INFLUENCE OF TEACHER PREPAREDNESS ON THE USE OF ICT IN MATHEMATICS INSTRUCTION IN SECONDARY SCHOOLS IN BUNGOMA COUNTY

by

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A Research Thesis Submitted in Partial Fulfillment of the Requirement for the Degree of Masters of Science in Mathematics Education of Masinde Muliro University of Science and Technology.

JULY, 2021

DECLARATION

DECLARATION BY THE CANDIDATE

This thesis is my original work prepared with no other than the indicated sources and support and has not been presented elsewhere for a degree or any other award.

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PLAGIARISM STATEMENT

DEDICATION

I dedicate this thesis to my family members whose wish, prayers, humility and encouragement have been my main source of inspiration to complete this work.

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Many people have undoubtedly contributed to the success of this work. Therefore, I owe them many debts of gratitude. Firstly, I thank the Almighty God for His guidance and grace that was sufficient throughout my study programme. Secondly, I am indebted to my supervisors Dr. Wanjala Martin and Dr Shikuku Beatrice for their interest in my work, commitment, encouragement, invaluable guidance and contribution towards the success of this work.

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ABSTRACT

Technology in general has advanced greatly as more computers and curricular materials for utilization of current technology are now available in schools. However, the utilization of these technological tools is not an integral part of the curriculum in Kenya. The main problem facing mathematics instruction generally is the need to improve performance of students through use of innovative approaches that involve technology. This study investigated the teacher preparedness towards the use of Information Communication Technology in mathematics instruction. Specifically, the study focused on determining the knowledge and skills needed for use of ICTs, teachers' attitudes towards the ICTs and the kind of technical and infrastructural support needed for instructional use of ICTs in mathematics. The descriptive survey research design was adopted and involved a target population of secondary school teachers of mathematics in the three sub-counties of Bungoma: Kimilili, Bungoma North and Bungoma East. A sample of 218 including teachers and heads of departments were selected using proportionate stratified and simple random sampling techniques. Using Yamane's sampling technique at 95% confidence interval, the sample size of 218 was obtained. Data was collected using questionnaires, interview and observation schedules. A pilot study was conducted and the data used to validate the instruments and compute the Cronbach's alpha reliability measure which was found as 0.704 for the instrument. Data analysis involved both descriptive and inferential statistics that included frequencies and percentages and the Chi-square test. The findings indicated a lack of the necessary knowledge and skills for use of ICTs among teachers, the teachers attitude affects the use of ICTs in instruction and need for infrastructural and technical support for integration of ICT tools in teaching and learning mathematics. Therefore, a review of curriculum to ensure that teachers acquire relevant ICT knowledge and skills in ICT is needed in the teacher training institutions. The ministry of education should formulate policies that aim at ensuring acquisition of ICT infrastructure including computers, instructional software based on mathematics content, technical support to teachers and professional development of teachers in ICT pedagogy.

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LIST OF ABBREVIATIONS AND ACRONYMS

CMT	-	Conventional Method of Teaching
GoK	-	Government of Kenya
ICT	-	Information Communication Technology
IT	-	Information Technology
KCSE	-	Kenya Certificate of Secondary Education
KICD	-	Kenya Institute of Curriculum Development
MTQ	-	Mathematics Teacher's Questionnaire
NEPAD	-	New Partnership for Africa Development
TAM	-	Technology Acceptance Theory
TPCK	-	Technological, Pedagogical and Content Knowledge
TSC	-	Teachers Service Commission
UNESCO	-	United Nations Educational, Scientific and Cultural Organization

CHAPTER ONE

INTRODUCTION TO THE STUDY

1.1 Overview of the Chapter

This section includes a description of the background to the study, the problem statement, purpose and objectives of the study, the research questions and hypothesis, scope and limitations of the study, assumptions, theoretical framework, conceptual framework, significance of the study and the operational definition of terms.

1.2 Background to the Study

Mathematics subject is regarded as a very important subject and plays several roles in the society. Governments around the world recognize the importance of mathematics for national development (Barnett, 1995; Stacey, 1998). The usefulness of mathematics has been noted in relation to science, technology, economics, education and even humanities (Tella, 2008). Numerical competency of learners in early years has been shown to affect their future academic achievement mastery of other (Oketch et al., 2010). In Kenya, mathematics subject is required to join courses such as engineering medical and health sciences courses, accounting, finance, human resource, banking etc (University of Nairobi, 2008). According to Ishenyi, (2015), Hughes (2005), Macau (2000) and Friendland (1985), Mathematics forms an essential prerequisite for joining tertiary colleges and universities and useful for self-employment. Many professionals such as engineers and accountants use it. Mathematics therefore is important because of its social, utilitarian and communication roles in the society. Communication of messages, ideas and research findings are done by use of Mathematics. Research findings are represented both in numerical and graphical forms then analyzed and decisions made based on the findings. Mathematics has aesthetic role in the society. Beauties generated from architectural and engineering designs, for instance the beautiful houses, cars and other models are because of Mathematics. Mathematics has a social role too. Mathematics teaches intervals, sequences and series which are applied in social life, for instance, rhythms in the music world and in a variety of entertainments. Concepts such as diagonals, course and tracks are well applied in games such as soccer,

basketball, hockey and swimming among many other games. Besides the roles of Mathematics in society, the world view depicts instructional weaknesses in the subject in learning institutions (European Mathematical Society, 2012). A lot of research evidence is accumulating regarding teachers' impact on student's learning experiences in Mathematics.

There is research evidence of the ineffectiveness of traditional instructional methods which are teacher dominated and learners remain passive and only rely on memorization and hence rote learning (Bransford et al 2000; Moon 2004; Kozma 2005). Professional development of teachers as a human capital has thus been suggested by the researchers who argue that educational productivity in classrooms can be improved by upgrading teachers' knowledge and skills. There is thus emphasis on building communities of practice where focus is on continuous teacher improvement in instructional practices (Bransford 2000 cited in Kozma 2005).

As noted by Yusuf, (2005), ICTs have affected the education field especially in classroom instruction and research. The quality of education has been noted to improve as the use of ICTs especially computers have proven potentials in innovations, accelerating, enriching and deepening skills motivation and engagement of students, school experiences related to work practices, developing economic viability for future work-related skills and strengthening teaching and learning activities in schools (Al-Ansari, 2006; Jhurree, 2005; Yusuf, 2005). The 21st century has witnessed remarkable changes as a result of growth in ICTs that have constituted demands in the modern society. The importance of ICTs has been noted in the education system and our daily lives especially in knowledge and skills dissemination and which has had positive impacts on the economy in society (Andoh, 2012; Kipsoi, Chang'ach & Sang, 2012). This has resulted in numerous efforts to enhance the teachers' competencies and self confidence in the use of ICTs in instruction by initiatives to ensure acquisition of the necessary infrastructure and resources for preparation of teachers.

In the current initiatives for the country's economic growth and development guided by the Kenya's Vision 2030, mathematics is important for advancements in technology and science. In its endeavours to transform into a digital society, the

government has put in place the National ICT Policy and E-Government with aims to produce an ICT literate workforce with the necessary ICT knowledge and skills that will enhance a knowledge based for a dynamic and sustainable economic growth.

The emergence of new technologies such as computers in addition to other technologies such as radio and telephone has improved the practice of education (Farrell, 2007). The adoption and use of ICTs has been identified to proceed through emerging, applying, infusing and transforming stages of ICT development (Senapaty, 2004; UNESCO, 2005). The Technological, Pedagogical and Content Knowledge (TPCK) framework has been developed that explains how teacher's understanding of technology, pedagogy, and content knowledge can interact for specific subject areas instruction using technology (Koehler & Mishra, 2008; Mishra & Koehler, 2006). However as noted by Senapaty, the challenge is in implementing pedagogy-technology integration in mathematics instruction despite concerted efforts for use of ICTs in education worldwide (Senapaty, 2004). For improved learning, ICTs must be infused in pedagogy as they have the potential to enhance the quality of teaching and learning, research productivity and effectiveness in management of institutions (Kashorda et al. 2007). ICTs thus provide tools for learning, enhance accessibility to other areas of curriculum and administration and generally in teaching.

The integration of ICTs in mathematics curriculum is emphasized because of the effectiveness of the technologies in instruction. However, its use in instruction has proved to be slow and difficult owing to the teacher's unpreparedness and attitudes. There have been efforts to enhance use of ICTs by teachers as findings reported by researchers have shown that there is increasing knowledge of and familiarity with technology among teachers and that there is infrastructural support to it though teachers are still not using these tools in instruction (Foley & Ojeda, 2007). According to Li, (2007), teachers are not using these technologies because of fear of their replacement in the school system. The ineffective integration of technology is attributed to the lack of adequate knowledge and skills that is attributed to a lack of sufficient training (Jamieson-Proctor & Finger, 2008).

There exists the lack of professional development in use of ICTs in instruction by mathematics teachers and several authors have suggested remedies to this. There has

been emphasis on on-going professional development (Wells, 2007 & Sprague, 2007); courses in formal training in technology (Swan and Dixon, 2006); software packages training (Toumasis, 2006); instructional strategies and training in software use (Sorkin et al., 2004); and mathematics lesson planning in integrating technology (Hardy, 2004).

Previous researches have indicated that despite the availability of ICT infrastructure in schools, teachers do not make use of these tools in instruction (Wanjala, 2010). Teachers are thus encouraged to adopt teaching approaches that enhance learner active participation, engagement, attitudes and creativity and achievement (Kalkanis, 2002; Keraro, Wachanga & Orora, 2006; Minas, 2003 & Vlachos, 2004). However, mathematics classroom in most cases are dominated by use of traditional methods that promote passiveness and rote-learning among students. There is emphasis on the use of innovative teaching approaches that create strong self-directed learners who actively construct own knowledge and ideas for dynamic learning (Trilling & Fadel, 2009) and with control over instructional activities for enhanced motivation (Wilson & Corpus, 2005). There is therefore a need for mathematics teachers to transform mathematics lessons into student focused environment using technology for meaningful learning.

Research has shown that technology has the potential to improve instructional practices and therefore for meaningful instruction, there is need for teachers in secondary schools to explore the use of ICTs in classroom instruction and hence the need for this study. The study sought to investigate the teachers' preparedness for use of ICTs in mathematics instruction in secondary schools in Bungoma County, Kenya.

1.3 Statement of the Problem

The need to improve the student's performance in mathematics is the problem facing curriculum implementation in Kenya. This continues to affect the country's growth and development in technology in its quest for the realization of millennium development goals (MDG's) and attainment of vision 2030. The poor performance is attributed to lack of quality teaching and learning pedagogy that may prompt learners to construct knowledge on their own through the guidance of an expert. Teaching

methodology that can enhance the learners' participation, engagement, creativity and achievements may result to an improved performance. In most mathematics classrooms, students are low in motivation and do not acquire the necessary knowledge and problem-solving competencies. Therefore, there is need for improved teaching method to enhance student's performance in mathematics. To improve students' cognitive, affective and psychomotor abilities in mathematics, teachers must explore the use of ICTs in instruction. Currently the problem to supplement teaching with the innovative and student-centered techniques can no longer be ignored. Previous research has shown that computer-based learning is more superior to students learning mathematics as compared to conventional methods of instruction (Chen, 1999; Mubichakani, 2012; Wanjala 2005).

With the advancements in technology worldwide, people's lives have improved in terms of learning, communication and business. The role of computer in classroom instruction in mathematics has been highlighted in many empirical studies (Mubichakani, 2012; Wanjala, 2005). However, the integration of these tools in instruction is still slow and difficult owing to existence of barriers.

Other studies have been conducted worldwide particularly in developed nations on integration of ICT in Mathematics instruction with more emphasis on teacher related factors such as teacher training and attitude (Hennessy, et al. 2010; Wanjala, et al. 2012). This study intends to fill the existing gap by examining the shifts in instructional practices using ICT tools in mathematics with emphasis on teacher preparedness. Furthermore, most studies regarding integration of ICT in education have been done in Western countries with very few in Africa and Kenya in particular. There is therefore need for more of these studies to be done in secondary schools in African countries Kenya included.

In Kenya, the initial teacher training has been identified as one that does not offer student-teachers the experiences they need to become competent in integrating information and communication technology in their teaching. The Government of Kenya has attempted to invest heavily to improve the quality of instruction through ICTs but there has been minimal improvement. The uptake of ICT tools has been slow and difficult probably owing to some bottlenecks related to classroom

instruction. This explains the need for this study that investigated the preparedness of mathematics teachers for ICT integration in instruction in mathematics in secondary schools.

1.4 Purpose of the Study

To investigate the teacher preparedness in use of ICTs in mathematics instruction to improve learner achievements in secondary schools in Bungoma County, Kenya.

1.5 Research Objectives

Specifically, the study purported:

a) To determine the type of knowledge and skills needed by teachers to enable them use the ICTs in mathematics instruction.

b) To investigate the influence of teachers' attitude on integration of ICT in mathematics instruction.

c) To establish the infrastructural and technical support required by teachers for use of ICTs in mathematics instruction.

1.6 Research Questions

The study sought answers to the following questions;

a) What types of knowledge and ICTs skills are needed by mathematics teachers to enable them use ICT in mathematics instruction?

b) What is the influence of attitude of teachers on the use of ICT in mathematics instruction?

c) What kind of infrastructural and technical support is needed by teachers for integration of ICTs in mathematics instruction?

1.7 Research Hypothesis

The following null hypothesis was formulated and tested at 0.05 level of significance.

Ho_1: There is no relationship between the teacher's attitude and use of ICTs in mathematics instruction.

1.8 Significance of the Study

This study will be a great contribution towards implementing ICT use in Bungoma County secondary schools and particularly mathematics instruction. It will establish the barriers to ICTs' use in mathematics instruction by teachers. The findings from this study will help increase awareness for future planning for the new and emerging technology especially the laptop project, such as provision of trained teachers in new technologies.

This study is intended to establish some groundwork to enable discussions and considerations of how national policy makers in education could improve on the level at which to introduce new technologies in the mathematics curriculum. This study will also provide educators with knowledge that will enable them to make decisions on a number of educational questions that pertain to integration of information technology in secondary education.

It will provide essential data upon which sound instructional approaches can be formulated in the County. It is anticipated that both teaching and learning using information communication technologies in mathematics in secondary schools will be enhanced. The findings of this study are envisaged to contribute towards greater realization of the need to resolve the perennial problems inherent in mathematics education as reflected by the poor performance in the subject.

1.9 Scope of the Study

The purpose of this study was to investigate the teacher preparedness and how it affects ICTs use in mathematics instruction. Mathematics as a discipline has various dimensions such as subject matter, the instructional and evaluation process. That is, mathematics curriculum implementation and the challenges in the instructional process. The focus of this study was only on the dimension of teaching and learning of mathematics using ICT as instructional tools. It specifically looked at the mathematics teacher preparedness and how it affects ICTs use in the instruction process. These included pedagogical practices, skills, knowledge and attitudes towards ICT especially computers. Data was collected from mathematics teachers of the secondary schools within Bungoma County. Research respondents included

teachers of mathematics and heads of departments in the secondary schools that participated in the study.

1.10 Limitations of the Study

Several limitations should be considered when interpreting the findings of this study. The study limited itself to the teachers of mathematics in secondary schools in Bungoma County within Kimilili, Bungoma North and Bungoma East sub counties. This may not be a true reflection of all the schools in Kenya, putting in mind that Kenya is a developing country so the behavior and performance of these institutions is different and so the responses and findings of this study cannot be generalized and are only limited to these specific institutions in Bungoma County, Kenya. The involvement of more teachers from secondary schools in Kenya though desirable was not possible due to economic reasons.

1.11 Assumptions of the Study

The following assumptions form basis for the study:

i. School personnel should not be facing certain challenges as they try to implement ICT in schools.

ii. That teacher's preparedness in ICT integration and use were captured through the questionnaire and interview responses.

iii. That the mathematics teachers honestly provided information required from them.

iv. The teachers had classroom teaching experience and that not all of them possess the necessary competence in teaching using computers

1.12 Theoretical Framework

The Roger's theory of Diffusion of Innovations formed the basis of this study. This theory explains how, why, and at what rate new ideas and technology spread through cultures. Innovation diffusion research has attempted to explain the variables that influence how and why users adopt a new information medium, such as the Internet. The diffusion of information communication technology turns out to be a powerful driver of growth, having an impact on worker productivity (Bollou, 2002). According to Robinson, (2009) this theory focuses on change of evolution of

products and behaviours as per the needs of individuals and groups other than persuasion of people to implement change.

The four elements in this theory include:

(i) Innovation perceived by an individual as a new idea, practice or object.

(ii) Communication channel which is how messages are transferred between individuals.

(iii) Time as the duration to pass through the innovation and decision making process. The relative speed with which an innovation is adopted by members of a social system.

(iv) A Social system is seen as a set of interrelated units that are engaged in joint problem solving to accomplish a common goal.

The innovation-decision of each member of a social system follows a five step process including knowledge, persuasion, decision, implementation and confirmation.

Knowledge involves a person's awareness of an innovation and having some idea of how the innovation works. Persuasion involves formation of a favourable or unfavourable attitude towards the innovation by a person. Decision is where the choice to adopt or reject the innovation is exhibited by the activities the person engages in. Implementation where the innovation is put into use by the person and Confirmation is where the results of an innovation decision already made are evaluated by the person (Orr, 2003, Sahin, 2006).

The user is thus compelled to continue adoption or later reject the technology and which is based on the relative advantage, compatibility, simplicity, trial-ability and observability. Therefore the strategy aimed at inducing system-wide change is aided by the understanding and utilization of diffusion networks (Orr, 2003; Robinson, 2009; Sahin 2006).

With the awareness of the spread of ICT innovations by education stakeholders across the world, the rate of adoption and use of these tools is still very slow and difficult. According to Medlin (2001) and Parisot (1995) the Rogers' (2003) diffusion of innovations theory has been found the most appropriate for investigating

the adoption of new technology in educational environments. Teacher preparedness in terms of knowledge and skills, attitude and infrastructure and technical support are important factors in implementation of innovations and utilizing this theory, this study investigated the teacher preparedness towards the use of ICTs in mathematics instruction.

1.13 Conceptual framework

The conceptual framework adopted shows the interaction of variables in this study as illustrated in the figure 1.1. This represents interactions between the independent variables teacher's ICT knowledge and skills, attitude towards ICTs and the available ICT infrastructure and technical support, and the teacher preparedness in using ICTs in mathematics instructional practices and the moderating variables including the government policies, laws or regulations.

