

**Access and Pedagogical Integration of Information and
Communication Technology in Secondary Schools in
Nairobi and Kiambu Counties: The Case of Computers
for Schools Kenya**

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the School of Education
of Kenyatta University**

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DECLARATION

This thesis is my original work and has not been presented for a degree or any award in any other university. All sources of information have been acknowledged by way of references.

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DEDICATION

I dedicate this doctoral thesis to my wife Juliah and my daughters Joyanne and Maricelle. Your patience and support have borne this thesis.

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ABBREVIATIONS AND ACRONYMS

- CAI** – Computer Assisted Instruction
- CEPAK** – Computers in Education Project in Kenya
- CFSK**- Computer for Schools Kenya
- CLASS** - Computer-based Laboratory for Automation of School Systems
- EFA** – Education for All
- GDP** – Gross Domestic Product
- GOK** – Government of Kenya
- IBM** - International Business Machines Corporation
- ICT** – Information Communication and Technology
- IDRC** – International Development Research Centre
- IICBA** - The UNESCO International Institute for Capacity Building in Africa
- IITE** – Institute for Information Technologies in Education
- InfoDev** - Information for Development Programme (World Bank)
- ISTE** - International Society for Technology in Education
- KENET** – Kenya Educational Network
- KESSP** – Kenya Education Sector Support Programme
- KIE** – Kenya Institute of Education
- LAN** – Local Area Network
- MDG** – Millennium Development Goals
- MoE** – Ministry of Education
- NEPAD** - New Partnership for African Development
- SITES** - Second Information Technology in Education Studies
- SPSS** – Statistical Package for Social Sciences
- STI** – Science Technology and Innovation
- UIS** – UNESCO Institute for Statistics
- UNESCO** – United Nations Educational Scientific and Cultural Organization
- WAN** – Wide Area Network
- WISE** - Working Group on ICT Statistics in Education

Abstract

This study sought to explore the status of pedagogical ICT integration by teachers in Kenyan secondary schools with special focus on schools that have been supported by Computer for Schools Kenya (CFSK). The need for this study was based on the premise that educational systems worldwide are vigorously pursuing the integration of ICT to enhance pedagogy and that a failure on the part of Kenya's educational system would not only create a digital divide but also affect the quality of learning in schools. In 2006, the Ministry of Education introduced the National ICT strategy for Education and Training which empowers schools to engage with stakeholders like CFSK in partnerships to facilitate access to ICT infrastructure and enhance ICT integration. However, according to Karsenti et al., (2009), in various education systems across Africa, ICTs are increasingly being taught as a completely separate discipline, while the integration of ICTs into pedagogical practices to improve the quality of teaching and learning across disciplines remains the exception. This study aimed at examining the level and manner of ICT integration in Kenyan secondary schools. A cross-sectional and descriptive survey design was adapted for the study. Research data was collected through triangulation, which made use of questionnaires, interview guides and checklists. The study targeted 30 secondary schools from Nairobi and Kiambu Counties. The study sample comprised 278 teachers, 375 secondary school students, 30 schools and two CFSK computer trainers. The data collected was then analyzed using SPSS and MS Excel statistical packages. The analyzed data was then discussed under suitable themes derived from the objectives of the study. The results showed that across all schools participating in the study, the use of ICTs to teach subject matter other than computing itself was almost completely absent. It also emerged from the study that although most teachers have positive attitudes towards ICT, they face a myriad of challenges including teacher-level and school-level barriers, factors that constrain their attempts to integrate ICT in instruction. Further, it was noted that although CFSK is contributing towards enhancing access to technology in Kenyan schools, the ICT infrastructure that is available in schools is way below the required amount. The 1:25 computer to student ratio found in the sampled schools was too high for meaningful ICT integration in schools. Secondly, the study shows that teachers lack requisite capacity to adopt ICTs for pedagogical integration. In order to aid the endeavors of teachers in integrating technologies, the study recommends among others more robust professional development programmes which use a convergent model as well as provision of adequate technologies. These strategies would continuously provide support in order for teachers to be able to overcome the aforementioned problems and challenges faced when attempting to integrate technology. Moreover teachers need to be provided with different types of learning opportunities, including periodic workshops, peer-to-peer training, mentoring, on-line training programmes, and conferences to enhance pedagogical ICT integration.

