time to access the lab</td>
<td></td>
</tr>
<tr>
<td>Inadequate infrastructure</td>
<td></td>
</tr>
<tr>
<td>Bureaucracy in getting access</td>
<td></td>
</tr>
<tr>
<td>Limited ICT facilities</td>
<td></td>
</tr>
<tr>
<td>Inadequate internet services</td>
<td></td>
</tr>
<tr>
<td>Lack of hands on experience</td>
<td></td>
</tr>
<tr>
<td>Management of the lab equipment’s</td>
<td></td>
</tr>
<tr>
<td>Lack of ICT policy</td>
<td></td>
</tr>
<tr>
<td>Others (please specify)</td>
<td></td>
</tr>
</tbody>
</table>

The end

Thank You for Filling this Questionnaire
Appendix III Questionnaires for ICT Managers

This questionnaire is aimed at obtaining information about the use of ICT in teaching and learning of Physics in secondary school. Please answer the questions in the spaces provided and Tick where necessary.

1. Please indicate your gender? (Tick the appropriate box) ☐ Male ☐ Female.

2. Indicate your age group
   ☐ Under 30 years  ☐ 31-40 years  ☐ 41-50 years  ☐
   ☐ Over 50 years

3. What is your qualification?
   ☐ PhD  ☐ Bachelors  ☐ Masters  ☐ Diploma
   ☐ Certificate  ☐ Others (please specify)…………………

4. How many hours per week are set for form two teachers of Physics to use computers? ☐ Hours

5. Is computer room easily accessible by both students and teachers? ☐ Yes ☐ No
   If NO please give reasons
   ………………………………………………………………………….
   ………………………………………………………………………….

6. Please indicate how students acquire basic ICT skills to enable them use computers to learn other subjects. (Tick all that applies)

   | They have prior knowledge from primary school. | ☐ |
   | They are trained by subject teachers | ☐ |
   | They learn from regular computer study lessons | ☐ |
   | During form one Orientation | ☐ |
   | Trained by their peers | ☐ |
   | A common course is organized for all students | ☐ |
   | They take up special classes for ICT | ☐ |
   | Others (please specify) | ☐ |
   | ………………………………………………………………………….
   | ………………………………………………………………………….

7. Do teachers seek help from you when the lessons are ongoing? ☐ Yes, ☐ No
   (If yes please state the type of help they seek.)
   ………………………………………………………………………….
   ………………………………………………………………………….
   ………………………………………………………………………….

8. What types of PCs are available in the ICT Centre?
   ………………………………………………………………………….
   ………………………………………………………………………….
   ………………………………………………………………………….
10. How much storage capacity (hard disk) do these computers have?

☐ Gigabytes

11. How fast are these computers? ☐ Hertz

12. How much memory (MB or GB of RAM) do these computers have?

☐ Megabytes

13. Do these computers have CD Rom or DVD ROM? ☐ Yes ☐ No

14. Please fill in the software available in your computers under the endings below.

<table>
<thead>
<tr>
<th>Software Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating system</td>
</tr>
<tr>
<td>Word processing</td>
</tr>
<tr>
<td>Spread sheets</td>
</tr>
<tr>
<td>Database</td>
</tr>
<tr>
<td>Desktop publishing</td>
</tr>
<tr>
<td>Search engine</td>
</tr>
<tr>
<td>Document readers</td>
</tr>
<tr>
<td>Animators/media player</td>
</tr>
<tr>
<td>Learning suites</td>
</tr>
<tr>
<td>Others</td>
</tr>
</tbody>
</table>

17. Which software tools do Teachers of Physics and students mostly use?

………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………

18. What would be the challenges that teachers and students of physics face when using computers to learn?

………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………

The End

Thank you so much for taking your time to fill this Questionnaire
Appendix IV Interview Schedule and Questions for school principals

1. How many computers do you have in the school?
2. How did you acquire these computers?
3. Do you have internet connectivity?
4. How many hours would a teacher use internet per week?
5. How many hours are computers idle in a week?
6. Why are computers not in use during those hours?
7. On average what is the level of teachers and students expertise on computer use?
8. How do you ensure that the form ones and newcomers who join your school later in the year are equipped with ICT skills?
9. Is computer room/centre/lab/resource easily accessible by both teachers and students?
10. Do teachers plan for the use of computers in their schemes of work?
11. Has there been any ICT training for teachers in the last three years?
12. According to you, do you feel the computer to teachers’ ratio is satisfactory?
13. What would be your suggestion to improve the integration of ICT in curriculum?