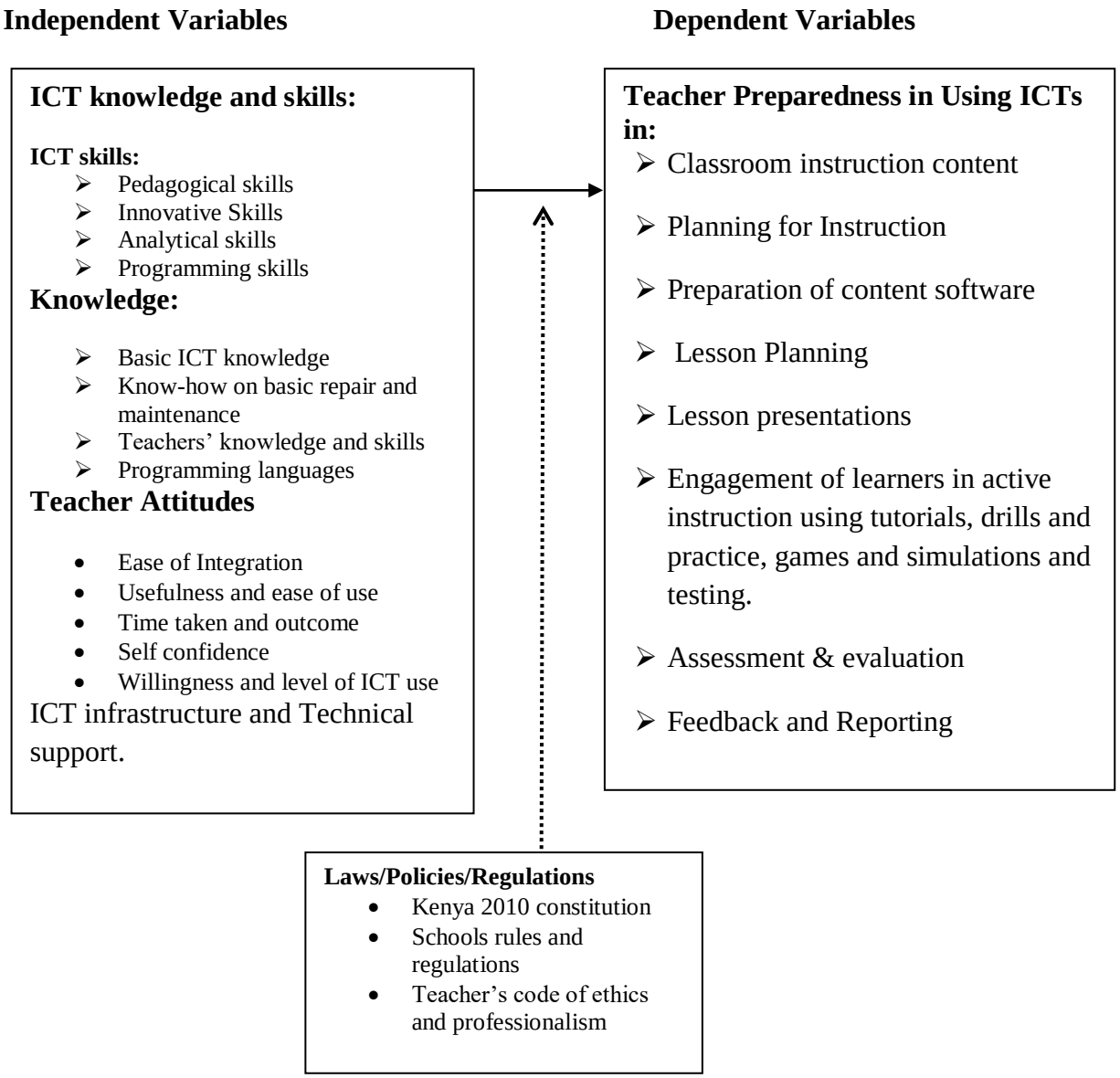


Figure 1. 1: Conceptual Framework of the Study

(Source Researcher, 2018)

1.14 Operational Definition of Terms

Conventional methods of instructions*:* CMI refers to the instructional procedures in which class is given instructions on any topic using other teaching aids like textbooks, chalkboard as sources of reference. In addition to instructional aids, teacher-lecture, teacher-demonstration, assignments and classroom discussions are commonly used. This definition will be adopted in this proposal.

Educational software: This is taken to mean computer software designed to teach, aid the teacher, or reinforce the teaching of specified content.

Implementation: This as used refers to the use of information technology in the instructional purposes.

Information Technology: As used refers to the hardware and software used in computer applications including tutorials, drill & practice, games and simulations, and other computer accessory programmes and operations.

Instruction: As used refers to the process of imparting knowledge through a deliberately managed environment to enable a learner acquire new behaviour.

Performance: This refers to the status of students with respect to attained skills or knowledge as compared to other students or other school's adopted standards or national educational standards.

Simulation: This refers to the production of a computer model of a real or imagined system or situation, designed to teach how a certain system or a similar one works.

Teacher Training: As used in this study refers to any process of professional development including pre-service and in-services courses through workshops and seminars.

Tutorials: This as used refers to brainstorming sessions after the overview/presentation/introduction of a concept.

Utilization: As used refers to the conversion for or making use of computer in instructional processes.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

The main objective of this chapter is to provide a detailed and comprehensive review of literature on teacher preparedness and its effect on the use of ICT in mathematics instruction. It begins with a brief description of Information Communication Technology in and for Education in Kenya. A more in-depth examination of teacher preparedness issues which includes skills, knowledge and attitudes are explored. The impact of ICT use on classroom teaching and learning are further identified.

2.2 ICT in and for Education

The idea that teaching and learning can successfully take place using technology inspires both hope and dismay. There is the hope that more learners can be reached at a more convenient pace than has previously been the case, and a dismay in that the infrastructure necessary for deploying technological resources or constructing an effective ICT platform are lacking in low-income countries. Tella et al. (2007) examined Nigerian secondary school teachers' use of ICTs and its implications for further development of ICT use in schools through a census of 700 teachers. The results showed that for teachers, a lack of technical support in the schools and teachers' lack of expertise in using ICT were the prominent factors hindering teachers' readiness and confidence of using ICT during lessons. Teachers are not always fully aware that pedagogic uses of the ICT require the development, among teachers as well as students, of new skills, knowledge and attitudes for the effective use of ICT. Computer literacy has been perceived by teachers to arouse interest in students in various subjects and thus promoting learning and attitude towards information technology. Building on this, it becomes clear that ICT must be linked to the specific needs of developing countries and desists from the 'one size fits all' approach (Leach 2005) with ICT being used as a learner–centered tool, instead of within the more traditional pedagogy.

The ways ICTs have been used in the education can be clearly divided into two broad categories: (1) ICT for Education and (2) ICT in Education. ICT for education refers

to the development of information and communications technology specifically for teaching/learning purposes, while ICT in Education involves the adoption of general components of technologies in the teaching process (more specifically, often for the training of teachers in the use of technology for teaching (Olakulehin, 2007).

In a similar vein, UNESCO (2004) classifies ICT in education into three broad categories: (1) pedagogy, (2) training, and (3) continuing education. Pedagogy is focused on the effective learning of subjects with the support of the various components of ICT. Olakulehin (2007) emphasizes that the pedagogic application of ICT involves effective learning with the aid of computers and other information technologies as learning aids, which play complementary roles in the classroom, rather than supplementing the teacher.

2.3 Knowledge and Skills for use of ICT In Mathematics Instruction

Many school leaders perceive the lack of ICT-related skills by teachers as one of the main impediments to the realization of their ICT-related goals (Pelgrum, 2002). The literature describes the kind of skills teachers may need when integrating ICT in new student-controlled learning approaches. However, which competencies each teacher needs to acquire very much depend on the specific circumstances of their particular school. Teachers themselves need to become lifelong learners, with traditional teacher "training" models perhaps being replaced by models that allow teachers to learn independently, at their own pace and supported by ICT (including teacher educators who are virtually present in addition to physical presence). Important support tools would be tools for self-assessment that direct teachers to relevant knowledge sources. There can also be recognition that substantial learning can take place while teaching and even by learning from students. Albion (1999) indicates that the focus on information technology in education has shifted towards curriculum integration. Consequently, teacher education programmes need to prepare graduates for teaching with ICT.

Graduates should possess skills in the use and integration of ICT into teaching and learning. Ferbar and Trkman (2003) reported that the use of information technology for mathematics education offers students the choice of pathways to acquire knowledge. They however indicated that the main limitation to full utilization of IT

in education can be teacher inexperience in using computers and the internet and limited support for teachers to learn how to use technology to develop and enrich learning experiences for students (Woerner, Rivers & Vockel, 1991; McNamara 2004). The use of the internet in teaching is easier because one can include practical examples and project work. This enhances the usefulness of mathematics which in turn increases other positive effects such as clarity, motivation and interest. A study on the effect of computer assisted instruction in teaching mathematics on a sample of prospective teachers showed that students who work co-operatively out performed those who worked individually. Teachers can only pass on the latest skills and ideas to learners if they are at the cutting edge of knowledge and developments in their subjects. This is, unfortunately not the case in many developing countries where most teachers have minimal or no ICT skills and hardly use existing opportunities to develop them. Trainee teachers need to acquire very specific ICT competencies to enhance the quality of the teaching and learning that takes place in schools. Clearly, the specific skills cannot be acquired without the general abilities, and the general abilities are not of much benefit if teachers do not possess specific skills for applying ICTs in their teaching activities. Olakulehin (2007) identifies four broad approaches through which ICTs could be adopted for teacher training and professional development.

Figure 2. 1: Model depicting a continuum of approaches to ICT application for Teacher training and development

EMERGING	APPLYING	INFUSING	TRANSFORMING

Source; Olakulehin (2007)

The continuum model above (Figure 2.1) shows teacher skills flowing from the emerging to the applying into the infusing and then culminating in the transforming processes of the educative activities which takes place in schools. The Emerging approach is the first stage of ICT skills development in teachers, focusing on the technical functions, components and general uses of ICTs for education. This approach tends to be theoretical with the practical components involving the personal use of ICT. The emphasis here is on training of teachers in a range of tools and applications, and increasing teachers' awareness of the opportunities for applying

ICT to their teaching in the future. The next level of the continuum model emphasizes the application of ICTs to teachers' subject areas. In the applying approach, teachers use ICT for professional purposes, focusing on improving their subject teaching in order to enrich how they teach, with a range of ICT applications. This approach often involves teachers in integrating ICT to teach specific subject skills and knowledge; beginning to change their methodology in the classroom, and using ICT to support their training and professional development. The infusing approach involves the inclusion of ICT in all aspects of teacher's professional lives in such ways as to improve student learning and the management of learning processes. The approach supports active and creative teachers who are able to stimulate and manage the learning of students, integrating a range of preferred learning styles and uses of ICT in achieving their goals. The infusing approach often involves the teacher easily integrating different knowledge and skills from other subjects into project based curricula. Moving along the model, transforming teaching through ICTs involves teachers and other support staff in the school system regarding ICT as a natural part of everyday life of the system with the emphasis changing from a teacher-centric to a learner-centric system where the teacher is seen to help students as a facilitator. This shift of emphasis to learners' needs also calls for new training needs on the part of the teachers.

In Singapore, the government realizes the importance of ICT for the survival of the country and it has implemented the Singapore IT2000 Masterplan to transform the country into an intelligent island so as to enhance the country's competitiveness and to enhance the quality of life for the people through the exploitation of information technology (Infocomm Development Authority of Singapore, 1997). The education service is one of the most strategic factors for the success of the Singapore IT2000 Masterplan, as it is responsible for nurturing the youngsters who will contribute to all aspects of nation building in the future. To reach such a goal, NIE has adopted a two-pronged approach.

Infusing IT into the teaching and learning of curriculum subjects and providing a core module for all trainees specifically on the integration of IT in teaching and learning. Supporting teachers before they will need to use a particular ICT aspect or skill is important so that there is the full confidence in understanding the proper use

of each of the different types of Mathematics software. Without adequate professional development of prospective teachers, little progress is possible. These teachers need to familiarize themselves with ICT for their Mathematics lessons through experimentation, adoption and integration.

Though many teachers do make regular use of ICT in the classroom, most feel that they lack the competence or confidence to do so effectively (Harris, 1999). Teachers may readily admit that they do not understand ICT fully and there is generally little appreciation of the potential of ICT to enhance teaching and learning (Fox, Montague- Smith & Wilkes, 2000).In order to achieve this, the teachers were taken through the following skills:

1. Dynamic Mathematics Series

Trainees were introduced to the CD-Rom series: The Dynamic Mathematics Series produced by Curriculum Development Institute of Singapore (CDIS) and Educational Technology Division (ETD) of the Ministry of Education. This series comprises of 6 CD Roms. They are: Building a City with Linear Graphs (CDIS, 1994);

Space Trek Through Symmetry (CDIS, 1994);

The Undersea World of Algebra (CDIS, 1995);

Through the Ages with Congruency and Similarity (CDIS, 1995);

Jungle Survival with Quadratic Equations (CDIS, 1996); and

The Business of Graphs (ETD, 1997).

2. Graphmatica

Graphmatica is a friendly equation plotter written by Keith Hertzer, Ksoft, Inc. It can be downloaded from the following website: http://www8.pair.com/ksoft.

Here is an abstract from the webpage:

Graphmatica is an easy-to-use, powerful equation plotter with numerical and calculus features. Graph Cartesian functions, relations, and inequalities, plus polar, parametric, and ordinary differential equations. In summary, a great tool for students and teachers of anything from high-school algebra through college calculus.

3. The Geometer's Sketchpad *(GSP)* (Key Curriculum Press, 1995)

The Geometer's Sketchpad (or GSP for short) is a tool for drawing / constructing

Geometrical figures. It comprises of menus and toolbox. For constructions, geometrical instruments such as: straight edge and compasses are used. It also has a graph menu and a calculator.

4. The Internet as a resource for mathematics lessons

During this 2-hour lesson, trainees are shown a few websites on the internet that are suitable for teaching of some mathematical concepts, like the proof of Pythagoras theorem or the simulation of a travel graph.

In the IT Masterplan 1(http://www1.moe.edu.sg/iteducation/Welcome.htm, 1997), expected IT competence for teachers included being able to evaluate software and adapt available software resources to their needs and to prepare lesson plans via ICT. In addition to this, because a perfect fit between software and curricula requirements is rarely possible, teachers were also trained on how to design & create IT-based materials for effective instruction. A study (Agyei and Voogt, submitted) conducted in Ghana among pre-service and in-service mathematics teachers explored the influence of computer attitudes, competencies and access of the teachers on their levels of ICT integration using the will, skill and tool concept. The study reported low levels of ICT integration as a result of low competencies and access levels of ICT. Furthermore, the study showed fairly high levels of positive ICT attitudes and indicated among others to be a necessary condition to prepare teachers for new teaching methods which are flexible and involve appropriate use of ICT. Of equal importance to ICT integration is teacher preparation programmes. Research have shown that such programmes have not adequately modelled the use of technology in their method courses (Adamy & Boulmetis 2006) or incorporated effective approaches to technology integration into a single technology course (Brown & Warschauer 2006).

The UNESCO ICT competency standards for teachers (UNESCO, 2008) describe three approaches: technological literacy; knowledge deepening; knowledge creation. These approaches are seen as part of a development continuum and each approach has different implications for education reform and improvement; each has different implications for changes in the components of the education system: pedagogy, teacher practice and professional development, curriculum and assessment, and

school organization and administration. ICT plays a different, but complementary role in each of these approaches, with new technologies requiring new teacher roles, new pedagogies, and new approaches to teacher education. The successful integration of ICT into the classroom depends on the ability of teachers to structure their learning environments in some non-traditional ways, merging technology with new pedagogies, to develop active classrooms that encourage cooperative interaction, collaborative learning, and group work. Education systems around the world are under increasing pressure to use ICT to teach knowledge and skills learners needed in the 21st century. ICT tools have the potential to transform the nature of education; where and how learning takes place and the roles of students and teachers in the learning process (Newhouse, 2002). ICT provides an array of powerful tools that may help in transforming the present isolated, teacher centred and text bound classrooms into rich, student focused, interactive knowledge environment. Computer integration in the classroom is the application of technology to assist, enhance and extend students' knowledge. Teachers do not necessarily need to learn about technology; they need to learn how to use technology to enhance their learners' understanding and critical thinking skills. McNamara (2004) in his study on mathematics teachers learning on the incorporation of ICT in their teaching reported that the development of teachers' teaching expertise with ICT was characterised by personalisation. The participating teachers perceived and used the potential of ICT applications in different ways according to their personal view of what an application was capable of and how it could be incorporated into the classroom practice. McNamara's findings indicate that ICT use was found by some teachers to be rewarding in terms of enhancing pupils' enjoyment of the lesson and obtaining good results. Muriithi (2005) points out that in Kenya like most developing countries ICT usage is still limited to computer literacy training. The present ICT curriculum merely deals with 'teaching about computers' and not how computers can be used to transform the teaching and learning process in our schools. "Being digital fluent" means not only knowing how to use the technological tools but also knowing how to construct things of significance with those tools. Mathematics Association (2002) identified six ways in which ICT can be used in teaching and learning mathematics.

Learning from feedback: ICT, especially computer often provides fast and reliable feedback which is non-judgmental and impartial. This can encourage students to make their own conjectures and to test out and modify their ideas.

Observing patterns: The speed of computers and calculators enables students to produce many examples when exploring mathematical problems. This supports their observation of patterns and the making and justifying of generalizations.

Seeing connections: The computer enables linking of formulae, tables of numbers and graphs readily during teaching and learning. Changing one representation and seeing changes in the others helps students to understand connections between them.

Working with dynamic images: Students can use computers to manipulate diagrams dynamically. This encourages them to visualize the geometry as they generate their own mental images.

Exploring data: Computers enable students to work with real data which can be represented in a variety of ways. This supports interpretation and analysis.

Teaching' the computer: When students design an algorithm (a set of instructions) to make a computer achieve a particular result, they are compelled to express their commands unambiguously and in the correct order; they make their thinking explicit as they refine their ideas.

Research done in Canada showed that in-service and pre-service mathematics teachers believe that they are not adequately trained and often are not given appropriate tools to implement educational technology in their classrooms (Hardy, 2003). Bauer (2000) indicated that even though teachers have formal training in instructional technology, most new teachers have limited knowledge on integrating computer technology into their professional practice and curriculum. It has been observed that even in situations where teachers have been trained on the use of ICT, the integration of these technologies in teaching has been weak due to absence of systems management support, lack of ownership by the school, lack of integration into existing curriculum and textbooks, teacher overload and lack of incentives and motivation, lack of ICT based materials that are interactive for teachers to use and

shortage of personnel. The absence of policies and management support to the use of ICT in schools is hindering the progress of the use of ICT in the classroom (Omwenga, Waema & Wagacha, 2004). Jimoyiannis (2010) describe the various parts that make up technological pedagogical content knowledge;

Pedagogical Content Knowledge: This includes scholastic strategies and techniques, representation and formulation of scientific concepts, knowledge of what makes those concepts difficult or easy to learn, knowledge of students' misconceptions, prior knowledge or cognitive difficulties, knowledge of students' theories of epistemology etc.

Technological Content Knowledge: Incorporates issues of how science and mathematics subjects are transformed by the specific technological environments. For example, the changes in the nature of science technology brings, new methods and tools used to solve scientific problems, modelling methods in science, and mathematics simulation software in physics etc.

Technological Pedagogical Knowledge: Includes the knowledge of how technology can support specific educational strategies in the classroom; for example, fostering inquiry or collaborative learning.

2.4 Implications for Professional Development

The implications for change in teacher professional development and other education system elements differ as a country moves from traditional education to (1) technology literacy, (2) knowledge deepening, and (3) knowledge creation. Of the three approaches, the technology literacy approach involves the most basic policy changes. The policy goal of this approach is to prepare students, citizens, and a workforce that is capable of taking up new technologies so as to support social development and improve economic productivity.

Professional development programmes though have the goal of developing teachers' technological literacy so as to integrate the use of basic ICT tools into the standard school curriculum, pedagogy, and classroom structures. Leach and Moon (2002) describe the concepts underlying the process of teachers coming to know how, where, and when (as well as when not) to use technology for classroom activities, for

management tasks, and obtaining extra subject materials and also pedagogical knowledge in support of their own professional development.