CHAPTER ONE

INTRODUCTION

This chapter presents the fundamental elements of the study on the integration of information and communication technology (ICT) into the secondary school curriculum. It begins with setting the background by exploring the basis of the study, both generally and specifically. The concept of ICT integration and ICT integration across subjects in the curriculum are further discussed. It is from this background that the problem has been delineated, objectives formulated and the purpose for the study stated. Other key elements in this chapter include the research questions, the significance of the study, the scope of the study, the theoretical framework, the conceptual framework as well as definition of operational terms.

1.1 Background to the study

In today's competitive world that is driven by knowledge and innovation and where productivity, performance and efficiency is dependent to a large extent on technology, the skills, ingenuity and agility of people therein are critical for the country's competitiveness. In Kenya, as elsewhere in the world, our potential to successfully compete in socio-economic development demands for a fresh approach to education at all levels. In the 21st century therefore, education is the basis for competitiveness especially because unlike in the past when the industrial

economy relied more on manufacturing, today we grapple with the service economy that is driven by knowledge, information and innovation.

Around the world, applications of information and communication technology (ICT) are causing major changes to occur in economic and social development. These changes go beyond a mere increase in the number of ICT devices in work places, schools and homes to more fundamental changes in economic growth and human capital development. These economic and social changes have led to growth of knowledge economies and learning societies, something that has made knowledge and learning the core of economic productivity and social development (Kozma, 2003). International development partners like the World Bank argue that ICT has the capacity to advance education goals as well as reduce the poverty of a country. The World Bank argues that with increasing globalization trends coupled with information revolution, nations must give priority to building capacity for effective technology utilization in education (World Bank, 2007).

Around the world, there is growing consensus among education leaders, researchers and educators that teaching and learning must change to help students to learn and develop the skills they will need to succeed in the 21st century (Ananiadou and Claro, 2009; Partnership for 21st Century Skills, 2004; Scheuermann and Pedro, 2009). Attention is therefore being focused on how

information communication and technology can make teaching and learning more effective. Consensus seems to have been formed that the integration of ICT in education has potential to promote educational transformation by motivating learning and leveraging efficiencies in education systems and practices (Trucano, 2005).

According to Farrell et al., (2007) most governments around the world are developing digital strategies to support education. The shift in worldwide computer usage and the need for computer skills in today's workforce have pushed many governments to develop policies and guidelines for educators to ensure that students are prepared to meet the demands of the 21st century. Such changes along with the changes in the ways that 21st century learners communicate have impacted the ways that classroom computers are utilized. Currently, teachers are tapping into the enhanced abilities of current classroom computer technology by utilizing various ICT applications to enhance their instruction. Such tools are also being used to extend classroom communication beyond the school through online collaborative tools. Centered primarily on collaboration and sharing, ICTs encourage student self-expression; interaction with peers, and opportunity for authentic learning experiences. Through the implementation and integration of ICTs into the classroom setting, authentic and meaningful learning experiences are now able to occur in ways that were previously unimaginable. Integration of ICT allows for much more than just

simply learning about typical concepts or facts as laid out in school curricula. Instead, it aids in the process of building connections. As a result, the awareness of the importance and the value of communication are instilled among the learners.

According to Moore (1989), the rapid development of these computer technologies coupled with the world-wide challenge to provide education for all, have led to global reforms and major developments of teacher education. Teachers are challenged to redesign and restructure their teaching methods, adopt constructive teaching approaches and expose students to quality learning opportunities as well as equip them for the future. The emerging practice of 'multi-channel learning', which focuses on enriching the educational experience of learners with information, stimulation and mediating interactions is receiving much attention because of its potential especially in areas of great resource scarcity.