The End

Thank you very much for sparing your time to respond to these questions
## Appendix V: Hardware check list

<table>
<thead>
<tr>
<th>Item</th>
<th>Device</th>
<th>Number available for checkout or scheduled use</th>
<th>Number in classroom</th>
<th>comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computers</td>
<td>Model</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Monitor type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TFT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CRT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Processor type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Computers without internet connectivity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Computers with internet connectivity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Speakers available for the instructor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Head phones available for students</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Printer</td>
<td>Type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scanner</td>
<td>Type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Network</td>
<td>Printer/ scanner</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recording</td>
<td>Video cameras( note analog or digital)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Still cameras( note analog or digital)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Projection system</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>VCRs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other ICT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Room layout</td>
<td>Power A/C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Network and power access</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ventilation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lab manager</td>
<td>Trained</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Appendix V: Computer lab Software Checklist

<table>
<thead>
<tr>
<th>Name</th>
<th>Version</th>
<th>Product name</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating system software</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School standard software</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Department specific software</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antivirus</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Print shop deluxe</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Page maker</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teachers power pack</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teachers tool kit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student learning kit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix VII Sample Frame

Eastern zone
1. MWERONYANKI DAY
2. ANTUAMBI DAY
3. MIKINDURI GIRLS
4. KIANDIU DAY
5. LAILUBA DAY

Western zone
6. ATHWANA SEC
7. MWANKA DAY
8. LACIATHURIU DAY
9. LIMORO DAY
10. MWERONDU DAY
11. MWERONKANGA DAY
12. THINYAINE DAY
13. AKITHI GIRLS
14. MUTIONJURI DAY
15. NAIIRI DAY
16. ST. JOHN’S MANTHI

Upper zone
17. URRU DAY
18. KIANJAI BOYS
19. KIANJAI GIRLS
20. MIATHENE DAY
21. ST. LUKES SEC
22. MIATHENE BOYS

23. KITHEO SEC
24. MUCHUUNE SEC
25. KALIENE SEC
26. AKAIKA SEC
27. THAMARE DAY
28. KIMANCIA SEC
29. KIBULINE SEC
30. KUNENE SEC
31. MINTUNTU GIRL
32. LUBUNU DAY
33. THAUIDAY
34. KIORIMBA SEC
35. MULIKA DAY
36. KIMUTHI DAY
37. URINGU GIRLS
38. ST. ANN’S SEC
39. ST FRANCIS MURAMBA SEC
40. KALITHIRIA DAY

Source: Tigania West District Education office records on registered public and private secondary file no. TDSR.10/2011
Appendix VIII: Demonstration of the use of micrometer (simulation)

Source: Edurite Physics simulation software on measurement II

Appendix IX: Magnetization method by use of an electric current

Source: Edurite Physics simulation software on magnetism
Appendix X: Demonstration of Fleming’s left hand rule and right hand rule

Source: EduRite Physics simulation software on electromagnetism
Appendix XI: verification of ohms law (simulation)

<table>
<thead>
<tr>
<th>V</th>
<th>I in mA</th>
<th>I in A</th>
<th>V/I = R</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.50</td>
<td>81.00</td>
<td>0.081</td>
<td>104.94</td>
</tr>
</tbody>
</table>

*Source: Edurite Physics simulation software on Ohms law*

Appendix XII: demonstration of heat transfer

*Source: Edurite Physics simulation software on Heat Transfer*
## Appendix XIII: Photographs of sample computer labs

<table>
<thead>
<tr>
<th>Photo 1. Shows the computers that were in use (foreground) and dozens of cartons of exercise books that are unopened. This computer lab was turned into a temporary store for books, which was noted as one of the reasons that made the school to restrict teachers and students from accessing the ICT facilities.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photo 2. The second photo shows computers that were donated by the government but they were kept in their boxes for lack of a secure room. They were kept in one corner of the principal’s office. However there were two computers that was in use in the principal’s and secretaries office.</td>
</tr>
<tr>
<td>Photo 3. Shows a computer lab that was used awkwardly. The projector is seen displayed on the computer table, a sign that it is used occasionally because the projector screen is seen placed at the middle folded. This lab is similar to the first one because it contained text and exercise books that restricted the accessibility and the free use of computer lab.</td>
</tr>
</tbody>
</table>
### Appendix XIV: Commonly Free ICT Tools used by teachers