According to UNESCO (2009), educational changes related to the knowledge deepening approach have more impact on learning as they aim at adding value to society and the economy by having learners apply the knowledge of school subjects to solve complex problems encountered in real world situations of work and life. Coordinated teacher professional development would provide teachers with the skills to use more sophisticated methodologies and technologies with changes in the curriculum that emphasize depth of understanding and application of knowledge to real world problems and a pedagogy where the teacher serves as a guide and manager of the learning environment and students are engaged in extended, often collaborative project-based learning activities that can go beyond the classroom.

The most complex of the three approaches to educational improvement, the knowledge creation approach, aims to increase civic participation, cultural creativity and economic productivity by developing a population that is continuously engaged in and benefits from knowledge creation, innovation, and participation in the learning society (ibid). Here, the curriculum goes beyond a focus on knowledge of school subjects to explicitly include the 21st century skills that are needed to create new knowledge and engage in life-long learning—the ability to collaborate, communicate, create, innovate, and think critically. Teacher training coordinates the teachers' sophisticated professional knowledge with the pervasive use of technology to support students who are creating knowledge products and are engaged in planning and managing their own learning goals in a school that is a continuously improving, learning organization. So, teachers model the learning process for students and serve as model learners through their own ongoing professional development – individually and collaboratively. It is only when potential users have a sound understanding of how they can use new ICTs effectively that they have real influence. Otherwise, ICT becomes just a drain on the organization or community (Unwin, 2005).

2.5 ICT Use in the Classroom

In the developing world, more often than not, ICTs such as computers are installed into schools without sufficient thought given to how they will be used. In "Ten

Lessons for ICT and Education in the Developing World," Robert Hawkins (2002) from World Links discusses his programme's experience in connecting schools to the internet, training teachers, and dealing with curriculum and education reform issues in developing countries citing a practical lesson that: "to take full advantage of new technologies, we need to fundamentally rethink our approaches to learning and education— and our ideas of how new technologies can support them." Yet it is clear that many different types of technology can be used to support and enhance learning. The technologies available in classrooms today range from simple tool-based applications (such as scientific calculators), to online repositories of scientific data and include other forms such as electronic versions of primary historical documents, handheld computers, radios, closed-circuit television channels, and two-way distance learning classrooms. Prensky (2005) also strongly asserts that cell phones can be used to learn.

Lei and Zhao (2007) describe how each technology is likely to play a different role in students' learning. Yet, rather than trying to describe the impact of all technologies as if they were the same, it is clear that we need to think about what kind of technologies are being used in the classroom and for what purposes. Two general distinctions are found in the literature. First, students can learn from computers where technology is used essentially as tutors to increase students' basic skills and knowledge, and second, they can learn with computers where technology is used as tools applied to a variety of goals in the learning process and being a resource to help develop higher order thinking, creativity and research skills (Reeves, 1998; Ringstaff and Kelley, 2002).

According to UNESCO (2004), the three main approaches to ICT taken by teachers are: An Integrated approach: planning the use of ICT within the subject to enhance particular concepts and skills and improve students' attainment; An Enhancement approach: planning the use of an ICT resource which will enhance the existing topic through some aspect of the lessons and tasks; and a Complementary approach: using an ICT resource to empower the pupils' learning

All three approaches can enhance attainment, but the effects may be different. In the integrated approach, students' learning is enhanced because they are confronted with challenges to their existing knowledge and given deeper insights into the subject

being studied. The enhancement approach presents knowledge in new ways, encouraging learners to formulate their own explanations. The complementary approach frees the learner to focus on more challenging and subject-focused tasks (Kemmis et al., 1977 in UNESCO, 2004). These different types of use require the teacher to have an extensive knowledge of ICT and to be able to fit its use either into their existing pedagogy or to extend their pedagogical knowledge so they can accommodate ICT effectively in their teaching.

2.6 Mathematics Teachers' Attitude towards Use of ICTs in Teaching

Several authors have defined attitude in different ways. According to Taiwo (1998), attitudes are inclinations and feelings, prejudices or bias, preconceived notions, ideas, fears and convictions about any specific topic (Paul et al 2007). According to Allport (1935), it is a mental and neutral state of readiness organized through experience exerting directive or dynamic influences upon an individual's response to all objects or situations with which it is associated. Attitudes represent the conceptual value of these technologies in the minds of the users, not the values of the technologies themselves. According to Spacey, et al. (2003); Fine, (1986) and Evald (1996), positive attitudes are fundamental in implementing new technologies. As a result, a lot of research on the attitude of both students and teachers towards the use of ICT in teaching and learning had been done with outcome being either positive or negative. For instance, Becta (2004) reported that negative attitude was a barrier towards integration of ICT in teaching and learning while Rhoda and Gerald (2000) found that positive attitudes towards ICT use are widely recognized as a necessary condition for effective ICT use in teaching and learning. Similarly, study findings by Kubiatko and Hălăkovă (2009) pinpointed that attitude towards use of ICT in teaching and learning in learners was as a result of its impact.

According to Selewyn (1999), integration of ICT in education environment depends, to a great extent, on teachers and student attitude towards their use. This view is supported by Slouti and Barton (2007) findings which indicated that ICT can motivate students in their learning by bringing variety into the lessons and at the same time sustaining teacher's own interest in teaching. Myers and Halpin (2002) asserted that attitude of both students and teachers towards ICT use was a major

predictor of future classroom use. It therefore appears that teachers' and students' attitude may influence adoption of ICT in teaching and learning.

Use of ICTs such as computer technology and internet is intended to enable teachers to facilitate learning more effectively and enhance students' understanding of concepts which are expected to translate into expansion of Knowledge and improved examination outcomes. 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 & Voogt, 2011; Bingmlas, 2009). 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). Even though there is a dramatic impact and growth of ICT in the society, many classrooms, staffrooms, schools and colleges look like and operate in remarkably similar ways to those of two decades. 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.

School technology leadership is a strong predictor of teachers' use of computer technology in teaching (Anderson and Dexter 2005). Rodgers (2003) in his Technology Acceptance Theory (TAM) argues that people's intention to use technology is influenced by their attitude towards it. This suggests that schools' administrators' attitudes towards ICT can affect their support to ICT integration in schools. According to Pelgrum, (1993) Schools whose principals have positive expectations regarding the educational impact of computers tend to emphasize integrated learning more than schools with principals who are less positive. Wash (2002) stresses that ICT integration could be achieved in schools only if school leaders are totally committed over a period of time. Kyriacos (2011) carried out a study to examine principals' attitudes towards ICTs and their perceptions about the factors that facilitate or inhibit ICT integration in primary schools in Cyprus. It was

found out that Cyprus' primary school principals generally hold a positive attitude towards ICT. However, a number of statistically significant differences were observed across gender, years of service, academic qualification, access to computers and the internet at home. Kyriacos (2011) argues that school leadership attitudes towards ICT should be of primary concern. It is for this reason that the current study seeks to find out how teachers' attitude towards ICT affects its use in mathematics instruction.

2.7 Type of Infrastructure and Technical Support for ICT Instruction Use

Provision of adequate appropriate ICT infrastructure is crucial for effective and productive lesson delivery in instruction. They would apply teaching strategies that would appeal to the learners' senses to enhance on retention of what is learnt (EMSK Journal, 2010). It is important that such gadgets are incorporate and integrated in the curriculum alongside other learning resources in the instructional environment. To the learners, this simplifies the lesson content and it is a real reflection of what life is in this 21st century.

The ICT tools according to this study that may be generally and commonly used include; digital cameras, video recorders, computers, audio tape recorders, DVD, laptop computers, recorders, fax machines, printers, mobile phones, internet, power point, email, virtual teaching, environment, inclusive of both hardware and software available, overhead projectors, photocopiers and interactive whiteboards (Erb, W. 2008). These may also entail the laboratory technicians to arrange the learning environment and do some repairs and maintenance of the ICT gadgets.

Learners may use ICTs during classroom lessons to document and share learning experiences. According to Jordan (2006), ICT resources refers to tangible visible way to create possibilities and avenue to interpret teaching and learning experiences between teachers and learners plus arranged learners themselves. By the help of integrated ICT tools learners acquire peer to peer discussions and how to create knowledge based on each other's contributions under the guidance of skilled teachers. This may be well facilitated by the available ICT technicians in the learning institutions.

2.7.1 Infrastructure Support for ICT use in Instruction

Adequate infrastructure is needed for ICT integration to be realized. The use of computers and other ICT tools may be recognized of making the teaching and learning process more effective and enriched. The GoK in its financial year 2010/2011 allocated Ksh 1.3 billon towards the purchase of over 200 computers for each constituency to make ICT a reality in schools. For E- learning schools require adequate desktop computers to exploit the potential offered by ICT and to bridge the digital divide in our economy.

The GoK partnered with other well-wishers such as Equity Bank, TSC and KICD for teachers to acquire laptops. The ICT integration software content packages are also to be developed by the KICD. The National ICT policy and E-government strategy also supports in the provision of funds and ICT tools in schools as an important infrastructure. Schools also require to be connected to the to the main electricity line although this is a stiff challenge in the rural areas. Access to ICT facilities is one of the challenges in African countries especially Kenya which may be due to the socio-economic disparity between the urban and rural areas. Schools also require well ventilated strong rooms or more open with sockets. They should also be connected to the internet which sometimes is costly to the developing countries like Kenya.

There is also need to have original curriculum content at the lower primary school level made by the specialists at KICD who are the designers, audio, video and script writers, programmers, multimedia, course authors and web designers. This is because ICT integration in instruction is as per the new paradigm shift and constructivists theory in which learners are no longer seen as recipients but other active agents of learning (Wekesa, 2015). ICT tools further enhance on learner confidence, initiative, and cognitive, psychomotor and affective learning skills.

2.7.2 Need for Technical Support on ICT integration in classroom practices

Technological skills are increasingly important for advancement in education, work, and leisure. The curriculum integrates ICT into the teaching and learning process and provides children with opportunities to use modern technology to enhance their learning in all subjects (Department of Education and Science, 1999). This suggests

that ICT in is seen primarily as a tool for facilitating teaching and learning throughout the curriculum, rather than ICT as a subject.

Digital literacy is increasingly becoming an essential life and work skill. The inability to access and use Information and Communication Technologies on an everyday basis has effectively become a barrier to social and professional integration as well as personal development. ICT, including computer applications, mobile technology and communication systems, seems to have become an important means in teaching (Coates & Friedman, 2009). Teachers should therefore acquire the necessary skills and knowledge to use and maintain these technologies (Cuban, 2001). Apart from training teachers, school requires qualified assistants in ICT skills. Such highly trained technical work force with required skills to service, repair and arranging for the learning environment just like it was with the laboratory sciences with technicians. Such experts may include ICT media analysts who carry out general, quantitative and qualitative research to improve the effectiveness of media programmes management systems in schools (Thomas, 2008).

Training and capacity building is needed on the knowledge and technical skills on ICT tools. Research done by Brown and Murray (2006) shows that curriculum implementers should be aware of the potential that ICT tools play in classroom instruction. They observe that where ICT expertise was lacking, policies planned by the government and investment towards the implementation of ICT in schools is bound to fail in realizing the desired school reforms. However, it seems that the investment and planning for training teachers in ICT skills was regarded as an additional cost rather than as an essential component for transforming teaching and learning.

ICT integration involves several instructional facilities and materials which require technical support in innovativeness, repair and maintenance. Such experts are needed where there is teacher in-experience and skill deficiencies just like it is in pure sciences where we have science laboratory technicians. This will share their technical and pedagogical delivery methods as they work with teachers and learners in interactive teams. Such specialists will take the lead to teach others the basics of

word processing, spreadsheets, presentation software, using web and the internet being pre-requisite to boost their computer skills.

Teachers may find this being motivational as they perfect their knowledge and competencies in ICT technology. Teachers experiencing challenges will gradually, be mentored and encouraged to pursue ICT training programmes. This broadens knowledge and skills in integrating ICT in Classroom Instruction (MOEST, 2013). This creates a shift from traditional instructional methods to technology enabled, learner-centered pedagogy.

2.8 Knowledge Gap in the Reviewed Literature

The literature reviewed in this chapter is geared towards an understanding of the influence of teacher preparedness for integration of ICTs in mathematics instruction. This relates to teacher preparedness in pedagogical knowledge and skills, attitude towards ICTs and the kind of infrastructure and the technical support available teachers ICT integration in mathematics instruction. Previous studies carried out lay emphasis on the contribution of ICTs for holistic child development: Cognitively, physiologically and health wise. It also emerges from the literature review that the effective use of Information Communication Technology (ICT) gadgets enhances the attainment of many learning skills and for integration in classroom practices, there is need for professional development of teachers.

Use of information communication technologies in the teaching and learning of mathematics has profound benefits over the conventional methods of instruction. ICTs could solve the perennial problems of poor performance and negative attitudes of learners towards mathematics subjects if effectively integrated in instruction. However, several factors including teacher preparedness in knowledge and skills, attitudes and support in terms of infrastructure and technical expertise help have been established with most studies as impending the use of these tools in instruction. This establishment created the need for this research in order to suggest the findings to educational planners for the purpose of effective integration of ICTs in mathematics instruction in secondary schools.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter involves a discussion of the procedures used in this study. The discussion includes the research design and methodology, study area, target population, the sample of study, sampling procedures, research instruments, research variables, the procedures used in data collection and analysis.

3.2 Research Methodology

The descriptive survey research design was adopted in this study and involved collection of both quantitative and qualitative data to test hypothesis or to answer questions concerning the status of the subject of study (Ader, Van Marwik, Deltaan & Beekman, (2008). The design enables the researcher to gather data at a point in time and use it to describe the nature of the existing conditions (Borg & Gall, 2007). It also enables a researcher because of its rapid data collection and ability to help understand populations from a part of it (Gay, 2006; Orodho, 2002). The use of the survey design was necessitated by the need to study the variables of interest at their natural occurrence without any form of manipulation and enhanced the collection of quantifiable information from the sample. The issues of economy, rapid data collection and ability to understand pupulations by considering part of it guided the choice of this design that also enabled collection of firsthand information that describes the existing phenomena as noted in terms individual's perceptions, of attitudes, behavior and values (Oso & Onen, 2005).

3.3 Study Area

This study was carried out in the Western Region of the Republic of Kenya and involved teachers in the secondary schools in Kimilili, Bungoma North and Bungoma East sub-counties of Bungoma County. Other sub-counties in the County include; (Bungoma West, Bungoma south, Bumula, Sirisia, Cheptais and Mt Elgon sub-counties). To the North-West part at Lwakhakha Border point, the County borders the Uganda republic, Trans-Nzoia West District to the North Eastern part, Kakamega North and Mumias Districts to the South, Lugari to the Eastern side, and Teso North and Busia to the Western part. The whole study area (Bungoma county) lies between latitude $0^0$25.3 North and $0^0$53.2' North and longitude $34^0$21.4'3" East.

It covers an area of about 2063 km^2, which is approximately 25% of the total area of the Western region of Kenya.

The three sub-counties in the County were involved in the study. This county was chosen for various reasons: First, it had a large number of secondary schools. Secondly, it had many categories of public schools for example national schools, day mixed schools, boys boarding, girls boarding, day mixed and boarding schools.

3.4 Target Population

The mathematics teachers involved in this study were drawn from a stratum of secondary schools in Kimilili, Bungoma North and Bungoma East sub-counties. The study population were the Secondary School mathematics teachers in the 133 secondary schools in the three sub-counties**.** According to Statistics from the County Director of Education, there were 793 mathematics teachers in the three Sub-counties.

3.5 Sample size and Sampling Procedure

The sampling procedure involved an examination of part of the population using the information obtained (Mingers, 2005; Myers, 1997). In order to get sampling units, which are a proportion of the population, Taro Yamane (1967) formula was used using the following formula as suggested by Ikeo, a researcher (Ikeo, 2014).

$$n = \frac{N}{1 + N(e^2)}$$

Where: **N** = Population (793)

n= size of the sample

e=The (0.05) level of confidence preferred

Table 3. 1: Sampling Frame

Respondents	Study population (N)	Sample Size(n)	Sampling technique
Males	547	136	Stratified Sampling
Females	246	82	Stratified Sampling
Total	793	218	

Source: Field Data (2018)

n= 218 was the number of sampling units that study considered. Procedurally, stratified sampling was used to identify sampling units based on various characteristics such as level of experience, level of education, gender, age, and even type/nature of school they taught. To ensure all-inclusiveness, the strata comprised of respondents from Girls' Schools, Boys' Schools, Mixed Day and Mixed Day and Boarding Schools.

3.6 Data Collection Instruments

Mathematics Teachers' Questionnaire (MTQ), Principals' Questionnaire (PQ) Interview) and Observation schedules were used in this study. These methods were preferred because of their perceived high accuracy generalizability and explanatory power, with low cost, rapid speed and maximum management demands and administrative convenience (Warwick and Lininger 1975). The instruments were used because no one instrument can elicit data sufficient enough to make valid and reliable conclusions. In research, the use of triangulation allows the researcher to obtain information fully and reveals varied dimensions to the phenomena under investigation. In using triangulation, bias is minimized, and validity enhanced. The choice of the data collection instruments was based on the type data, available time as well as the objectives of the study.

3.6.1 Mathematics Teachers'/Heads of Departments Questionnaire (MTQ)

Questionnaires were preferred because they are appropriate tools through which many respondents can be reached. The questionnaire made it possible to obtain a wide variety a short time (Borg and Gall, 1983). The MTQ was used to collect data on, status of computers resources, teachers' accessibility to computer resources,

status of computer uses and teachers' attitude towards computer integration and use. The respondents filled in a prepared questionnaire. This was aimed at measuring perception attitude, values and behavior. They were rated using the Likert scale (Appendix II, pg. 81).

3.6.2 The Interview Schedule

The interview schedule was prepared and used to collect qualitative in-depth data. The interview schedules provided the researcher with greater opportunity to explain the purpose of the study (Stone and Harris 1984). This instrument were used to obtain data from the mathematics teachers (Appendix III, pg. 91).

In the development of the interview schedule, the fixed-choice and open-ended formats of items was used to avoid limiting the respondents' response and to facilitate guidance and probing for further clarification. The questions are designed on the basis of the objectives of the study, the research questions and the theoretical framework stated in chapter one.

The choice of interview was based on the many advantages of the interview schedule among them is that interviews provide access to what is inside a person's head, makes it possible to measure the person's knowledge and information, considers what a person's values and preferences, attitudes and beliefs. Interviews are also flexible, adaptable to individual situations and avoid the high non-return rate common with survey questionnaires. Also interviewing gives an opportunity for triangulations to supplement data elicited by questionnaires thus provided more information for the study. The researcher held face to face interviews with the respondents.

3.6.3 Observation Checklist

This method was used because it was a qualitative primary research instrument for gathering data in a more natural way that ensures validity and reliability. For the purpose of this study, direct observation was employed to collect data concerning the availability of resource materials and facilities for effective use of ICT in mathematics instruction in selected secondary schools. Direct observation technique was found suitable for such a descriptive study because it was objective–based and

facilitates derivation of more authentic data (Best, 1970). Areas that were observed included the status of the physical facilities such as computer laboratories, mathematics laboratories, projectors and instructional software materials (Appendix IV, pg. 93). This instrument enabled the researcher to enter the world of the respondents to learn and experience how they use ICTs in mathematics instruction.