The need to reform education through technology integration and the emphasis on developing information literacy skills for students implies the need for current understanding on computer technology integration practices that support student learning. Whereas most technologically advanced countries are making massive investments in ICTs, African countries are being isolated because of communication barrier caused by lack of infrastructure in telecommunications

and limited access to ICTs. ICT is one of the main drivers of inclusion in the ‘global village’ (UNESCO, 2010). According to the International Telecommunication Union (2007), out of 1,270 million fixed telephone lines worldwide, less than two percent of these are found in Africa. Asia alone has 48% of these fixed telephone lines. The survey however shows that Africa has begun to experience a significant growth of mobile telephone penetration.

Table 1.1: ICT Status in Selected African Countries, 2007

Country	GDP Per Capita (US\$)	Main Telephone lines Per 100 inhabitants	Mobile Subscribers Per 100 inhabitants	Internet Users Per 100 inhabitants
Kenya	1,200	0.84	18.47	7.89
Uganda	1,100	0.36	6.73	2.51
Tanzania	800	0.40	14.78	1.0
Seychelles	8,209	25.44	86.52	35.67
Morocco	4,400	4.12	52.07	19.85
South Africa	4,200	9.97	83.33	10.75

Source: International Telecommunication Union Report, 2007

Table 1.1 provides a statistical overview of the ICT trends in selected African countries. From the statistics of these countries, it is evident that Kenya is way ahead of the other two countries in East Africa namely, Uganda and Tanzania in the three ICT parameters that are highlighted in table 1.1. Since these ICT

infrastructure are critical in the integration of ICT in instruction in schools, it is important to find out the status of their availability and use in schools in Kenya.

Research indicates that ICT use in education is at a particularly dynamic stage in Africa, which means that there are new developments that are happening on a daily basis somewhere on the continent (Farrell et al., 2007). In Africa the process of adoption, diffusion and integration of ICT in education is in transition as noted by Farrell et al., (2007). They further observe that in Africa, there appears to be a marked shift from a decade of experimentation in the form of donor-supported, NGO-led, small-scale, pilot projects on ICT use in education, towards a new phase of systematic integration that is informed by national government policies and multi-stakeholder-led implementation processes.

Several macro-trends related to ICT use in education have been observed recently in Africa. In most African countries for example, there are multi-partnerships often involving public-private partners, ICT organizations, civil society and institutions of learning. Another common trend is the development of digital content. At national levels, ministries of education are encouraging collaborative efforts towards digital content development. Several initiatives are also emerging to enhance connectivity. These include procurement of wireless networks and investment in fibre optic technology (Evoh, 2007 and Farrell et al., 2007).

Despite these notable developments, there are several limiting factors to effective integration of ICT in education in Africa as highlighted by Farrell et al., (2007). First, lack of valid information on the status of integration of ICT into education impedes planning. Secondly, although data on ICT use in education has been collected in the past, the results remain scattered across a number of publications, hence the need for consolidating such information. Thirdly, in most countries, there is an emphasis on training for ICT literacy without subsequently emphasizing integration of ICT in computer assisted instruction. Karsenti et al., (2009) observe that ICTs are increasingly present in African societies and have been introduced to varying degrees at all levels from pre-school to university and in both the formal and informal sectors. However, according to Karsenti et al., in various education systems across Africa, ICTs are increasingly being taught as a completely separate discipline, while the integration of ICTs into pedagogical practices to improve the quality of teaching and learning across disciplines remains the exception.

The government of Kenya has over a period of time recognized the importance of ICT in the country's development processes. This is well reflected in the ICT related policies formulated to guide the use of ICT in various sectors of the economy including education. Firstly, in 2006, the government developed a national ICT policy that aims at improving the livelihoods of Kenyans by ensuring the availability of accessible, efficient, reliable and affordable ICT

services. The national policy puts emphasis on ICT, telecommunication and broadcasting. In the area of ICT use in education, one major target outlined in the policy is that the government will encourage the use of ICT in schools, colleges, universities and other educational institutions in the country so as to improve the quality of teaching and learning.