<table>
<thead>
<tr>
<th>Diagnoser Tool</th>
<th>GEM *****</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics diagnostic tool with “corrective” lesson suggestions for Description of motion, Nature of forces, Forces to explain motion, and Sound/light/waves. Diagnostic tests very critical thinking-oriented, but displayed results are somewhat difficult to interpret holistically.</td>
<td><a href="http://www.diagnoser.com/diagnoser/">http://www.diagnoser.com/diagnoser/</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annenberg Media</th>
<th>GEM *****</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Internet Archive (Physics B/C)</th>
<th>GEM *****</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent introductory minutes-long videos for most physics subjects. Click on chosen lesson; to start video, click on “Click here to begin lesson” found in upper left corner.</td>
<td><a href="http://www.archive.org/details/ap_physics_b">http://www.archive.org/details/ap_physics_b</a> <a href="http://www.archive.org/details/ap_physics_c">http://www.archive.org/details/ap_physics_c</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>National Center for Case Study Science</th>
<th>GEM *****</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case study teaching method, comprehensive case collection, case ideas, assessment plans, professional development.</td>
<td><a href="http://ublib.buffalo.edu/libraries/projects/cases/case.html">http://ublib.buffalo.edu/libraries/projects/cases/case.html</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physics Teaching Resources (Illinois State University)</th>
<th>*****</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curriculum, resources. Some searching required, but lots of great resources found embedded in “Methods Courses: Syllabi”</td>
<td><a href="http://www.phy.iastate.edu/ptc/resources.html">http://www.phy.iastate.edu/ptc/resources.html</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ClassNotesOnline.com</th>
<th>****</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Socratic Dialogue Inducing Labs</th>
<th>****</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Dolores Gende Homepage</th>
<th>****</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal teacher page with traditional labs, innovative projects (equilibrium mobiles, lawnmower science), and great resources.</td>
<td><a href="http://dolores.gende.homestead.com/">http://dolores.gende.homestead.com/</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Activity-Based Physics</th>
<th>****</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>The Physics Hypertextbook</th>
<th>***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online book/workbook under construction. Many topics missing, but what can be found is generally high quality. For practice problems and high quality worksheets, click on “Problem Sets,” choose a topic, and browse pages to find “worksheets.”</td>
<td><a href="http://hypertextbook.com/physics/">http://hypertextbook.com/physics/</a></td>
</tr>
</tbody>
</table>
Physics Education Research Group
Research information and publications on latest trends in physics teaching.
http://tampers.physics.umass.edu/

How Stuff Works
Explanations of how a myriad of things work.
http://www.howstuffworks.com/

Experiment Problems
Real-world inquiry problems easily implemented into classic labs.
http://www.physics.ohio-state.edu/~physedu/index2.html

compADRE
Science partnership information. Search lesson plans, activities, and labs. Search categories very specific, but some results are commercial.
http://www.compadre.org/portal/index.cfm

The Physics Front
Search engine from ComPadre. New teacher focus
http://www.thephysicsfront.org/

Physical Science Resource Center
Same search engine as from ComPadre. No significant difference from The Physics Front.
http://psrc.aaspt.org/

Movie Physics
Movie reviews with physics ratings. Physics concepts explained, but few suggestions for teaching.
http://imiauto.com/moviephysics/index.html

Physics Central
Physics news, Ask a physicist, How things work.
http://www.physicscentral.com/

Physlink.com
Physics news, Careers, Higher Education, Internet hub, but little information of its own.
http://www.physlink.com/TheEducation/Index.cfm

Physics Teaching Technology Resource
Videos of traditional demonstrations. Click on side menu after selecting category.
http://paer.rutgers.edu/PT3/index.php

Video Analysis Investigations for Physics and Mathematics
Videos of traditional demonstrations. Allow time for video to load.
http://www.science.tamu.edu/CMSE/videoanalysis/index.htm