3.7 Piloting of Research Instruments

Tuckman (1988) observes that it is highly desirable to run a pilot test on a questionnaire and to revise it based on the results of the test. Piloting was done to establish whether the instruments could be used to collect relevant data, identify any problems likely to occur at the time of actual data collection process and to check whether the instructions in the questionnaires are understandable to the respondents. The results were used to test the validity and reliability of the research tools, determine field experiences and the instruments will be revised according to the findings. Piloting of the instruments was done in selected schools from the same region i.e. three sub-countries in Bungoma. This was because schools any school in the three sub-counties (targeted though not sampled had the same characteristics as those sampled.

3.7.1 Validity of the Instruments

Polit & Beck (2010) define the validity of a questionnaire as the degree to which the instrument measures what it is intended to measure. It is the most critical criterion that indicates the degree to which an instrument measures what it is supposed to measure (Kothari, 2009). The questionnaire should adequately address all aspects of the issues being studied. Face validity and content validity are the validity issues most frequently reported in the literature (Parahoo, 2006). Face validity basically checks that the questionnaire seems to measure the concept being tested (LoBiondo-Wood & Haber, 2010) and this will be assessed by getting friends to test-run the instrument to see if the questions appear to be relevant, clear and unambiguous as outlined by Jones & Rattray (2010).

The research tools were developed and validated by the researcher before their use with expert help from supervisors. The instruments were validated by subjecting

them to respondents and if the responses were true and could be generalized then, then they were valid. A survey of opinion was sought to find the most appropriate design. These tools were preferred for this study because they enabled the researcher to get views from a large number of respondents within a short time. They made it easy to collect relevant information and were times saving. For the research instrument to be considered valid the content selected and included in the questionnaire must also be relevant to the variables being investigated. Validity for this study was done through collection of data from respondents identified in the considered areas. In consultation with experts from the department of Science and Mathematics Education and Faculty of Education and Social Sciences, the researcher analyzed the responses and made informed decisions as to whether the instruments were valid or not.

3.7.2 Reliability of the instruments

According to Parahoo (2006) reliability is a necessary but not sufficient condition for validity. Reliability of a questionnaire refers to its ability to yield the same data when it is re-administered under the same conditions, but it is difficult to obtain a replication of data when you are dealing with people (Robson, 2007). Reliability refers to accuracy of measurement and for research data to be reliable, the data collection tool must have the ability to consistently yield the same result when repeated measurements are taken under the same conditions (Sharma et.al., 1989 and Lokesh, 1992). Reliability for quantitative research focuses mainly on stability and consistency (Polit and Beck, 2010). The stability of a questionnaire is the degree to which it produces similar results on being administered twice.

To establish the reliability of the questionnaire, Cronchbach's Alpha was used to determine the reliability. After identifying the 30 sampling units to be considered in the pilot study, data was collected and analyzed to test the instrument reliability. The results arrived after data entry were as follows:

Table 3. 2: Reliability Statistics

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.704	.705	3

From the table 1, it was clear that the Cronbach's Alpha value of 0.704 was a good indication that the research instrument was reliable and would give consistent results with a small margin of error.

3.8 Research Variables

The study sought to investigate the teacher preparedness, that is, ICT skills, knowledge and attitude affect the use of these tools in mathematics instruction in secondary schools. It ascertained the relationships between the independent and dependent variables.

3.8.1 Independent Variables

These comprised of the factors affecting the integration of ICT in mathematics instruction that included the teacher's knowledge and skills in ICTs, attitude, and other significant factors such as infrastructure and technical support to teachers.

3.8.2 Dependent Variable

In this study, the dependent variable was the willingness and level of use of ICT in mathematics instruction by teachers. This was ascertained by teachers' intention to and actual use of ICTs in instruction.

3.9 Data Collection Procedures

The researcher sought a research permit (Appendix VI, pg. 95) from the permanent secretary in the ministry of Education, Science and Technology through the School of Graduate Studies at Masinde Muliro University of Science and Technology, and thereby clearance from the Bungoma County Education Office. Notification letters to

do research in the selected schools in Bungoma County were availed to the head teachers and teachers in the departments concerned. The researcher visited the schools and inform the head teacher the purpose of the study. The researcher was then handed over to the teachers of Mathematics.

Data collection involved distribution of research instruments to the teachers in the selected schools for the research. Interviews were conducted by the researcher to get in depth information and understanding of the issues surrounding the teacher preparedness, attitudes and use of computers in mathematics instruction. Observations were done to collect the necessary data for understanding the factors that hindered or promoted the integration of computers in mathematics instruction as perceived by the teachers in the schools. The observation checklist was used to obtain data on the availability and computer use.

3.10 Data Analysis

Data analysis involved both descriptive and inferential statistics because the research instruments yielded both quantitative and qualitative data. After data analysis, findings were presented in tables where frequencies and percentages were used to describe the characteristics of variables. Descriptive statistics included computation of frequencies and percentages from which interpretations and recommendations are made. Inferential statistics used included the Chi-square which was used to make a prediction about the relationship between the teacher's attitude towards ICTs and use in teaching and learning.

3.11 Ethical Considerations

The study observed all the rules and regulations in carrying out research in Kenya. The study took note of the ethical issues that are important in research and thus privacy, confidentiality and openness in data collection was ensured throughout the study. The major ethical issues of concern are informed consent from the participants to remove job insecurity, privacy and confidentiality on information supplied, anonymity to safeguard the identity of the respondents and the researcher's sensitivity to human dignity (Oso & Onen, 2002).

The research confidentiality was assured to all the respondents and all participants were informed to voluntarily participate in the research. The respondents were requested to be open and honest when dealing with the questions. The identity of the respondent is kept out of this documentation and data availed was used only for this study. The study was carried out with the consent of the relevant authorities.

3.12 Summary of Chapter Three

This chapter has focused on the various details concerning research design and methodology the study adopted. Details on specific study area, population, research tools and how they were administered to obtain data, analysis and ethical considerations are presented.

CHAPTER FOUR

RESEARCH FINDINGS, ANALYSIS AND DISCUSSION

4.1 Introduction

This study sought to establish the influence of teacher preparedness in the use of ICT in mathematics instruction, in secondary schools in Bungoma North Sub-County. The study considered a sample of 218. The presentation of findings based on demographic characteristics of respondents, and research questions will feature in this study. This will be followed by a detailed analysis and discussion of the research results.

4.2 Response Rate

The whole sample of 218 successfully responded to questionnaires and interviews. This was a response rate of 100%, which was good to be used in generalizing about the study.

4.3 Demographic Characteristics

In this section, descriptive results for the distribution of respondents based on gender, age bracket, level of education and level of experience are presented. The results describe the respondents in terms of frequency and percentages regarding the various characteristics. The results are as presented in table 4.1.

Table 4. 1: Demographic Profile of the Teachers

Teachers Data			
Gender	Male	136	62%
	Female	82	38%
Age Bracket	below 25 years	13	6%
	25-35 years	34	16%
	36-45 years	131	60%
	above 45 years	40	18%
Level of Education	College	21	10%
	Dip. Ed/ SI	27	12%
	Graduate	150	69%
	Post Graduate (MED/ MSc. PhD)	20	9%
Position/Responsibility	Classroom Teacher	135	62%
	head of department	61	28%
	deputy head teacher	15	7%
	head teacher	7	3%
Work Experience in Years	Less than 2 years	25	11.5%
	2-3 Years	25	11.5%
	4-5 Years	114	52%
	Above 5 years	54	25%

As in table 2, it is observed that out of the 218 sampling units who responded by filling questionnaires, 136 (62%) of the teachers were male while 82 (38%) were female. This was an indication that there were many male teachers as opposed to female counterparts of the same cadre. It is also noted that 13 (6%) of the teachers were aged below 25 years, 34 (16%) were aged between 25-35 years, 131(60%) were aged between 36-45 years, and 40 (18%) of the teachers were aged above 45 years. From the results, it is evident that most of the teachers of mathematics in the schools that participated in the study were aged above 35 years. There was need to establish their highest academic qualification and as indicated, 21 (10%) had acquired college certificate qualification, 27 (12%) had acquired Diploma in Education/S1, 150 (69%)

most teachers were graduates, while 20 (9%) had postgraduate qualifications. The results show that in the schools that participated in the study, most of the mathematics teachers were graduates or had post graduate qualifications and thus deemed well prepared as teachers of mathematics at this level of education. It was necessary to ascertain the responsibilities that the teachers had in their schools and as indicated, 135 (62%) of the teachers were just classroom teachers, 61(28%) were heads of departments, 15 (7%) were Deputy Head teachers while 7 (3%) were Head teachers respectively. The results show that most of the teachers who took part in this study were just classroom teachers and had the crucial role of ensuring effective teaching and learning of mathematics. There was also need to ascertain the teaching experience of the mathematics teachers who participated in the study and as indicated, 25 (11.5) had an experience of less than 2 years and 2-3 years respectively, 114 (52%) of the teachers indicated to have a an experience of between 4-5 years as 54 (25%) indicated to have an experience of more than 5 years. The results show that of the teachers who participated in the study, a majority had an experience of 4 years and above and thus were deemed appropriate for this study.

4.4 Findings according to the Objectives of the Study

This study sought to establish the influence of teacher preparedness in the use of ICT on mathematics instruction in secondary schools. The study was guided by the following objectives:

a) To determine the type of knowledge and skills needed by teachers to enable them to use the ICTs in mathematics instruction.

b) To investigate the influence of Teachers' attitude on the use of ICTs in mathematics instruction.

c) To establish the kind of infrastructural and technical support needed by teachers for integration of ICTs in mathematics instruction.

Answers were sought to the following research questions:

a) What types of knowledge and ICTs skills are needed by mathematics teachers to enable them use ICTs in mathematics instruction?

b) What is the influence of attitude of teachers on the use of ICTs in mathematics instruction?

c) What kind of infrastructural and technical support is needed by teachers for integration of ICTs in mathematics

4.4.1 Knowledge and Skills for Use of ICTS In Mathematics Instruction

The study sought to determine the type of knowledge and skills needed by teachers to enable them to use the ICTs in mathematics instruction. To ascertain the knowledge and skills required by the teachers, answers were sought from the teachers who participated in the study on the kind of knowledge and skills they need to use these technologies in mathematics instruction. The findings are as presented in the following sections.

4.4.1.1 Type of ICT knowledge and Skills

The teachers were asked to rate their knowledge and skills of basic ICTs operations which involve use of computers and other ICT materials in instruction. The findings are as indicated in table 4.2.

Table 4. 2: Type of ICT knowledge and Skills

		Highly Adequate	Adequate	Inadequate	Highly Inadequate	Not Available
1	Start and shut a computer	52(24%)	26(12%)	68(31%)	0	72(33%)
2	Use internet	54(18%)	18(15%)	68(31%)	6(3%)	72(33%)
3	Use word processor	0	0	26(12%)	52(24%)	139(64%)
4	Use spread sheets	0	0	26(12%)	40(18%)	152(70%)
5	Use database applications	0	6(3%)	26(12%)	(25%)	152(70%)
6	Use presentations applications	0	0	33(15%)	33(15%)	152(70%)
7	Teach basic computing algorithms	0	0	25(11 %)	30(14 %)	163(75%)
8	Use mathematics software	0	0	33(15%)	22(10%)	163(75%)
9	Prepare ICT content materials	0	0	44(25%),	33(15%)	152(70%)
10	Use ICT devises	0	0	33(15%)	44(25%)	141(65%)

On the teacher's knowledge and skills of use of ICTs in mathematics instruction, teachers were asked to respond on their knowledge of how to start and shut a computer, Use internet, word processor, spreadsheets, data base application, presentations applications and ICT content material. The results show that on how to start and shut a computer, highly adequate was noted by 52 (24%), adequate by 26 (12%), inadequate by 68 (31%), highly inadequate by none as a majority 72 (33%) of the teachers indicated that the computers are not available. On how the use of internet highly adequate was noted by 54 (18%), adequate by 33 (15%), inadequate by 68 (31%), highly inadequate by 6 (3%) as a majority 72 (33%) of the teachers indicated that the computers are not available. The use of word processor was not rated highly adequate or adequate but inadequate by 26 (12%), highly inadequate by 52 (24%) as a majority 139 (64%) of the teachers indicated not available. The use of spreadsheets was not rated highly adequate or adequate but inadequate by 26 (12%), highly inadequate by 54 (18%) as a majority 152 (70%) of the teachers indicated that computers are not available. The use of data base application was not rated highly adequate but adequate by 6 (3%), inadequate by 26 (12%), highly inadequate by 33 (15%) as a majority 152 (70%) of the teachers indicated that the computers are not available. The use of presentations applications was not rated highly adequate or adequate but inadequate and highly inadequate by 33 (15%) as a majority 152 (70%) of the teachers indicated that the computers are not available.

The teachers ability to teach basic computing algorithms was rated inadequate and highly inadequate by 25 (11%) and 30 (14 %) respectively as a majority of the teachers 163 (75%) noted not available indicated a lack of use in their instructional activities. Asked about the knowledge of use of mathematics software such as Geogebra, Geometer's Sketchpad, Graphmatica, SPSS, STATA among others, inadequate and highly inadequate were noted by 33 (15%) and 22 (10%) respectively as 163 (75%) a majority of the teachers indicated that they are not available in their schools. The knowledge of preparation and use of ICT content material was not rated adequate but inadequate by 33 (15%), highly inadequate by 44 (25%) as a majority (70%) of the teachers indicated that the computers are not available. On the use of the ICT devices in instructional activities, highly inadequate and inadequate were noted by 44 (25%) and 22 (10%) of the teachers respectively as not available was

noted by 141 (65%) most of the teachers who participated in the study. The results show that in most schools most of the teachers indicated that ICTs such as computers, projectors, instructional software and other ICT materials and equipment's are not available and in the schools with these ICT facilities and materials, the use was inadequate or highly in adequate in most cases as noted by the teachers who participated in the study.

There was need to find out the teachers rating of their ability in knowledge of preparation and use of the ICT resources in instruction. They were asked to rate their levels as relates to the use of these resources and the findings are as indicated in table 4.3.

Table 4. 3: Level of Knowledge and Skills for Use of ICT Resources

How do you rate	Highly Adequate		Adequate		Inadequate		Highly Inadequate		Not Available	
	F	%	F	%	F	%	F	%	F	%
levels of personal ICT skills	0		13 (6%)		91 (42%)		114 (52%)		0	
quality of training in ICT use	0		0		21 (10%)		77 (35%)		120 (55%)	
levels of technical support	0		10 (5%)		21 (10%)		65 (30%)		120 (55%)	
preparation and use of ICT content material	0		0		55 (25%)		65 (30%)		98 (45%)	
maintenance of ICT equipment	10 (5%)		22 (10%)		55 (25%)		76 (35%)		55 (25%)	

There was need to ascertain the teacher's rating of the level of preparedness in use of ICTs in instruction. Answers were sought on rating of their levels of personal ICT skills, technical support, quality of training in ICT integration, preparation of ICT content material and maintenance of ICT equipment. The results show that the level of teacher's personal skills was rated adequate by only 13 (6%) and inadequate and highly inadequate by 91 (42%) and 114 (52%) respectively most of the teachers who participated in the study. The teacher's quality of training in ICTs use was rated inadequate by 21 (10%) and highly inadequate by 77 (35%) as 120 (55%) most of the

teachers indicated that it is not available. The level of technical support was rated adequate by only 10 (5%), inadequate by 21 (10%), highly inadequate by 65 (30%) and 120 (55%) most of the teachers indicated not available. The preparation and use of ICT content material was rated inadequate by 55 (25%), highly inadequate by 65 (30%) and not available by 120 (45%) most of the teachers who participated in the study. The maintenance of ICT equipment was rated highly adequate and adequate by 10 (5%) and 22 (10%) of the teachers respectively, inadequate by 55 (25%) and highly inadequate by 76 (35%) most of the teachers as 55 (25%) of the teachers indicated not available. The results show that levels of personal ICT skills, technical support, quality of training in ICT integration, preparation and use of ICT content material and maintenance of ICT equipment were rated inadequate and not available by most of the teachers who participated in the study. This implies that in most of the schools, the mathematics teachers don't use ICT materials in instruction because of lack of the necessary knowledge and skills and which is pointed to the lack of initial training in college and university. From the findings, teachers require to be trained in pedagogical skills more so in selecting the relevant software and how to integrate the same in instruction. From the responses, teachers require assistance in how ICTs can be well applied and utilized to realize the educational objectives and how to organize learner friendly classroom environment (Mwelese, Wanjala, Simiyu & Amadalo, 2016).

Based on the results presented most of the teachers acknowledged the fact that teacher of mathematics needed to possess skills in ICT that would help them prepare to teach effectively and improve performance. Notably, skills that enable them use the internet for research in order to enhance and share knowledge, they needed to have basic computing skills, skills to use a variety of ICT devises, skills to repair and maintain devises and skills to integrate teaching and ICT technology. However, as Ferbar & Trkman (2003) reported in their study, failure of teachers to possess relevant ICT skills such as how to use the internet, projector, radio, and video player deprives learners of their right to acquire quality education. The use of the internet in teaching is easier because one can include practical examples and project work. This enhances the usefulness of mathematics, which in turn increases other positive effects such as clarity, motivation, and interest. In a study on the effect of computer assisted instruction in teaching mathematics on a sample of prospective teachers

showed that students who work co-operatively out performed those who worked individually (Woerner, Rivers & Vockel, 1991; McNamara 2004).