Secondly, the Ministry of Education developed a Kenya Education Sector Support Program (KESSP) in 2006 that featured ICT as one of the priority areas with the aim of mainstreaming ICTs into the teaching and learning process. The National ICT Policy embedded this intent as a national priority and provided the impetus for the Ministry to develop its sector policy on ICT in Education. The Education sector policy document, referred to as the ICT policy for the education sector, consists of the following components: ICT in education policy, digital equipment, connectivity and network infrastructure, access and equity, technical support and maintenance, harnessing emerging technologies, digital content, integration of ICT in education, training (capacity-building and professional development) and research and development. The Ministry of Education leads the monitoring and evaluation of its sector's policy implementation, guided by overall government policies on education and ICT, specific education strategic documents for implementing its mandate, and global goals such as Education for All (EFA) and the Millennium Development Goals (MDGs) (Government of Kenya, 2006). Thirdly, Government of Kenya (2007) in Kenya's Vision 2030 recognizes the role

of science, technology and innovation (STI) in a modern economy, in which new knowledge plays a central role in wealth creation, social welfare and international competitiveness. The vision identifies a dynamic ICT infrastructure as a key element to the effective exploitation of knowledge and for innovation.

Government of Kenya (2007) in Kenya's Vision 2030 also points out that the process of the emergence of the knowledge economy is always associated with an increase in science-related and technology-related activities. Among other strategies for strengthening science, technology and innovation that has been highlighted in Vision 2030 is the training of high skilled human resource pool for the country's economy. Vision 2030 has in mind Kenya's pool of talent which is comparatively small and inadequately trained for integration into the job market. The Vision intends to spur measures to improve the national pool of skills and talent through training that is relevant to the needs of the economy (Government of Kenya, 2007).

The Government and Ministry of Education in the National Development Plan also proposed to develop Information and Communication Technology (ICT) syllabus for primary and secondary schools. It was the intention of the government to initiate ICT in-service teacher training programme to train 43,000 primary and secondary school teachers by the end of 2008 and to achieve a universal primary and secondary student ICT literacy by the end of the same

period. The Government of Kenya proposed to make 2,500 primary and secondary schools, ICT ready by the end of every year from 2002-2008 (Government of Kenya, 2002). This is yet to be achieved.

Apart from policies, several programmes have so far been launched with the support of the Ministry of Education with the aim of integrating ICT into the secondary school curriculum. Some of these projects and their objectives are highlighted in table 1.2:

Table 1.2: ICT in Education Related Projects in Kenya

	Project	Objectives
1	School-Net, Kenya	<ul style="list-style-type: none"> -To establish appropriate ICT infrastructure in schools and communities; -To develop relevant e-content for integration of ICT in education; -To learn and localize best practices from other countries in Africa and beyond on the integration of ICT in the education system; -To enhance connectivity in Kenyan schools and communities; -To create local, regional and international partnerships and value-chains among ICT and education sectors
2	NEPAD	<ul style="list-style-type: none"> -To provide ICT skills and knowledge to primary and secondary school students to function in the emerging Information Society and Knowledge Economy; -To provide teachers with ICT skills for use in education -To provide school managers with ICT skills so as to facilitate the efficient management and administration in the schools; and
3	KENET	<ul style="list-style-type: none"> -Establish appropriate internet infrastructure in institutions. -Provide a platform and infrastructure for electronic teaching and learning. -Provide opportunities for collaboration in research and training.
4	School Broadcasting	-To broadcast educational content to 11 million students in 18,000 primary and 3,000 secondary schools by the end of 2006.