Lecture Demonstrations
List/diagrams of classic demonstrations.
http://www.mipt.berkeley.edu/physics/index.html
Hyperphysics
Extremely thorough concept map encyclopedia, calculators for common physics problems.
http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html

Fear of Physics
Visual physics, homework help, answers to common questions. Be wary about giving this link to students – the “homework help” section has calculators for multiple common physics problems, possibly resulting in cheating. It may be a good review or problem checking tool, however.
http://www.fearofphysics.com/

Virtual Physics Laboratory (I)
Most comprehensive applet site so far (traditional physics phenomena)
http://www.phy.ntnu.edu.tw/java/indexPopup.html

Concept Simulations
Audio with applets (traditional physics and applications)
http://www3.interscience.wiley.com:8100/legacy/college/ cutnell/0471151831/concepts/

Flash Animations for Physics
Very catchy flash applets (physics and mathematical processes)
http://www.upscale.utoronto.ca/GeneralInterest/Harrison/Flash/-miss

Computer Animations
Applets of physical processes and famous experiments. Not seemingly appropriate for showing to entire class – images not big enough.
http://physics.nndu.ru/Physics/English/index.htm

SPECIFIC PHYSICS CONTENT

Mechanics and Energy

Grade-appropriate worksheets about types of energy and conservation
http://www.eere.energy.gov/education/science_projects.html

Amusement Park Physics
Tutorials about roller coasters, carousels, bumper cars, free fall, pendulums, and ride safety. Activities include: Design a Roller Coaster (and receive a safety and fun rating), and Colliding Cars prediction quiz.
http://www.learner.org/exhibits/parkphysics/

Roller Coaster Physics (Virginia Instructors of Physics)
Roller coaster science articles, labs, and tests.

Beginner’s Guide to Aerodynamics
Physics of airplanes, activities, lessons, assessments.
http://www.kerc.nas.gov/WWW/K-12/airplanes/bga.html
PASCO Physics Online Experiments
Traditional labs to be used with Panco equipment.
http://www.pasco.com/experiments/physics/

Dr. Hoselton’s Physics Pages
Traditional labs, applets, worksheets.
http://faculty.trinityvalleyschool.org/hoselton/

National Science Digital Library
Web search, General science focus.
http://nsdl.org/

Discovery
Search for upcoming TV shows about physics (check Mythbusters)
http://www.discovery.com/

Low Cost Physics Activities
Traditional labs and worksheets for the low-budget teacher.
http://www.science.tamu.edu/CMSE/LowCostPhysicsActivities.htm

IB Physics
Step-by-step visuals of traditional labs, accompanying questions.
http://www.saburcill.com/physics/practicals/contents.html

---------------------------------------------------------------
GENERAL PHYSICS SITES for Students (Interactive Applets, On-line Activities, Tutorials)
---------------------------------------------------------------

Physics Education Technology GEM *****
http://www.colorado.edu/physics/phed/web-pages/index.html

Physics.org GEM *****
Physics Life interactive program to discover physics in the everyday world, Physics Evolution clickable map, Equation toolbox, Common questions, Careers.
http://www.physics.org/

The Physics Classroom *****
Tutorials, On-line textbook.
http://www.physicsclassroom.com/

Nobelprize.org *****
List of Nobel prize winners by year. Click under winner’s name in lower right corner to access other resources, including online tutorials and games regarding the winner’s work.
http://nobelprize.org/nobel_prizes/physics/laureates/
Appendix XV: Map of Meru County Showing Tigania Sub-County

Source: courtesy of Tigania west sub county Administration Office (2010)
Appendix XVI: Research Permit

MINISTRY OF EDUCATION

Email: districtedofftw@yahoo.com

Telephone: 064 856495

When replying please quote


TO ALL PRINCIPALS
TIGNANIA WEST DISTRICT

REF: ITHILI PETER KIUNGA REG. NO. E55/CE/11548/2008

This is to inform you that the above named person has been granted authority to carry out an academic research based on "Utilization of ICT in Teaching and Learning of Physics in Secondary Schools in Tignania West District". The research is for academic purposes only.

Kindly, accord him the necessary assistance.

MWITI G M
FOR DISTRICT EDUCATION OFFICER
TIGNANIA WEST

CC Permanent Secretary Ministry of Education
P.D.E Eastern Province
County Director of Education