4.4.2. Teachers' Attitude and Use of ICTs in Mathematics Instruction

The study sought to determine the attitude of teachers towards ICTs and its influence on the use these technologies in mathematics instruction. To establish this, answers were sought from the teachers and heads of departments of mathematics and the responses are as indicated in the following sections. Attitude in this case focused on defiance, approach used, adherence to misconceived perceptions, motivational influence and related issues as they affect the teacher's willingness to use the ICT materials in mathematics instruction. To establish the attitude of teachers towards ICTs and how it impacts on the use of these tools in mathematics instruction, answers were sought on 23 statements that solicited their opinions by indicating their level of agreement on the attitude scale. The findings are as indicated in table 4.4

Table 4. 4: Teachers' attitudes and ICT Use in mathematics Instruction

		Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	Computers do not scare me at all	22 (10%)	33(15)	10(5%)	65 (30%)	88 (40%)
2	I'm no good with computers	119(55%)	65(30%)	0	10(5%)	21(10%)
3	I would like to work with ICTs	33(15%)	43(20%)	0	65(30%)	77(35%)
4	Working with ICTs would make me very nervous	132(60%)	65(30%)	0	21(10%)	0
5	I can try out a new problem using ICT	21(10%)	33(15%)	10(5%)	30%	88 (40%)
6	Learning about ICTs is a waste of time and very hard for me	77(35%)	55(25%)	43(20%)	21(10%)	21(10%)
8	Working with ICTs is enjoyable and stimulating	33(15%)	33(15%)	21(10%)	55(25%)	35%
9	Learning about ICTs is worthwhile	55(25%)	55(25%)	43(20%)	33(15%)	33(15%)
10	ICTs make me uncomfortable	98 (45%)	65(30%)	10(5%)	21(10%)	21(10%)
11	I am sure I could learn a computer language	10(5%)	55(25%)	0	55(25%)	98 (45%)
12	I feel at ease using a ICTs in class	33(15%)	43(20%)	4(2%)	55(25%)	85(38%)
13	I get a sinking feeling when I think of trying to use ICTs	77(35%)	65(30%)	10(5%)	43(20%)	21(10%)
14	Anything that ICTs can be used for, I can do just as well some other way	119(55%)	88(40%)	10(5%)	0	0
15	I do not think I could use ICTs to teach mathematics concepts	88 (40%)	77(35%)	10(5%)	21(10%)	21(10%)
16	Working with ICTs make teaching easy and efficient	26 (12%)	58(27%)	6(3%)	33(15%)	95(43%)
17	I have a lot of self-confidence when it comes to working ICTs	21(10%)	33(15%)	21(10%)	43(20%)	77(35%)
18	Working with ICTs will not be important and efficient in my work	77(35%)	88 (40%)	10(5%)	21(10%)	21(10%)
19	ICTs can enhance students' problem-solving skills and learning	77(35%)	77(35%)	0	55(25%)	10(5%)
20	ICTs encourage individualized instruction	98 (45%)	77(35%)	10(5%)	21(10%)	10(5%)
21	ICTs motivate students to solve mathematical problems	88 (40%)	77(35%)	10(5%)	33(15%)	10(5%)
22	ICTs save time and effort	98 (45%)	88(40%)	10(5%)	10(5%)	10(5%)

On whether computers scare the teachers, 22 (10%) and 33(15%) indicated agreement, 10(5%) were undecided as 65(30%) and 88(40%) most of the teachers disagreed respectively. Most 119 (55%) and 65 (30 %) of the teachers, indicated that they are not good working with computers, some 33(15%) disagreed on this statement. Asked whether they would like to work with ICTs, agreement was noted by 22 (10%) and 33(15%) of the teachers as 65 (30%) and 77(35%) most of the teachers disagreed. On whether working with a ICTs would make them nervous, agreement was noted by (60%) and 65 (30%) most of the teachers, as 22 (10%) disagreed on this. The teacher's ability to try out a new problem using ICT was noted 22 (10%) and 33(15%) of the teachers who agreed, 10 (5%) were undecided as 65 (30%) and 88 (40%) most of the teachers disagreed. On whether working with ICTs is enjoyable and stimulating, 65 (30%) of the teachers agreed, 22 (10%) were undecided as 55 (25%) and 77 (35%) most of the teachers disagreed. On whether learning about ICTs is a waste of time and very hard 77 (35%) and 55 (25%) most of the teachers agreed, 43(20%) were undecided as 43 (20%) disagreed. On whether ICTs make them feel uncomfortable 98 (45%) and 65 (30%) most of the teachers agreed, 10 (5%) were undecided as 43(20%) disagreed. On whether they can learn a computer language, 10 (5%) and 55 (25%) of the teachers agreed, as most 55 (25%) and 98 (45%) disagreed. On whether they feel at ease using a ICTs in class, 33 (15%) and (20%) of the teachers agreed, 4 (2%) were undecided as most 55 (25%) and (38%) of the teachers disagreed.

On whether anything ICTs can be used for, they can do just as well some other way, 119 (55%) and 88 (40%) most of the teachers agreed as 10 (5%) were undecided. Most 88 (40%) and 77 (35%) of the teachers noted that they do not think they could use ICTs to teach mathematics concepts, 10(5%) were undecided as 43 (20%) disagreed. On whether ICTs make teaching easy and efficient, 26 (12%) and 58 (27%) of the teachers agreed, 6 (3%) were undecided as 33 (15%) and 95 (43%) of the teachers disagreed. The results show that most of the teachers could not acknowledge that ICTs make teaching easy and efficient which could be attributed to their not interacting with ICTs during and after training.

On whether the teachers have a lot of self-confidence when it comes to working ICTs, 22 (10%) and 33(15%) of the teachers agreed, 22 (10%) were undecided as (20%) and 77 (35%) most of the teachers disagreed. Working with ICTs will not be

important and efficient as noted by 77 (35%) and 88 (40%) most of the teachers who agreed, 10 (5%) were undecided as 43 (20%) of the teachers disagreed.

On whether ICTs enhance development of problem-solving skills and learning, 77 (35%) and 77 (35%) most of the teachers agreed, as 65 (30%) of the teachers disagreed. On whether learning how to use the ICTs materials is worthwhile, 33 (15%) and 81 (27%) of the teachers agreed, 18 (6%) were undecided as (37%) and 33 (15%) most of the teachers disagreed. On whether ICTs encourage individualized instruction, 98 (45%) and 77 (35%) most of the teachers agreed, 10(5%) were undecided as 22 (10%) and 10 (5%) of the teachers disagreed. The results show that (80%) most of the teachers acknowledge that ICTs encourage individualized instruction. ICTs motivate students to solve mathematical problems as indicated by 88 (40%) and 77 (35%) most of the teachers agreed, 10(5%) were undecided as 33 (15%) and 10 (5%) of the teachers disagreed. Most 98 (45%) and 88 (40%) of the teachers noted that ICTs save time and effort 10 (5%) were undecided as 22 (10%) of the teachers disagreed.

The teachers were also asked to state their feelings about the benefits of ICT, the findings are as indicated in table 4.5

Table 4. 5: Teachers Perceptions of the Benefits of ICT

		Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	Assist students in accessing digital information efficiently and effectively	88(40%)	119(55%)	0	11 (5%)	0
2	Support student-centered and self-directed learning	88(40%)	65(30%)	10(5%)	33(15%)	10 (5%)
3	Produce a creative learning environment	98(45%)	88(40%)	6(3%)	26(12%)	0
4	Promote collaborative learning in a distance-learning environment	98(45%)	65(30%)	10(5%)	22(10%)	22(10%)
5	Support teaching by facilitating access to course content	119(55%)	88(40%)	0	10 (5%)	0
6	Offer more opportunities to develop critical (higher-order) thinking skills	132(60%)	66(30%)	0	10 (5%)	10 (5%)
7	Improve teaching and learning quality	98(45%)	65(30%)	10(5%)	22(10%)	22(10%)

On whether the use of ICTs assist students in accessing digital information efficiently and effectively 88 (40%) and 119 (55%) most of the teachers agreed as 11(5%) of the teachers disagreed. ICTs were noted to support student-centered and self-directed learning as noted by 88 (40%) and 65 (30%) most of the teachers who agreed, 10(5%) were undecided as 33(15%) and 10(5%) of the teachers disagreed. Most 98(45%) and 88 (40%) of the teachers noted that the use of ICTs produces a creative learning environment, 6(3%) were undecided as 26(12%) disagreed. On whether the use of ICTs promotes collaborative learning in a distance-learning environment, 98(45%) and 65 (30%) most of the teachers agreed 10(5%) were undecided as 44 (20%) of the teachers disagreed. ICTs support teaching by

facilitating access to course content as noted by 119(55%) and 88(40%) most of the teachers who agreed as compared to only 10 (5%) of the teachers who disagreed. Most 132(60%) and 66(30%) of the teachers who participated in the study noted that ICTs offer more opportunities to develop critical (higher-order) thinking skills in students as compared to only 44 (20%) of the teachers who disagreed. The use of ICTs improves teaching and learning quality in mathematics as noted by most 98(45%) and 65 (30%) most of the teachers who agreed, 10(5%) were undecided as 44 (20%) of the teachers disagreed.

To find out the influence of teacher's attitude on the use of ICTs in mathematics instruction, the teachers data was scored and subjected to the chi-square test to ascertain the relationship between the variables attitude and use of the ICT resources. The findings are as indicated in table 4.6

Table 4. 6: Chi-Square Test on Attitude and Use of ICT resources

			Attitude scores
Chi-Square			277.303
df			43
Asymp. Sig.			.000
Monte Carlo Sig.	Sig.		.000
	95% Confidence Interval	Lower Bound	.000
		Upper Bound	.000

The results indicate that the larger Chi- Square ($\chi 2$) value 277.303 at the degree of freedom of 43 is significant at 0.05 level of significance. The analysis reveals that the difference in teacher responses for most of the responses were statistically significant for the test items. This implies that, generally the teachers rated their feelings on the relationships between the variables in a similar way. This suggests that all the mathematics teachers in different categories generally rated the associations between the variables in a similar way.

The successful integration of ICT into the classroom depends on the ability of teachers to structure their learning environments in some non-traditional ways,

merging technology with new pedagogies, to develop active classrooms that encourage cooperative interaction, collaborative learning, and group work (UNESCO, 2008).

The use of ICT is significantly associated with the belief that knowledge on ICT devises improves working and teaching of Mathematics. Majority of the respondents who were not using ICT disagree that knowledge on ICT devises improves working and teaching of Mathematics. This is a subjective response that is based on misconceived perceptions indicating that they had a negative attitude towards the integration of ICT in mathematics instructions.

According to Selewyn (1999), integration of ICT in education environment depends, to a great extent, on teachers and student attitude towards their use. Slouti and Barton (2007) findings support this view, which indicated that ICT could motivate students in their learning by bringing variety into the lessons and at the same time sustaining teachers own interest in teaching. Myers and Halpin (2002) asserted that attitude of both students and teachers towards ICT use was a major predictor of future classroom use. It should therefore be known that teachers and students' attitude might influence adoption of ICT in teaching and learning.

4.4.3 Infrastructural and Technical Support for Use of ICTs in Mathematics

The objective of the study was to find ascertain the kind of infrastructural and technical support needed by teachers for integration of ICTs in mathematics instruction. To establish this, answers were sought from the teachers, heads of departments and the head teachers who participated in the study and the findings are as indicated in the following sections.

4.4.3.1 Infrastructural Support for Use of ICTs in Mathematics Instruction

The objective of the study was to ascertain the teacher's perceptions of the type of infrastructure and technical support available for ICT integration in mathematics instruction in schools that participated in the study. The teachers were asked to respond on the type of infrastructure support available for ICT integration in instruction by rating of availability of the items in their schools. The findings are as indicated in table 4.7.

Table 4. 7: Available ICT Infrastructure

		Highly Adequate	Adequate	Inadequate	Highly Inadequate	Not Available
1	Electricity	(3%)	(30%)	(37%)	0	(30%)
2	Internet	0	(21%)	(36%)	0	(43%)
3	Computers	0	(3%)	(15%)	(6%)	(76%)
4	Electronic materials	0	0	(12%)	(12%)	(76%)
5	Television sets	0	(3%)	(18%)	(6%)	(73%)
6	Projectors	0	0	(9%)	(9%)	(82%)
7	CD/DVD player	0	(23%)	(17%)	(20%)	(40%)
8	Word Processors	(9%)	(21%),	(30%)	(30%)	(10%)
9	Spreadsheets	0	(9%),	18%	(33%)	(40%)
10	Data bases	0	0	(9%)	(9%)	(82%)
11	Presentation applications i.e. Power point	0	0	(6%)	(12%)	(82%)
12	Computer/ICT laboratories/rooms	0	0	(15%)	0	(85%)
13	Technical experts	0	(6%)	0	(9%)	(85%)
14	Content software	0	(3%)	(6%)	(6%)	(85%)

The teachers were asked to respond on the availability of ICT infrastructure including electricity, internet, computers, E-materials, television, projectors, CD/DVD player, word processor, spreadsheets, data base applications, presentation applications (power point), computer/ICT laboratories/rooms, technical experts and content software. The availability of the ICT infrastructure was rated highly adequate, adequate, inadequate, highly inadequate and not available.

The results show that on availability of electricity in the schools, highly adequate was noted by (3%), adequate by (30%), inadequate by (37%), highly inadequate by none as (30%) of the teachers indicated that electricity is not available. On the availability of internet, adequate was noted by (21%), inadequate by (36%) as a majority (43%) of the teachers indicated that the internet is not available. The use of

availability of computers was not rated highly adequate but adequate by (3%), inadequate by (15%), highly inadequate by (6%) as a majority (76%) of the teachers indicated that the computers are not available. The use availability of E-materials was not rated highly adequate or adequate but inadequate by (12%), highly inadequate by (12%) as (76%), most of the teachers indicated that they are not available. The availability of television was not rated highly adequate but adequate by (3%), inadequate by (18%), highly inadequate by (6%) as a majority (73%) of the teachers indicated that the television is not available. The availability of projectors was not rated highly adequate or adequate but inadequate by (9%) and highly inadequate by (9%) as a majority (82%) of the teachers indicated that the projectors are not available.

The availability of CD/DVD player was not rated highly adequate but adequate by (23%) inadequate by (17%), highly inadequate by (20%) and not available by (40%) most of the teachers who participated in the study. The availability Word Processors was rated highly adequate (9%) and adequate by (21%), not available by (10%), inadequate and highly inadequate by (30%) respectively most of the teachers who participated in the study. The availability Spreadsheets was not rated highly adequate but adequate (9%), inadequate by 18% and highly inadequate by (33%) and not available by 40%, most of the teachers who participated in the study. The availability of Data base was not rated highly adequate and adequate but inadequate by (9%), highly inadequate by (9%) as a majority (82%) of the teachers indicated that the computers are not available. The availability of presentation applications was not rated highly adequate and adequate but inadequate by (6%), highly inadequate by (12%) as a majority (82%) of the teachers indicated that the presentations applications are not available.

The availability of computer/ICT laboratories was rated inadequate by only (15%) of the teachers who participated in the study as a majority (85%) of the teachers indicated that such laboratories or rooms are not available. The availability of technical experts was not rated highly adequate and adequate but inadequate by (6%), highly inadequate by (9%) as a majority (85%) of the teachers indicated that the technical experts are not available. Availability of content software was not rated highly adequate but adequate by (3%), inadequate by (6%), highly inadequate by

(6%) as a majority (85%) of the teachers indicated that the content software materials are not available. The results show that in most schools most of the teachers indicated that ICT infrastructure and materials are not available and in the schools with these ICT infrastructure materials, they were inadequate or highly in adequate.

4.4.3.2 Technical Support for Integration of ICTs in Mathematics Instruction

The mathematics teachers were asked to comment on the accessibility to technical support for integration of ICT in instruction, the results are as indicated in table 4.8.

Table 4. 8: Teacher Accessibility to ICT Resources

	Statement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1	Computers are only available to those teachers who teach computer studies	(3%)	(31%)	(9%)	(39%)	(18%)
2	There are no adequate software/programmes	(15%)	(46%)	(6%)	(24%)	(9%)
3	Computer desktops are too few for lessons	(27%)	(46%)	(3%)	(18%)	(6%)
4	Computers are not free whenever I want to use them in a lesson	(12%)	(52%)	(6%)	(21%)	(9%)
5	Software are too difficult or complex to use	(15%)	(55%)	(9%)	(9%)	(12%)
6	Software are not adaptable enough for class instruction	(21%)	(46%)	(6%)	(21%)	(6%)
7	Repair and maintenance services of ICT hardware and software	0	(6%)	(36%)	(6%)	(52%)
8	Problems in time tabling lessons for using computers	(46%)	(36%)	0	(6%)	(12%)
9	There is an ICT technician for support	0	0	0	(20%)	(80%)
10	School sponsors in-service training for teachers	0	(12%)	(36%)	(6%)	(44%)

On whether computers are only available to teachers who teach computer studies, results show that (3%) and (31%) of the teachers agreed, (9%) were undecided as (39%) and (18%) most of the teachers disagreed. There are no adequate software/programs for primary school classes as shown by (15%) and (46%) of the teachers who agreed, (6%) were undecided as (24%) and (9%) of the teachers disagreed. This agrees with the study done by Kipsoi (2012) on the Challenges

facing Adoption of ICT in education management in Kenyan schools. The study established that most schools lack software for classroom instruction. Computer desktops are too few for lessons as acknowledged by (27%) and (46%) most of the teachers who agreed, (3%) were undecided as (18%) and (6%) of the teachers disagreed. On whether computers are not free whenever they want to use them in a lesson, (12%) and (52%) most of the teachers agreed, (6%) were undecided as (21%) and (9%) of the teachers disagreed.

Software are too difficult or complex for use as acknowledged by (15%) and (55%) most of the teachers who agreed, (9%) were undecided as (9%) and (12%) of the teachers disagreed. Software not adaptable enough for class instruction as noted by (21%) and (46%) most of the teachers who agreed, (6%) were undecided as (21%) and (6%) of the teachers disagreed.

Asked on whether their schools have an ICT technician for support results show that 208 (100%) all the teachers disagreed. Similarly, on whether there is technical help for computer problems (12%) and (88%) all the teachers noted in disagreement showing that in there is no form of technical help to the teachers in as far as computer problems is concerned. On whether there is repair and maintenance services of ICT hardware and software in their schools, only (6%) of the teachers agreed, (36%) were undecided as (6%) and (52%) most of the teachers disagreed. On whether the school sponsors teachers to attend in-service training only (12%) of the teachers agreed, (36%) were undecided as (6%) and (44%) most of the teachers disagreed.

From the findings of this study, minimal achievement has been realized in use of ICTs in mathematics instruction. Teachers, being the key implementers of the mathematics curriculum ought to be equipped with ICT requisite knowledge and skills for the integration of technology in classroom practices.

The teachers were asked to comment on the availability of technical support for ICTs use. The results are as indicated in table 4.9.

Table 4. 9: Teachers Data on Technical Support for Integration of ICT

Teachers Data		Frequency	Percent
Who oversees ICTs section in your school?	Head teacher	51	24%
	Computer teacher	14	6%
	Subject teacher	33	15%
	Don't know	120	55%
How available is the person in charge of ICTs section in your school?	Readily Available	33	15%
	Available	34	15%
	Not Available	151	70%

There was need to ascertain the management of ICT section in the schools. Asked about who oversees ICTs section in school, 51 (24%) of the teachers indicated the head teacher, 14 (6%) indicated the computer teacher, 33 (15%) indicated the subject teacher as 120 (55%) most of the teachers indicated that they don't know. On how available the person in charge of ICTs section is in school, 33 (15%) indicated readily available, 34 (15%) indicated available as a majority 151 (70%) of the teachers indicated that they are not available. The results show that in most of the schools that participated in the study, the mathematics teachers noted that on who oversees the ICTs section and availability of the person, majority did not know. The results are indicative of the non-existence of these key personnel for monitoring the utilization of these tools in instruction in the schools.

To ascertain the teachers, need for use ICT materials, the teachers were asked to rate their awareness and levels of use of the various computer instructional software and the results are as indicated table 4.10.

Table 4. 10: Technical and Infrastructural Support for Integration of ICT

Rating of	Adequate		Inadequate		Highly Inadequate		Not Available	
	F	%	F	%	F	%	F	%
Personal ICT skills	4	2%	52	23%	130	60%	43	15%
Technical support	0	0	0	0	0	0	0	0%
Quality of training in ICT integration	18	8%	20	9%	140	64%	40	18%
Preparation of ICT content material	8	4%	60	27%	50	23%	100	46%
Maintenance of ICT equipment	0	0	8	4%	140	64%	70	32%

There was need to ascertain the teacher's rating of the level of technical and infrastructural support for the integration of ICTs in mathematics instruction. Answers were sought on rating of levels of personal ICT skills, technical support, quality of training in ICT integration, preparation of ICT content material and maintenance of ICT equipment. The results show that the level of teacher's personal skills was rated adequate by 4 (2%) and inadequate and highly inadequate by 52 (23%) and 130 (60%) respectively most of the teachers who participated in the study. The level of technical support was rated adequate by 4 (2%), inadequate by 50 (23%) and highly inadequate and not available by 84 (38%) and 80 (37%) most of the teachers. The quality of training in ICT integration was rated adequate by 18 (8%), inadequate by 20 (9%) and highly inadequate and not available by 140 (64%) and 40 (18%) respectively, most of the teachers who participated in the study. The preparation of ICT content material was rated adequate by 8 (4%), inadequate and highly inadequate by 60 (27%) and 50 (23%) respectively, and not available by 100 (46%) most of the mathematics teachers. The maintenance of ICT equipment was rated not available by 70 (32%) inadequate by 8 (4%), highly inadequate by 140 (64%) most of the teachers. The results show that levels of personal ICT skills, technical support, quality of training in ICT integration, preparation of ICT content material and maintenance of ICT equipment Were rated highly inadequate and not available by most of the mathematics teachers who participated in the study.