Source: Adapted from Farrell et al, 2007

In the recent past, the Ministry of Education in Kenya has identified a number of challenges related to ICT integration in teaching and learning. First, is the uncoordinated approach to imparting knowledge and ICT skills and competencies to teachers. It is seen to be one of the major challenges not only in Kenya but also in Africa. Secondly, limited capability for effective use and maintenance of ICT infrastructure. It has been found that most schools use less than 40% of the available ICT infrastructure. The third challenge is to customize or develop education software to meet local education requirements in teaching, learning and administration (Ministry of Education, 2006).

In Kenya as elsewhere in developing countries, not much data is available on ICT in education. The UIS postulates that the shortage of ICT in education data in such countries is due in part to the following factor: ICT in/for education not occupying a prominent position in the country's public policy agenda; limited application of ICT in education in public institutions; restricted use of ICT in education to vocational, post-secondary and tertiary education and the problem of data collection on ICT in education because of the gaps in countries' capacities (UNESCO Institute for Statistics, 2009).

This study focused on Computer for Schools Kenya project. The study thus investigated the manner and extent of integration of ICT into the secondary school

curriculum. The study therefore targeted schools that have received support from Computers for Schools Kenya (CFSK). This organization was established to facilitate the productive and sustainable use of computers in education in schools.

CFSK which has its headquarters in Nairobi began its operations in January 2003. It began distributing the first batch of 200 computers to 10 schools in Nairobi. The project is an adaptation of the Computers for Schools Canada, which led to the development of similar organizations in Chile and Colombia. By 2008, CFSK had helped to establish laboratories of twenty (20) computers each to 150 secondary schools. One aim of the project is to ensure that even the marginalized schools and regions in Kenya benefit from this ICT in education project (CFSK, 2008). As of March, 2008, CFSK had established seven regional centres in Kenya to provide technical support in the respective regions and in some cases also serve as training, refurbishment and dispatch centres.

This study focused on the secondary school education because of its critical nature in any educational system. First, as the World Bank (2005) notes, secondary school education is a crucial link between primary schooling, tertiary education and the labour market. Secondly, as Evoh (2007) points out, the need for integration of ICT in secondary education in Africa is underscored by the nature of expansion of secondary schools. There is therefore need to provide quality and value consequent to the expansion of secondary education. Quality

secondary education is therefore indispensable in creating a bright future for individuals and nations alike. Thirdly, according to Government of Kenya (2005), there are obvious benefits for integrating computers into secondary schools as students at this age need to focus on subject-specific content, greater critical thinking skills, scientific inquiry, and mathematics, science and languages. Through ICT students benefit greatly from the analytical, creative, and collaborative power of computer technology to map out and analyze assumptions, present ideas, and participate in projects with peers from around the country and around the world. An overarching question concerns the relevance for monitoring ICT in education.

It is possible to argue that ICT is one among many other instructional tools (including textbooks, television, calculators), most of which are not monitored regularly. It may therefore appear not very necessary or unique to single out ICT for monitoring in educational institutions. Though this may appear to be the case, in reality ICT is not just an instructional tool, but the epicenter of the information society (World Bank, 2007), which touches upon almost every aspect of private and professional life. It is thus discernable that just like reading and writing which are traditional competencies transmitted through education; the effective use of ICT for learning, for communication and cooperation is one of the basic competencies which schools need to embrace in the current information age. Monitoring and evaluation of ICT integration is needed in order to determine to

what extent education systems realize the benefits of ICT in education. According to World Bank (2007), monitoring and evaluation (M&E) of development activities like ICT integration provides governments, development managers, institutions and organizations with better means for learning from past experience, improving service delivery, planning and allocating resources. However, the World Bank notes that in some countries especially in Africa, even those with a rather large amount of ICT for Education investments, there is relatively little monitoring and evaluation that goes on. The World Bank further notes that the few scenarios of evaluation efforts of the impact of ICT in the education sector remains subjective and is often based on what is deemed “common sense” as well as testimonies of a few actors.

These numerous efforts by the government, private sector and non-governmental organizations geared towards ICT use point to the importance of ICT integration in education. However despite this noble realization, there is a dearth of information concerning pedagogical ICT integration in Kenya. Kidombo et al., (2013) argues that the existing literature on ICT integration in education in Kenya appears to indicate limited knowledge on the quantity and quality of research in the area of pedagogical integration of ICT. For instance, some findings of a “knowledge mapping” exercise conducted by the World Bank's InfoDev Group (Trucano, 2005) revealed that, despite large investment in information and communication technologies (ICTs) to benefit education in different countries and

despite the increasing use of ICTs in education in developing countries, there remains a very elusive certainty about the impact of ICTs on education. These findings highlighted various knowledge gaps and recognized the urgent need for developing widely accepted methodologies and indicators to measure ICT in education in different countries.

1.2 Statement of the problem

ICT integration in education is critical in empowering participants to develop competitive skills and knowledge that are necessary in the global knowledge economy of the 21st Century (Economic and Social Research Council, 2005; Ministry of Education, 2006; Trucano, 2005). While there is wide acceptance, the world over that ICT integration supports effective teaching and learning, it has been noted that there is a considerable technology lag in educational institutions in most parts of the world especially in Africa.

In Kenya for instance, whereas there is high investment in ICT integration initiatives by the Government, institutions, private companies and non-governmental organizations like CFSK, little is known by way of research about the level and manner of ICT integration in schools. The heavy investment is reflected in the procurement and installation of ICT infrastructure, national policy formulation and teacher training initiatives on ICT integration. Unwin (2004)

however cautions that there is need to monitor progress because often times there could be a gulf between rhetoric and actual classroom practice.

While other developing countries have reported up to 41% levels of integration of ICT in teaching and learning, the proportion remains substantially low in Africa, Kenya included (Ministry of Education, 2006). In Kenya however, although non-governmental organizations like CFSK are busy equipping schools with ICTs and providing some training to teachers, by way of research little is known about the level and manner of ICT integration. According to Trucano (2005), previously in Africa there has been more effort put in collecting quantitative data on ICT in education infrastructure leaving out important aspects which directly affect teaching and learning and the quality of education as a whole. There is, therefore, a dearth of data and critical information on ICT integration amidst numerous initiatives like that by CFSK. This study was therefore meant to explore the level and manner of ICT integration especially in schools that have partnered with CFSK previously. The intention of the study was to explore on the various indicators that affect the level and manner of ICT integration in order to suggest recommendations for effective integration of ICT in instruction.

1.3 Purpose of the study

The purpose of the study was to investigate the level and manner of pedagogical integration of ICT in secondary schools in Kenya with special focus on schools

that had once partnered with CFSK. Additionally, the study was a key benchmark for evaluating the effectiveness of projects such as CFSK. Since Computers for Schools Kenya (CFSK) was among the first projects of its kind in Kenya, there was need to establish how it was being implemented to assess the impact of the support to schools, determine access to ICTs in schools and the level and manner of ICT integration and subsequently use the data collected to formulate suitable guidelines for future practice and policy in the area of pedagogical ICT integration.

1.4 Objectives

The study was based on the following specific objectives:

- i. To assess the availability of and access to ICTs by teachers in selected secondary schools;
- ii. To measure the level and manner of ICT integration by teachers in secondary schools in Kenya;
- iii. To measure teachers' perceptions towards ICT integration in schools;
- iv. To investigate challenges faced by teachers in integrating ICT in education;
- v. To assess teachers' professional development needs in pedagogical ICT integration.

1.5 Research questions

The study sought to answer the following key questions:

- i. What ICT resources are available in schools and what is their functional status?
- ii. How often do teachers and students access ICTs in school?
- iii. To what extent do teachers integrate computers in teaching and learning?
- iv. What factors affect the adoption and use of computer technology in secondary schools?
- v. What is the attitude of teachers and students towards ICT integration?
- vi. To what extent were the teacher professional development programmes effective in supporting teachers to integrate technology in the classroom?