There was need to confirm the availability of the basic ICT infrastructure in the schools that participated in the study. This data was collected using the observation schedule and the results are as indicated in table 4.11.

Table 4. 11: Results from observation checklist

Items for observation	**Adequate**		**Inadequate**		**Not available**	
	F	**%**	**F**	**%**	**F**	**%**
Availability of computer laboratories/ computers	6	18	12	36	15	46
Availability of Mathematics software	3	9	7	21	23	70
Availability of projectors	13	39	11	33	9	28
Availability of printers	19	58	10	30	4	12
Teachers' involvement in integration of computer technology in Mathematics instruction	Sufficient		Insufficient		Not at all	
	F	%	F	%	F	%
	3	9	8	24	22	67
Mathematics teachers' access to computer laboratory/ Mathematics computer rooms	Always		Sometimes		Rarely	
	F	%	F	%	F	%
	5	15	9	27	19	58

As observed during the study, the results show that the availability of computer laboratories with computers in the schools that participated in the study was rated adequate by 6 (18%) inadequate by 12 (36%) and not available by 15 (46%). On availability of mathematics software in the schools, adequate was noted by 3 (9%) inadequate by 7 (21%) and not available by 23 (70%). The availability of projectors in the schools was rated adequate by 13 (39%) inadequate by 11 (33%) and not available by 9 (28%). The availability of printers was rated adequate by 19 (58%) in most of the schools, inadequate by 10 (30%) and not available by 4 (12%). On the teacher involvement and integration of ICT in mathematics instruction, sufficient was noted by only 3 (9%) insufficient by 8 (24%) and not available by 22 (67%) in most of the schools. In most schools, mathematics teachers lacked access to computer labs and other ICT technology as sometimes and not at all was indicated by 9 (27%) and 19 (58%) respectively as always was noted by 5 (15%) only. The results show that in most of the schools that participated in the study, the ICT facilities and technical support was inadequate and lacking in most of the schools and this shows that the infrastructure and technical support for the use of these technologies was lacking in the schools that participated in the study. It is worth noting that this situation affected the use of the ICT tools in instruction by the teachers as the aspects influenced teacher preparedness, ability to enhance ICT skills and even contribute towards development of negative attitude towards integration of ICT in mathematics instructions.

In relation to the infrastructure and technical support needed for ICT uptake in mathematics instruction, the results support those of Mwelese, Wanjala, Simiyu and Amadalo (2016) who observed that ICT integration in instruction requires up-to-date software and hardware. From the study findings, it was established that most schools do lack appropriate software programmes. There is also lack of essential computer skills/knowledge of using computer for instruction. The results show that in most of the schools, the teachers acknowledge that they are not encouraged and supported to attend in-service ICT training. Further computers in their schools are not frequently serviced to ensure they are in good condition. There are no technical personnel to assist whenever a problem arises with computers. In addition, there is no alternative source of power in the school to avoid power inconveniences. There are no

classrooms/laboratories equipped with computers. Most schools have insufficient expertise/guidelines for helping teachers to use ICTs. In most schools, good software programs and skills/knowledge of using computer for instruction are lacking.

These findings are in agreement with what Afshari (2009) found out in his study on the factors affecting teachers' use of ICTs in Malaysia that there is need for the government to give priority to provide teachers with access to ICTs through proper teacher training, quality digital content and other necessary infrastructural ICTs materials for curriculum implementation.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter summarizes the major findings of the study, conclusions and recommendations for policy implication and suggests areas for further research based on each objectives of the study.

The chapter is organized based on the research objectives.

a) To determine the type of knowledge and skills needed by teachers to enable them to use the ICTs in mathematics instruction.
b) To investigate the influence of Teachers' attitude on the use of ICTs in mathematics instruction.
c) To ascertain the kind of infrastructural and technical support needed by teachers for integration of ICTs in mathematics instruction.

5.2 Summary of the Study

The study sought to find out the level of teacher preparedness towards the use of ICT tools in mathematics instruction in secondary schools. To ascertain this, there was need to seek opinions of the teachers on the types of knowledge and skills required for ICT integration in instruction, the teacher's attitude towards use of the ICTs in mathematics instruction and the kind of infrastructural and technical support needed by teachers for integration of ICTs in mathematics instruction. The study was guided by Roger's theory of Diffusion of Innovations that explains how, why, and at what rate new ideas and technology spread through cultures. This is based on the premise that the diffusion of information technology and telecommunications hardware, software, and services turns out to be a powerful driver of growth, having an impact on worker productivity. The study adopted descriptive survey research design to get the desired information from the targeted teachers. Proportionate stratified random and simple random sampling techniques were used to select a sample of 218 respondents drawn independently and randomly from the stratum of schools in the three Sub-Counties in Bungoma County, Kenya. The instruments included questionnaires, interview and observation schedules which were developed and validated, and their reliability determined before they were used to collect the data.

The data was analyzed using both descriptive and inferential statistics including frequencies and percentages presented in tables and chi-square test to determine the relationship between the variables attitude and integration of ICTs tools in classroom instruction. Given below is the summary of the main study findings: -

5.2.1 Knowledge and Skills for Use of ICT in Instruction

The results show that for the teachers who indicated to have undergone ICT training, they acknowledged that the knowledge and skills acquired assisted them in the integration of ICTs in instruction. Most of the teachers indicated to be aware of the need for ICT knowledge and skills though have not had ICT training and for those who have trained indicated to only have basic computer application skills at the certificate level that could not help them to competently use these technologies in instruction. In most of the schools, it was only the use of internet that was noted high by the teachers and this could be attributed to the personal use of internet for communication and search of new material and information and not instruction. The results show that in most of the schools, it was only the use of internet and ICT content material preparation applications that were noted high but with very few teachers and this could be attributed to the personal use of internet for communication and search of new material and information and not instruction.

The results show that the use of ICTs in preparation of schemes of work, instructional materials, student's progress records, instruction in class and in preparation of student's records was noted to a large extent by some of the teachers but in all the applications most of the teachers in the schools that participated in the study indicated none. The results show that the use of ICTs in Library management, Collaboration with peers and Class attendance management was not noted to a large extent by the teachers but in time table preparation and students' progress use was noted to some extend by some teachers but in the other applications rarely and none were noted by most of the teachers in the schools that participated in the study. The results generally show limited use of ICT materials in the mathematics instructional practices in the secondary schools.

5.2.2 Teacher Attitudes and Use of ICTs in Mathematics Instruction

The results show that in most of the schools that participated in the study, the teachers were in agreement that the use of ICTs is worthwhile, can enhance learners development skills, ICTs motivate students to want to learn, ICTs can be used to teach a new topic even in absence of a teacher, they would like to work with computers and that working with ICTs would be enjoyable and stimulating for teachers. However as indicated, most of the teachers think that what the ICTs can do teachers can do as well and therefore are not necessary, integrating ICTs in instruction is a very expensive venture, will just be a waste of time that can be used in syllabus coverage, ICTs encourage laziness among teachers and rote learning among pupils. The teachers acknowledge that ICTs assist students in accessing digital information efficiently and effectively, promote collaborative learning, ICTs support teaching by facilitating access to course content, and that ICTs improve teaching and learning quality. However, most of the head teachers had negative perceptions on the role of ICTs on supporting student-centered and self-directed learning, producing a creative learning environment and offering more opportunities to develop critical thinking skills.

The results show that in teachers in most schools noted that computers are not available and in the schools with these ICT materials, the use was inadequate in most cases. The teachers agree that ICTs encourage individualized instruction and that working with ICTs will be important and efficient. However, most of the teachers could not acknowledge that ICTs enhance development of problem-solving skills, knowing how to work with ICTs will improve my work/teaching, ICTs make teaching easy and efficient, learning how to use the ICTs materials is worthwhile and that anything ICTs can be used for, they can do just as well some other way.

5.2.3 Infrastructure and Technical Support for ICTs Use in Instruction

The study sought to ascertain the type of infrastructure and technical support needed for the integration of ICTS in mathematics instruction. The availability of the ICT infrastructure was rated highly inadequate and not available in most cases. The teachers acknowledge that there is inadequate ICT infrastructure including electricity, internet, computers, E-materials, television, projectors, data base

applications, presentation applications, computer/ICT laboratories/rooms, technical experts and content software. The results show that in most of the schools, the teachers acknowledge that they are not encouraged and supported to attend in-service ICT training, computers in their schools are not frequently serviced to ensure they are in good condition, there are no technical personnel to assist whenever a problem arises with computers, there is no alternative source of power in the school to avoid power inconveniences, there are no classrooms/laboratories equipped with computers, insufficient expertise/guidelines for helping teachers to use ICTs, good software programs and skills/knowledge of using computer for mathematics instruction are lacking. There is thus need to ensure adequacy of ICT infrastructure and technical support in schools if the benefits of ICTs are to be realized in mathematics instruction.

The results also indicated that there is inadequate financial support and that there are also insufficient training opportunities for teachers. From the opinions of the teachers, though computers fit in the school policy, computers being accessible to teachers, problems in timetabling lessons for using computers and lack of administrative support or initiatives from school were noted to some extent. The teachers noted that computers are only available to teachers who teach computer studies and that there are no adequate software/programs for mathematics instruction. Computer desktops are too few for lessons and that in most cases computers are not free whenever they want to use them in a lesson. It was also noted by teachers that in some cases the available computer software is too difficult or complex for use and not adaptable enough for class instruction. It was also noted that most schools do not have an ICT technician for support and that there is no technical help for computer problems and repair and maintenance services of ICT hardware and software in their schools. In most cases, the teachers are not sponsored to attend in-service training. These were noted as challenges facing the integration of ICTs in instruction practices and thus indicated as key areas to be addressed for successful integration of the ICT tools in mathematics instruction.

The areas pointed out for integration of ICTs in instruction include the following:

- Adequate infrastructure and technical support which includes among others electricity, computer laboratories/rooms and computer hard ware and software that are essential for use of ICTs in mathematics instruction.
- Support from schools and governments on the integration of ICTs technologies. Such governments institute policies that discourage investments in ICTs. Governments do not create incentives for school innovations.
- Provisions for considerable investments in ICTs which are integral in innovation.
- Provision of Financial support and other essential resources for ICTs use in instruction.
- Provision of knowledge and skills on how technologies can be infused into mathematics instruction effectively.

These were noted as key requirements for integration of ICTs in instruction and as observed in the study, the findings agree with results of other studies and the teachers who participated in the study suggested the need for the following:

- Educate governments to promote the use of technologies, build necessary infrastructures both physical and academic, train teachers in use of ICTs in instruction.
- Promote innovation through providing incentives and investing in ICT education and training of teachers at pre-service level and during seminars and workshops and through professional learning communities.
- Create transferable technology platforms that can have far reaching implications on the education quality.
- Include teachers in ICT integration in curriculum initiatives.
- Promote collaboration through knowledge transfer which enhances sharing of knowledge and experiences among teachers and other stakeholders in education.

5.3 Conclusions

This study attempted to explore the teacher preparedness towards the use of ICT tools in mathematics instruction in secondary schools. The potential of Information Communication Technology can only be realized if educators at all levels understand the issues facing them, define the role of information communication technologies in education, and plan for its appropriate use by classroom teachers. Teachers realize the tremendous potential ICTs can bring to teaching and learning. Teachers will continue to want to use ICTs in their classrooms despite the many factors affecting implementation. The challenges facing teachers in their initiative to use ICTs are vast and complicated and affect them on a personal and professional level. Teachers are expected to develop their technological skills and knowledge and use ICTs in their classrooms.

From the findings of the study, it can be concluded that the teacher, not the technology, is of central importance to the implementation of ICTs in mathematics instruction. Staff development must have a curricular focus and help teachers integrate (ICTs) technology into the mathematics curriculum. This implies changes to current professional development strategies. In-servicing that focuses on specific computer applications outside of the curriculum does little more than teach computer skills. If authentic integration of ICTs is to occur, professional development strategies must focus on giving teachers an understanding how educational objective can be supported by technology and ICTs will impact on their pedagogy. ICTs offer exciting possibilities to advance and change teaching. It is essential that mathematics educators define the computer's role and application if the true potential of this technology is to be realized. This study has been directed towards emphasizing the importance of professional development to any program concerned with the integration of the information communication technology more generally, into teaching and learning. The findings, the discussions and the implications of this study were important to the study and implementation of ICTs technology in an educational context. Thus, it is hoped that this study has stimulated thinking about the importance and methodology of professional development in any meaningful integration of the information communication technology more generally into mathematics teaching and learning.

5.4 Recommendations

There is need to increase awareness of the bottlenecks to the use of ICTS in curriculum practices and an effort by all stakeholders put in place to address the challenges immediately.

There is need for providing teachers with professional learning opportunities to enhance their capacity to fully utilize the opportunities presented using ICTs and to embed the use of ICTs in teaching and learning, including the ways in which ICTs can support instruction and assessment practices in schools. Teacher training courses should equip new teachers with required ICT knowledge and skills.

The government through the ministry of education should formulate policies that ensure mathematics and science teachers who complete their studies undertake and complete in-service training such as SMASSE In-service training to enhance their usability and integration of ICT in teaching and learning.

Adequate time must be allowed for teachers to develop new skills, explore their integration into their existing teaching practices and curriculum, and undertake necessary additional lesson planning, if ICTs are to be used effectively in instruction. The researcher recommends that teachers should make every effort to produce or obtain appropriate and well-articulated computer programmed instructional materials and use them in their lessons.

Support of school administrators and, in some cases, the surrounding community, for teacher use of ICTs is seen as critical if ICTs are to be used at all, let alone effectively in instructional practices. The researcher recommends that, whenever the matter at hand requires positive attitude towards the use of ICTs and a high level of motivation for effective learning, then the teacher should embrace the use of ICTs in their lessons.

Providing policies and protocols that facilitate the uptake and use of ICTs in curriculum practices schools. There is need for the Government to give priority to providing teachers with access to ICTs resources through professional development, quality digital content in mathematics and computer infrastructure. The researcher recommends that the ministry of education should embark on a serious campaign through its various arms, to enable teachers understand and appreciate that the

teaching of mathematics would be greatly enhanced in the event they use ICTs. Any teacher with the desire to improve student's achievement in mathematics should be sensitized on the use of ICTs in instruction.

The ministry of education should consider reviewing the teacher training curriculum in such a way that teacher trainees undertake a comprehensive and hand-on training where they gain knowledge and experience on the use of ICT in education.

Education stakeholders should work together to equip learning institutions with ICT devises and motivate teachers and learners to use them without restrictions to enhance quality education. Furthermore, ICT devises that breakdown should be replaced and/or be repaired to ensure easy accessibility and availability for learners and teachers.

There is the need for teachers and learners to undertake workshops and training on ICT usability to help them cultivate a positive attitude towards the usability of ICT technology in education. Rewarding and awarding those that perform by integrating ICT in teaching and learning should be a practice that school managers should encourage among learners and teachers.

5.5 Suggestions for Further Research

There are certain aspects of curriculum practices that this research felt needed some further investigation.

The following are some areas that could be considered for further research.

1. Paradigm shifts in use of ICTS in instructional practices in mathematics in secondary schools.
2. Study on other factors that influence teacher preparedness apart from type of skills, knowledge, and attitude of teachers towards the usability of ICT in mathematics instructions.
3. A study on the influence of availability, accessibility, policy, and rules on teacher use of ICT in mathematics instructions.
4. A study on preparation of mathematics teachers in ICT Technological, Pedagogical Content Knowledge and Skills in teacher training institutions.

REFERENCES

Adams, D. A., Nelson, R. R. & Todd, P. A. (1992). Perceived Usefulness, Ease of Use, and Usage of Information Technology: A Replication. *MIS Quarterly, 16(2), 227-247.*

Afshari,M.(2009). Factors Affecting Teachers' Use of ICT. *International JournalInstruction ,2,Universiti Putra : Malaysia.*

Ajzen, I. (1988) *Attitude, Personality, and Behaviour*. Dorsey Press, Chicago, IL.

Al-Ansari, H. (2006). Internet use by the faculty members of Kuwait University. *The Electronic Library* Vol.24, No. (6), Pp; 791-803.

Anderson, R. E., & Dexter, S.L. (2009). School Technology Leadership: Incidence and Impact (Teaching, Learning, and Computing: 1998 National Survey Report p. 6). Irvine, CA: *Center for Research on Information Technology and Organizations,* University of California, Irvine.

Anderson, V. (2009). *Research Methods in Human Resource Management.* (2nd Edition). London: Chartered Institute of Personnel and Development.

Andoh:A.C (2017):Factors Influencing teachers' adoption and integration of ICT :A Review of Literature.*International Journal of Education and Development using ICT (IJEDICT) ,8, 136 -155.*

Bennet, (1996). *Computers as tutors; solving the crisis in education*. Retrived on 7th September 2017, from: http://www.concentric.net/~Faben1/

Borg, W. & Gall, J. (2007). *Educational Research: An Introduction*. Retrieved January, 13 2012, from http://www.amazon.com/EducationalResearch-Introduction-M- all/dp/0205488498

Brand, G. A. (1998). What research says*:* Training teachers for using technology. *Journal of Staff Development*, 19(1). 10-13

British Education Commission & Technology Agencies (Becta) (2004). A Review of Research Literature on Barriers to the Uptake of ICT by Teachers. Retrieved September 3, 2010, from http://www.becta.org.uk

Brown, M. & Murray, F (2006): *ICT And Young Children: Laying the Foundations for the Digital Future.* Computers in New Zealand Schools.

Bulent, C., Pinas, C., Baham, K., & Tari k, K. (2009). Science Teachers' Attitude toward ICT in Education. *Turkish Online Journal of Educational Technology*.

Cohen (2014). *Research Methods in Education*. (3rd ed.) London: Croom.

Collis, B. (2002). *Information technologies for education and training*. In Adelsberger, H., Collis, B, and Pawlowski

Davis F.D. (1986) *A technology acceptance model for empirically testing new end-user information systems*: theory and results, Doctoral Dissertation, MIT Sloan School of Management, Cambridge, MA.

Davies F.D. (1989) Perceived usefulness, perceived ease of use and user acceptance. *MIS Quarterly 13, 319–341.*

Davis, F. D.; Bagozzi, R. P. &Warshaw, P. R. (1989), "User Acceptance of Computer Technology: A comparison of two theoretical models", *Management Science* 35: 982–1003.

Dexter, S.L., Anderson, R.E. & Baker, H.J. (1999). Teachers views of computers as catalysts for changes in their teaching practice. *Journal of Research on Computing in Education, 31*(3). 211-229.