1.6 Significance of the study

The findings of this study are useful to a number of stakeholders of education, especially at the secondary school education level in a number of ways. First, the study provides useful data and information for use in teacher training, at college and university levels. Secondly, the findings are valuable to organizations such as CFSK whose agenda is to provide support to schools by supplying computers and professional development of teachers to integrate ICT in their routine activities. Thirdly, the findings of the study are helpful to curriculum developers – Kenya Institute of Curriculum Development (KICD), in the course of developing e-content. Fourthly, the research findings also serve as foundational information for the educational research community to proceed with further research on ICT integration in education. Apart from that, the findings of the study provide the Ministry of Education with current data which is a constructive tool for making

better policy decisions and effecting educational strategies with greater certainty. The findings of this study provide new evidence about the pedagogical integration of ICT in secondary schools in Kenya which is critical knowledge for the training and retraining of teachers.

1.7 Scope of the study

The scope of the study included 30 public secondary schools in Nairobi and Kiambu counties of Kenya. The implication of this scope was that generalizations would be limited to secondary schools which are covered by the project. It was therefore not appropriate to make generalizations for all secondary schools in Kenya especially those not supported by ICT related projects like CFSK.

1.8 Assumptions

The study was based on the assumption that:

- i.) Respondents would participate freely without fear, bias or prejudice;
- ii.) Respondents would be truthful in their responses;
- iii.) The Ministry of Education and Teachers Service Commission supported the CFSK Project and provided the necessary resources to participating schools.

1.9 Limitations

- i.) In this study, one of the limitations was that teachers' dispositions, opinions and perceptions of change were assessed through self-reported assessment;
- ii.) There was limited literature in the area of ICT use in Education in both Kenya and Africa in general, hence the researcher found it necessary to explore much literature from sources outside Africa.

1.10 Delimitations of the study

It would have been ideal for this study to cover more schools especially the ones that have previously collaborated with CFSK. However, due to financial and logistical constraints, the study was limited to Nairobi and Kiambu Counties.

1.11 Theoretical framework

Today there are a number of theories and models that attempt to explain human behavior especially in relation to ICT usage. Previously, there was a tendency to focus more on technical aspects and systems while neglecting the behavioral factors associated with ICT use and this was found to largely account for the low up-take of ICT. The importance of drawing connections using theories from behavioral sciences to explain people's interactions with technology has been found useful.

In this study, the theories that were found relevant in explaining the acceptance or rejection of pedagogical ICT integration by teachers and students were the Technology Acceptance Model (TAM) and the Theory of Constructivism. Davis (1989) came up with the Technology Acceptance Model by arguing that in a system, use and response could be explained or predicted by user motivation, which is also directly influenced by external stimulus consisting of the actual system's features and capabilities.

Further, Davis (1989) suggested that the user's motivation of any technology is predetermined mainly by three main factors namely: perceived ease of use, perceived usefulness and attitude toward using the technology. As is the case in this study, the attitude of the teacher or learner is a determiner of whether they would use or reject the technology.

The attitude of the teachers or learners towards ICT as is proposed by Davis (1989) is influenced by two important factors: perceived usefulness and perceived ease of use. In the case of these two factors that determine an individual's attitude, Davis (1989) argued that perceived usefulness is predetermined by perceived ease of use. Prior to the proposal by Davis (1989) on the Technology Acceptance Model, several other studies had highlighted the importance of perceived ease of use and perceived usefulness in predicting a person's behavior. For instance Bandura (1982) further showed the importance of considering both perceived ease

of use and perceived usefulness in predicting behavior. According to Bandura, self-efficacy which is similar to perceived ease of use consists of the judgments of how well one can execute courses of action required to deal with prospective situations, while the outcome judgment, which is similar to perceived usefulness is defined as the extent to which behavior once successfully executed is believed to be linked to valued outcomes. On his part, Swanson (1982) provided evidence that perceived ease of use and perceived usefulness were both critical behavioral determinants of technology use.