Droup, P. (2004). Experience and Attitude towards Information Technology among First Year Med Students in Denmark: Longitudinal Questionnaire Survey. *Journal of Medical Internet.*

Erb, W. (2008): *ICT in the Early Years.* TukuTukuKoreno, New Zealand Land Education Gazette

Farrell G. (2007). *Survey of Information and Communication Technology and Education in Africa*: Kenya County Report

Farrell, G. and Shafika Isaacs. 2007. *Survey of ICT and Education in Africa: A Summary Report, Based on 53 Country Surveys*. Washington, DC: *info*Dev / World Bank. Available at http://www.infodev.org/en/Publication.353.html

Foley, J. & Ojeda, C. (2007). How do teacher beliefs influence technology use in the classroom? *A paper presented at the Society for Information Technology and Teacher Education International Annual Conference*, March 26-30, 2007, San Antonio, Texas, USA

Frankiline, C. (2007). Factors that influence elementary teachers' use of computers. *Journal of Technology and Teacher Education, 15*, 267-293.

Fulton, K., Glenn, A & Valdez, G. (2003) *Three pre-service programs preparing tomorrow's teachers to use technology: a study in the partnerships.* Retrieved on 2nd March 2010, from http: www.ncrel.org/tech/pre-service.

Hardy, M. (2004). The Technology in Mathematics Education (TIME) Project: Preparing Secondary Mathematics Teachers to Teach with Technology. *In Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications* 2004, AACE, (pp. 3222-3327). Chesapeake, VA.

Hu P.J.H., Clark T.H.K. & Ma W.W.K. (2003) *Examining technology acceptance by school teachers*: a longitudinal study. Information and Management 41, 227–241.

Ikeo, A. (2014). *A History of Economic Science in Japan: The Internationalization of Economics in the Twentieth Century*. New York: Routledge Publishers.

Jhurreev, V. (2005)"Technology Integration in Education in Developing Countries: Guidelines to Policy Makers". *International Education Journal* [Electronic], 6(4):467-483. Available: *http://ehlt.flinders.edu.au/ education/iej/articles /v6n4/jhurree/paper.pdf.*

Kipsoi, E.J. et. al. (2012). Challenges facing adoption of information communication technology (ICT) in educational management in schools in Kenya.*Journal of Sociological Research*.

KNEC. (2012). Syllabus and Regulations. Kenya National Examination Council, Nairobi.

Koehler, M. J. & Mishra, P., (2009). What is Technological Pedagogical Content Knowledge? *Contemporary Issues in Technology and Teacher Education Journal, 9*(1), 60-70.

Koehler, M. J., Mishra, P., & Yahya, K. (2007). Tracing the development of teacher knowledge in a design seminar: Integrating content, pedagogy and technology. *Computers & Education, 49*(3), 740-762. doi: 10.1016/j.compedu.2005.11.012

Kombo, D.K. & Tromp, D.L. (2006). *Proposal and Thesis Writing: An Introduction.* Nairobi Paulines publications.

Kothari, C.R (2009). Research Methodology: Methods and Techniques. New Delhi. Vishwa.

Kothari C.R (2004). *Research methodology*: methods and techniques. New Delhi. New Age International Press Ltd Publishers.

Koul, L. (1992). *Methodology of Educational Research*, 2nd Edition. New Delhi: Vikas Publishing House Development Ltd.

Kozma, R. B. (2005). National policies that connect ICT-based education reform to Economic and social development. *An Interdisciplinary Journal on Humans in ICT Environments*, 1(2), 117-156.

Legris P., Ingham J. & Collerette P. (2003) *why do people use information technology*? A critical review of the technology acceptance model. Information and Management 40, 191–204.

Li, Q. (2007): Student and Teacher Views about Technology: A Tale of Two Cities? *Journal of Research on Technology in Education*, Eugene: Summer 2007. Vol. 39, Iss. 4: pg. 337-398.

Lin, F. R., Hsueh, C. M., Lin, S. C. & Yeh, M. C. (2001). *The Socio-technical Perspective of Building Teachers' Professional Community*: SCTNet. The 5th Global Chinese Conference on Computers in Education / 10th International.

Macau, (2000). *Mathematics and its Role in Civilisation*. Proceedings of the first

2000 international conference held in the World Mathematical Year. University of Lisbon. Retrieved September 3rd, 201 from http: wmy2000.math.jussieu.fr

Mahmood M.A. & Swanberg D.L. (2001) *Factors affecting information technology usage*: a meta-analysis of the empirical literature. Journal of Organizational Computing 11, 107–130.

Mathieson K. (1991) *Predicting User Intention*: Comparing the Technology Acceptance Model with the theory of planned behavior. Information Systems Research 2, 173–191.

Mbugua S. N. (2014). *The influence of integration of information communication technology in teaching on students' academic performance in secondary schools in Nakuru County, Kenya.* Unpublished Ph.D thesis, Maasai Mara University, Narok, Kenya.

Ministry of Education, Science and Technology (2005) ICT's in Education Option Paper.

Mintz, D. (1997). Technology's promise: Responding to the la times. From Now on the Educational Technology Journal,7(1) [Online]. Available: http://fromnowon.org/sept97/latimes.htmlhttp://fromnowon.org/sept97/latimes.html.

Mishra, P., & Koehler, M. (2007). *Technological pedagogical content knowledge (TPCK):* Confronting the wicked problems of teaching with technology. In C. Crawford et al. (Eds.), Proceedings of Society for Information Technology and Teacher Education International Conference 2007 (pp. 2214-2226). Chesapeake, VA: Association for the Advancement of Computing in Education.

Mishra, P., & Koehler, M.J. (2006). Technological pedagogical content knowledge: A framework for integrating technology in teacher knowledge. *Teachers College Record*, 108 (6), 1017-1054.

Mubichakani, J. M., (2012). *Effect of Computer Based Learning in Mathematics on Learners Motivation and Achievement Level in Relation to Gender in Bungoma North District, Kenya*. Unpublished M.Phil Thesis, Moi University.

Mugenda, M. & Mugenda, G. (2003): *Research Methods.* Nairobi: ACTS Press

Mugenda, M., & Mugenda, G. (1999). *Research Methods*: Quantitative and qualitative approaches. Nairobi. Acts press.

Mureithi, M. and Munyua, W.A. (2006). Making ICT work for the poor in Kenya: *In search of an entry strategy framework working draft Ver 4* *mureithi@summitstrategies.co.ke*

Mukwa, C. W. (1979). *Towards a Systematic Approach to Educational Media Use in the Secondary School Education of the Republic of Kenya*. Technologies for learning. Unpublished Doctoral Dissertation, Michigan State University.

Ndubisi, N.O., Jantan, M. & Richardson, S. (2001), "*Is the technology acceptance model valid for entrepreneurs? Model testing and examining usage determinants*", The Asian Academy of Management Journal, Vol. 6 No. 2, pp. 31-54.

Newhouse, P. (1995). *Precipitation from computer-saturated learning environments*. [On-line]. Available: http://www.woodvale.wa.edu/acec95_papers/volume1/paper33.html

Nelson, O. N, & Muhamad J. *Logistics Information* Management Volume 16. Number 6 · 2003 · 440-450 450.

Olakulehin, F. K. 2007. "Information and communication technologies in teacher training and professional development in Nigeria". *Turkish Online Journal of Distance Education*, vol.8, no. 1, pp. 133-142.

Orodho, A.J. & Kombo, D.K. (2002). *Research Methods*. Nairobi: Kenyatta University, Institute of Open Learning.

Pelgrum,W. J., & Plomp, T. (1991). *The use of computers in education worldwide*: Results from the IEA 'Computers in Education' survey in 19 educational systems. Oxford: Pergamon press.

Polit D.F. & Beck C.T. (2010) *Essentials of Nursing Research*: Appraising Evidence for Nursing Practice, 7th edn. Wolters Kluwer Health / Lippincott Williams & Wilkins, Philadelphia.

Republic of Kenya, (1997), *Bungoma district development plans 1997-2001* Nairobi: Government printers.

Republic of Kenya (2005) *Sessional Paper No. 1 of 2005*, A Policy Framework for Education, Training and Research, Nairobi Government Printing Press.

Republic of Kenya (2006), Kenya Education Sector Support Programme, 2005-2010).

Republic of Kenya (2006), The National ICT Strategy for Education and Training, Nairobi.

Robinson, L. (2009). *A summary of diffusion of innovations*. Fully Revised and Rewritten Jan 2009.

Rogers, E.M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.

Roszell, D. D. (1995). *The use of information technology in schools.* Master's thesis, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

Selinger, M. (1996) Beginning Teachers Using Information Technology: The Open University Model. *Journal of Information Technology in Teacher Education*, 5, 3, 253–270.

Senapaty, H.K. (2004). Integrating Digital Technology into Constructivist Learning Environment. *Paper presented in the International Conference held at Saurastra University, Rajkot, Gujarat, India*

Senapaty, H.K (2005). Teachers Education *in a new Paradigm of ICT Integrated Constructivists Learning.* Regional Institute of Education. NCERT. Shyamla Hills, Bhopal.

Sharma, R. (2003), 'Barriers in Using Technology for Education in Developing Countries', IEEE0-7803-7724-9103. Singapore schools', *Computers & Education* Vol .41, No. (1), Pp; 49--63.

Soloman G. & Solomon S. (1995). *Technology and professional development-10 tips to make it better.* Learning and Leading with Technology, 23(3). 38-39.

Sorkin, S. et al. (2004): Teaching with Instructional Multimedia in Mathematics and Science in Secondary School. In C. Crawford et al (Eds.). *Proceeding of Society for Information Technology and Education International Conference 2004* (pp. 1864 – 1869), Chesapeake, VA: AACE.

Sprague, S. (2007): Research agenda for online teacher professional development. *Journal of Technology and Teacher Education* 14.4 (Winter 2006): p. 675(5).

Stallard, C. (1998). *Factors that influence the integration of technology into the secondary curriculum*. [On-line]. Available: http://ed.info.apple.com/**education**/techlearn/adapt/adaptfactors.html.

Subramanian G.H. (1994). A replication of perceived usefulness and perceived ease of use measurement. *Decision Sciences* 25, 863–874.

Straub D.W. (1989). Validating instruments in MIS research. *MIS Quarterly* 13, 147–169.

Stephenson, J., (2001). *Learner-managed learning- an emerging pedagogy for online learning*. Teaching and Learning Online: Pedagogies for New Technologies. London, Kogan Page.

Swan, B. & Dixon, J. (2006): The Effects of Mentor-Supported Technology Professional Development on Middle School Mathematics Teachers' Attitudes and Practice. *Contemporary Issues in Technology and Teacher Education* [Online serial] 6(1). http://www.citejournal.org/vol 6/

Toumasis, C. (2006): Expanding in-service mathematics teachers' horizons in creative work using technology. *International Journal of Mathematics Education in Science and Technology,* Volume 77, N0.8,15 December 2006, 901- 912.

Turner, G. (1986). *Computers at Starehe Boys' Centre*. Paper presented to 'Computers in Education' a workshop: Nairobi: UNESCO.

UNESCO. (2002). *UNESCO Report: Information and Communication Technologies in Teacher Education, A Planning Guide*, Division of Higher Education, UNESCO.

UNESCO, (2005). *UNESCO Report: How ICT Can Create New, Open Learning Environments Information and Communication Technologies in Schools* A Handbook for Teachers, Division of Higher Education, UNESCO.

UNESCO, (2009): ICT Competency Standards for Teachers: Policy Framework. Retrieved from http://portal,unescp,org/ci/en/ev,php-URL-ID=24540&URL-

Venkatesh, V. & Davis, F. D. (1996). *A Model of the Antecedents of Perceived Ease of Use:* Development and Test. Decision Sciences, 27(3), 451-481. Proceedings of the International Conference on Computers in Education (ICCE'02) 0-7695-1509-6/02 $17.00 © 2002 IEEE.

Venkatesh, V. (1999). Creation of Favorable User Perceptions: Exploring the Role of Intrinsic Motivation. *MIS Quarterly*, 23(2), 239-260.

Venkatesh, V. (2000), Determinants of perceived ease of use: integrating control, intrinsic motivation, and emotion into the technology acceptance model. *Information Systems Research, Vol. 11, pp. 342-65.*

Venkatesh, V. and Davis, F. (2000). A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies, *Management Science February*, vol. 46 no. 2 186-204

Venkatesh, V., Morris, M. G., Davis, G. B., and Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27(3), 425- 478.

Wanjala, M. (2005). *Effectiveness of Computer Based Instructional Methods on Students' Attitudes, Motivation and Achievement in Teaching of Mathematics in Secondary Schools of Bungoma District*. Unpublished Thesis Moi University.

Wanjala, M. (2010). *Factors Affecting the Integration of Computers in Mathematics Instruction in Secondary Schools of Bungoma District*. Unpublished Doctoral Thesis, Moi University.

Wanjala (2016): Information Communication Technology Pedagogical Integration in Mathematics Instruction among Teachers in Secondary Schools in Kenya. *Journal of Education and Practice* Vol.7, No.2, 2016, pp 66-73

Wanjala, M. M. S., Khaemba, E. N., &Mukwa, C. (2011). Significant factors in professional staff development for the implementation of ICT education in secondary schools: A case of schools in Bungoma District. *International Journal of Curriculum and Instruction*, 1(1), 30 – 42.

Watson, G. (1997) Pre-service Teachers' Views on their Information Technology Education. *Journal of Information Technology for Teacher Education,* 6, 3, 255–269.

Wekesa E.W. (2015): *Effects of Computer Based Instruction of Students' Attitude, perception of Classroom Environment and Achievement in Rural Secondary Schools in Kenya*. A PhD. Unpublished Thesis, MMUST.

Wetzel, K. (1996-97). *Teacher technology training curriculum based or personal*. and Leading with Technology, 24(4). 58-59

Wild, M. (1995) Pre-service Teacher Education Programmes for Information Technology: an effective education? *Journal of Information Technology for Teacher Education, 4, 1, 7-20.*

Williams, D., Coles, L., Wilson, K., Richardson, A. & Tuson, J. (2000) *Teachers and ICT*: current use and future needs. *British Journal of Educational Technology*, 31, 4, 307–320.

Yildirim, S. (2007). Current utilization of ICT in Turkish basic education schools: A review of Teacher's ICT use and barriers to integration. *International Journal of Instructional Media, 34,* 171-186.

Yilmaz, N.P. (2011). Evaluation of the technology integration process in the Turkish education System. *Cotemporary Educational Technology, 2,* 37-54.

Yusuf, M.O. (2005). Information and communication education: Analyzing the Nigerian national policy for information technology. *International Education Journal* **Vol.** 6 No. (3), Pp; 316-321.

APPENDICES

APPENDIX I: RESEARCH INTRODUCTORY LETTER

MUKENYA MOSES
P.O BOX 364 KITALE

Dear Informant/Respondent,

RE: REQUEST TO TAKE PART IN DATA COLLECTION

I am a student in Masinde Muliro University of Science and Technology pursuing a Master Degree course in Mathematics Education. As part of my course, I am required to carry out a research on "**TEACHER PREPAREDNESS AND ITS EFFECT ON THE USE OF ICT IN MATHEMATICS INSTRUCTION IN SECONDARY SCHOOLS IN BUNGOMA COUNTY.''** The objectives of my research are:

1. To determine the type of ICT skills required by teachers to enable them use the technologies in mathematics instruction.
2. To assess the types of ICT knowledge mathematics teachers, have and its effect on ICT use in teaching and learning of mathematics.
3. To investigate the influence of teachers' attitude on the use of ICT in mathematics instruction.

I am thus writing to request your kind participation by answering the questions in the attached questionnaire to enable me gather correct and relevant information for this research. It is important to note that all information given with be handled with utmost confidentiality and is meant for academic purpose. It is my wish that the successful completion of this study shall be of great benefit for relevant policy formulation for this sector and add scholarly knowledge on the subject. I shall highly appreciate your valued contributions and support towards this research.

Yours faithfully,

Moses Mukenya

APPENDIX II: QUESTIONNAIRE FOR TEACHERS/HEADS OF DEPARTMENT

Instructions:

Please do not write your name anywhere on this questionnaire. Respond by ticking (√) where appropriate or fill in the required information in the spaces provided.

SECTION A: DEMOGRAPHIC INFORMATION

1. Indicate your gender

   Male ( ) Female ( )

2. Indicate your age bracket

   Below 25 years [ ]
   25-35 years [ ]
   36-45 years [ ]
   Above 45 years [ ]

3. What is your current level of education

   College [ ]
   S1 [ ]
   Graduate teacher [ ]
   Postgraduate teacher [ ]

4. What is your occupation/position in the learning institution?

   Teacher [ ] Head of Department [ ] Deputy Headteacher [ ]
   Headteacher [ ]

SECTION B: STUDY VARIABLES

ICT skills needed by teachers in mathematics instruction

5. To which extent to you agree or disagree with the following statements as they apply to ICT skills needed by teachers in mathematics instruction.

	Strongly Agree	Agree	Undecided	Strongly Disagree	Disagree
Mathematics teachers should be able to use the internet in enhancing research and knowledge to be shared to learners					
The teacher should be able to incorporate mathematics lessons with the usability of ICT devises					
The teacher should be able to teach and train learners on how to use ICT devises					

6. In your own understanding, do you think you can teach basic computing and academic related program usability to learners? Yes [ ] No [ ]

7. In your own understanding, do you think you can repair and maintain computing devises and other related technology used in enhancing teaching and learning mathematics as a subject? Yes [ ] No [ ]

Types of ICT knowledge mathematics teachers have

8. Do you possesses basic computer knowledge (Microsoft office-suite…packages) that can help you integrate teaching and ICT? Yes [ ] No [ ]
9. Respond by ticking to show the extent to which you understand the usability of the following ICT devises

	Excellent	Good	Fair	Do not know
Computer				
Mobile phone				
Scientific calculator				
Projector				
Television sets				

10. Did you have any computer related training during the time you were in college?

    Yes [ ] No [ ]

11. If your answer in (12) is YES, how do you rate the computer training you underwent during your professional training?

    Highly adequate [ ] Adequate [ ] Inadequate [ ] Highly inadequate [ ]

12. Have you ever attended Strengthening Mathematics And Science in Secondary Education, SMASSE in-service cycle training?

    Yes [ ] No [ ]

13. If yes in the above questions, which was the last cycle you trained?

    Cycle 1[ ] Cycle 2[ ] Cycle 3[ ] Cycle 4[ ]

14. What do you recommend pre-service teacher training for teachers to prepare teachers adequately for ICT instructional teaching?

    ……

    ……

    ……

    ……

15. To which extend do you think teachers ICT application knowledge can better subject performance and results?

    Very Great extent [ ] Great extent [ ] Moderate extent [ ] No extent at al [ ]

16. Kindly rate your knowledge and skill to integrate ICT in teaching

		Highly Adequate	**Adequate**	**Inadequate**	**Highly Inadequate**	**Not Available**
1	Personal ICT skills					
2	Technical support					
3	Quality of training in ICT integration					
4	Preparation of ICT content material					
5	Repair and maintenance of ICT equipment					
6	Start and shut a computer					
7	Use internet					
8	Use word processor					
9	Use spread sheets					
10	Use database applications					
11	Use presentations applications					
12	Teach basic computing algorithms					
13	Use mathematics software					
14	Prepare ICT content materials					
15	Use ICT devises					

17. Teachers Data on Knowledge and Skills for Use of ICT in Instruction

	Highly Adequate	Adequate	Inadequate	Highly Inadequate	Not Available
Start and shut a computer					
Use internet					
Use of word processor					
Use of spreadsheets					
Use of data base application					
Use of presentations applications					
Preparation of ICT ICT content material					

18. Kindly rate your level of Knowledge and Skills for Integration of ICT

	Highly Adequate	**Adequate**	**Inadequate**	**Highly Inadequate**	**Not Available**
How do you rate levels of personal ICT skills					
How do you rate levels of technical support					
How do you rate quality of training in ICT integration					
How do you rate preparation of ICT content material					
How do you rate maintenance of ICT equipment					

Influence of Teachers' attitude on the use of ICT in mathematics instruction.

19. Do you use the ICT devises to administrate or manage aspects of your teaching?

    Yes ☐ No ☐

20. If no, explain why you do not use ICT devises to administer or manage aspects of your teaching

……

……

……

……

21. Do you own a computer? Has this been a factor in your integrating computers in your instructional process? Give your answer as yes or no and give a brief explanation

    …….....

    .....

    .....

    .....

22. If no in the above question, what are some of the factors that dissuaded you from using ICT technology in your instructional process?

    Not enough computers [ ]

    Bad attitude [ ]

    Not enough time to use computing program [ ]

    Lack of knowledge and skill [ ]

    Lack of support and/or training [ ]

23. Kindly respond to the following statements as they relate to "influence of teachers' attitude on the use of ICT in mathematics instruction" by ticking where appropriately, where SA= strongly agree, A= Agree, U=Undecided, D=disagree, SD=s

		SA	A	U	D	SD
1	Computers do not scare me at all					
2	I'm no good with computers					
3	I would like to work with ICTs					
4	Working with ICTs would make me very nervous					
5	I can try out a new problem using ICT					
6	Learning about ICTs is a waste of time and very hard for me					
8	Working with ICTs is enjoyable and stimulating					
9	Learning about ICTs is worthwhile					
10	ICTs make me feel uncomfortable					
11	I am sure I could learn a computer language					
12	I feel at ease using a ICTs in class					
13	I get a sinking feeling when I think of trying to use ICTs					
14	Anything that ICTs can be used for, I can do just as well some other way					
15	I do not think I could use ICTs to teach mathematics concepts					
16	Working with ICTs make teaching easy and efficient					
17	I have a lot of self-confidence when it comes to working ICTs					
18	Working with ICTs will not be important and efficient in my work					
19	ICTs can enhance students' problem solving skills and learning					
20	ICTs encourage individualized instruction					
21	ICTs motivate students to solve mathematical problems					
22	ICTs save time and effort					

24 Teachers Perceptions of the Benefits of ICT

Kindly indicate the level that conforms to your opinion

		SA	A	U	D	SD
1	Assist students in accessing digital information efficiently and effectively					
2	Support student-centered and self-directed learning					
3	Produce a creative learning environment					
4	Promote collaborative learning in a distance-learning environment					
5	Support teaching by facilitating access to course content					
6	Offer more opportunities to develop critical (higher-order) thinking skills					
7	Improve teaching and learning quality					
	ICTs devises manage teaching					

Kind of Technical and Infrastructural Support for Use of ICT in Mathematics Instruction

24. Type of Infrastructure Available for ICT Integration

Kindly indicate the level that conforms to your opinion

		Highly Adequate	**Adequate**	**Inadequate**	**Highly Inadequate**	**Not Available**
1	Electricity					
2	Internet					
3	Computers					
4	Electronic materials					
5	Television sets					
6	Projectors					
7	CD/DVD player					
8	Word Processors					
9	Spreadsheets					
10	Data bases					
11	Presentation applications i.e. Power point					
12	Computer/ICT laboratories/rooms					
13	Technical experts					
14	Content software					

26 Availability of Technical Support for ICT Integration

Kindly indicate the level that conforms to your opinion

	SA	A	U	D	SD
My school encourages and supports teachers to attend in-service ICT training					
Computers in my school are frequently serviced to ensure they are in good condition					
There is technical personnel to assist whenever a problem arises with computers					
There is an alternative source of power in the school to avoid power inconveniences					
Classrooms/laboratories are equipped with computers					
Insufficient expertise/guidelines for helping teachers to use ICTs in instruction					
The school lacks good software programs					
There is lack of essential computer skills/knowledge of using computer for instruction					

27. Kindly indicate the level that conforms to your opinion.

	Accessibility to ICT resources	**SA**	**A**	**U**	**D**	**SD**
1	Computers are only available to those teachers who teach computer studies					
2	There are no adequate software/programmes					
3	Computer desktops are too few for lessons					
4	Computers are not free whenever I want to use them					
5	Software are too difficult or complex to use					
6	Software are not adaptable enough for class instruction					

28 Technical skills for Integration of ICT

Rating of	**Highly Adequate**	**Adequate**	**Inadequate**	**Highly Inadequate**	**Not Available**
Personal ICT skills					
Technical support					
Quality of training in ICT integration					
Preparation of ICT content material					
Maintenance of ICT equipment					

Thank you for participating in the survey.

APPENDIX III: TEACHER INTERVIEW QUESTIONS GUIDE

RESEARCHER

SECTION A: Background Information:

What is your present teaching assignment?

Are you currently using or have you previously used computer technology as part of your instructional process?

SECTION B: Teacher Users - Enablers and Disablers

Describe how you use the computer in your instructional process. (grade level, subjects, frequency of use)

What are some factors, which enable you to integrate computer technology as part of your instructional process? What would be the major factor? Explain.

Possible ideas to be explored:

Access to computers, Availability of software, Priority in the school, Self-motivation

support, training and in-service, Attitudes of administrators and Personal familiarity

Do you use the computer to administrate or manage aspects of your teaching?

If yes! Explain. Has using the computer as an administrative tool been a factor in your using the computer in the instructional area?

If no! What are the reasons you don't use the computer to help you administer or manage aspects of your teaching?

Describe any in-service, training or workshop sessions involving computer technology that you've attended. Were you satisfied with what these sessions offered you? Is in-service an important reason you use computers in your instruction? What changes for improvement would you make to professional development in the area of the use of computer technology in the classroom setting?

Do you own a computer? Has this been a factor in your integrating computers in your instructional process?

SECTION C: Teacher Non-Users

1. What are some of the factors that dissuaded you from using computer technology in your instructional process?

Possible discussion points:
Access problems, not enough computers, not enough time to review software, Quality of software, Lack of personal knowledge and skill, not a priority, Lack of students', keyboarding skills, Prep time, Lack of support or training, not sure how to integrate, and Lack of administrative support

2. Overloaded with lessons2. Do you use the computer to administrate or manage aspects of your teaching?

Explain. (Use follow up questions from number 3 sections B)

3. Do you have a computer at home? Has your experience with it been a factor in your choosing not to use available computer technology in the school? Explain.

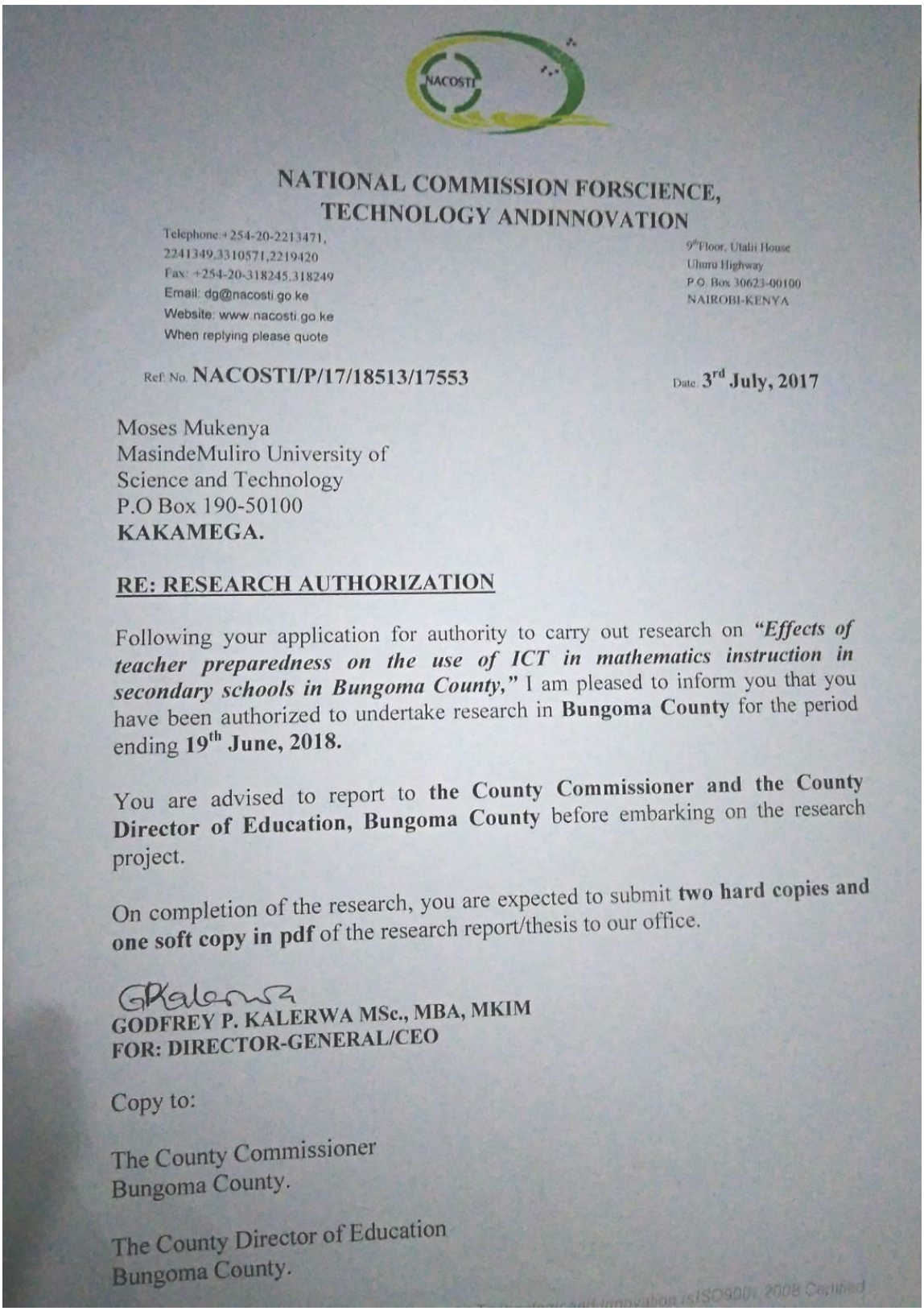
4. Have you attended any teacher in-services, workshops or training sessions involving computer technology? Describe the nature of the session. If answer is no what type of in-service session might you attend that involved computer technology and might this persuade you to begin to use computers as part of your instructional process? Explain

APPENDIX IV: OBSERVATION SCHEDULE

Tick appropriately in the space provided- RESEARCHER

Items for observation	Adequate	Inadequate	Not available
Availability of computer laboratories/			
Availability of computers			
Availability of Mathematics software			
Availability of projectors			
Availability of printers			
Teachers' involvement in integration of computer technology in Mathematics instruction	Sufficient	Insufficient	Not at all
Mathematics teachers' access to computer laboratory/ Mathematics computer rooms	Sufficient	Insufficient	Not at all

APPENDIX V: RESEARCH AUTHORIZATION



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P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/17/18513/17553**

Date. **3rd July, 2017**

Moses Mukenya
MasindeMuliro University of
Science and Technology
P.O Box 190-50100
KAKAMEGA.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Effects of teacher preparedness on the use of ICT in mathematics instruction in secondary schools in Bungoma County,"*** I am pleased to inform you that you have been authorized to undertake research in **Bungoma County** for the period ending **19th June, 2018.**

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

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

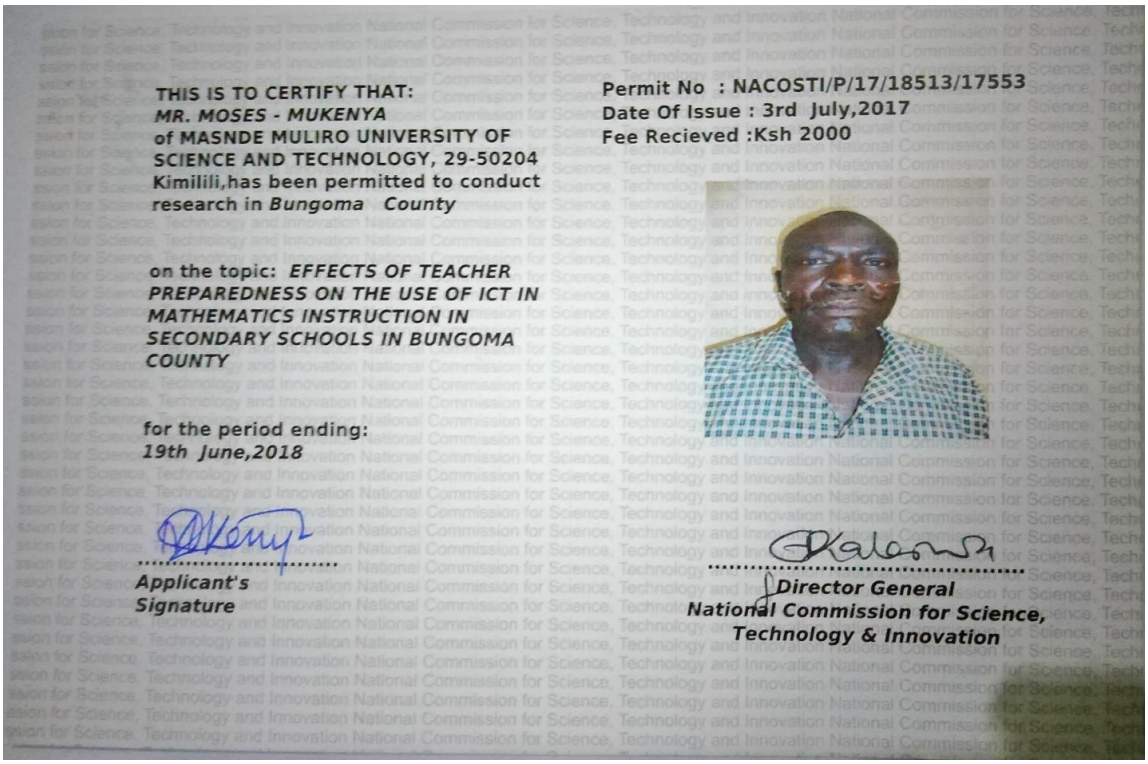
GODFREY P. KALERWA MSc., MBA, MKIM
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Bungoma County.

The County Director of Education
Bungoma County.

APPENDIX VI: RESEARCH PERMIT



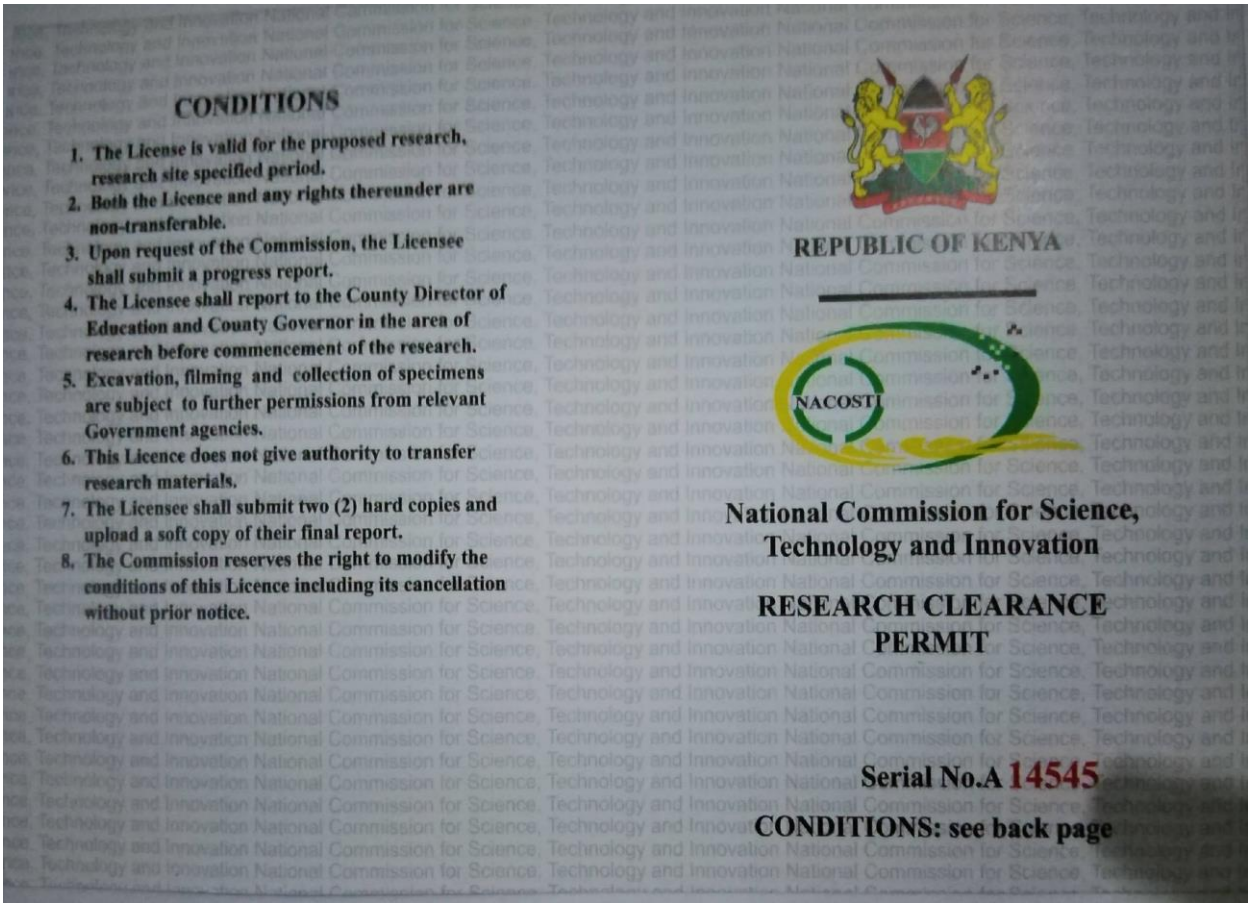
THIS IS TO CERTIFY THAT:
MR. MOSES - MUKENYA
of MASNDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY, 29-50204 Kimilili,has been permitted to conduct research in *Bungoma County*

on the topic: *EFFECTS OF TEACHER PREPAREDNESS ON THE USE OF ICT IN MATHEMATICS INSTRUCTION IN SECONDARY SCHOOLS IN BUNGOMA COUNTY*

for the period ending:
19th June,2018

.....
Applicant's Signature

Permit No : NACOSTI/P/17/18513/17553
Date Of Issue : 3rd July,2017
Fee Recieved :Ksh 2000



CONDITIONS

1. The License is valid for the proposed research, research site specified period.
2. Both the Licence and any rights thereunder are non-transferable.
3. Upon request of the Commission, the Licensee shall submit a progress report.
4. The Licensee shall report to the County Director of Education and County Governor in the area of research before commencement of the research.
5. Excavation, filming and collection of specimens are subject to further permissions from relevant Government agencies.
6. This Licence does not give authority to transfer research materials.
7. The Licensee shall submit two (2) hard copies and upload a soft copy of their final report.
8. The Commission reserves the right to modify the conditions of this Licence including its cancellation without prior notice.

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No.A 14545

CONDITIONS: see back page