Besides the Technology Acceptance model, this study is founded on the theory of constructivism which is rooted in the learning theories and principles advanced by Dewey, Piaget, Vygotsky and Bruner. The term constructivism is defined as constructing new knowledge from prior experience. Constructivism is founded on the creation of knowledge in environments; it is supported by active learning, reflective learning, creation of authentic tasks, contextual learning, and collaborative learning (Novak 1998).

Beyond accepting to use ICT in teaching and learning, the proper use of the learning resources requires the creation of constructivist learning environments. According to Brogan (1999), we learn 10% of what we read, 20% of what we hear, 30% of what we see, 50% of what we see and hear, 70% of what we discuss with others, 80% of what we experience and 95% of what we teach someone else.

Jonassen (1996) argue that the best type of education is that in which learners use computers as cognitive tools. Jonassen believe that learners learn best from thinking in meaningful ways. Thus, they believe that learning is meaningful when it is active, constructive, authentic and intentional. Computers according to Jonassen (1996) support exploration, knowledge construction and learning by reflecting. Constructivist learning environments are intended to provide multiple paths for students to explore with teachers performing the role of a guide, mentor or facilitator. Effective constructivist pedagogies incorporate various technology tools with active learning while allowing for teachers to act as guiding partners (Novak, 2010). Constructivist teachers facilitate learning through activities and exercises which challenge learners' previous thoughts and feelings about a particular subject or event. Additionally, their pedagogical practices focus on the learners as opposed to teacher-centered lecture approaches to learning (Jonassen, 1996). Integrating technology into instruction refers to the process in which technology is used as a tool to actively support the tasks of teaching and learning. Further, it refers to the different ways that technology tools can be used to support learners as they construct their own knowledge through completion of creative activities that enhance meaningful learning (Novak, 1998). Technology integration centers on best practices to incorporate technology into the curriculum as teaching tools (Keengwe and Onchwari 2008). In this study therefore, we propose that it is most effective to integrate technology into the curriculum rather than integrating curriculum into the technology.

1.12 Conceptual framework

Literature in ICT use in education indicates that the integration of ICT as a medium for the enhancement of the teaching and learning process is influenced by variety of factors that can be classified as either manipulative or non-manipulative (Mojgan et al., 2009). According to Mojgan et al., Manipulative factors include attitudes towards ICT use, ICT knowledge and skills, commitment of the school towards ICT integration and availability of support for ICT use. The non-manipulative factors on the other hand are those that cannot be directly influenced by the school including age, teaching experience, computer experience, government policy and availability of external types of support to schools. The success of integration of ICT postulated by Mojgan is attained by a dynamic interaction of all this factors.

Knezek and Christensen (2000) hypothesized that high levels of attitude, skill and knowledge (proficiency) and tools (levels of access) would produce high levels of technology integration that will reflect on students' achievements positively. Bhasin (2012) argues that a suitable framework for using ICT to transform education is made of four interrelated elements namely; hardware and infrastructure, software and services, human-ware and systematic planning and management. Bhasin however emphasizes that teachers have a very significant role in the realization of an optimal level of ICT integration.

According to Heeok and Myunghee (2009), at the meso level, the school environment and its surrounding factors may affect the use of ICT in educational practice. At the macro level, Heeok and Myunghee argue that ICT use and educational performance may be influenced by socio-cultural norms, economic forces and technological advances. In this study, effective integration of ICT is considered to be dependent on variables at the macro, meso and micro levels. Determinants of ICT integration can be ordered on the basis of four categories of variables at individual teacher level and at school level. These factors are the independent variables that explain the differences in ICT integration. At the level of teachers, cultural teacher characteristics including teacher beliefs and teachers attitudes towards computers are important determinants of ICT integration. Equally important are structural teacher characteristics that are non-changeable and they include age and gender. At the school level are cultural school characteristics which include characteristics such as leadership and ICT school policy. Structural school characteristics include infrastructure and class size.

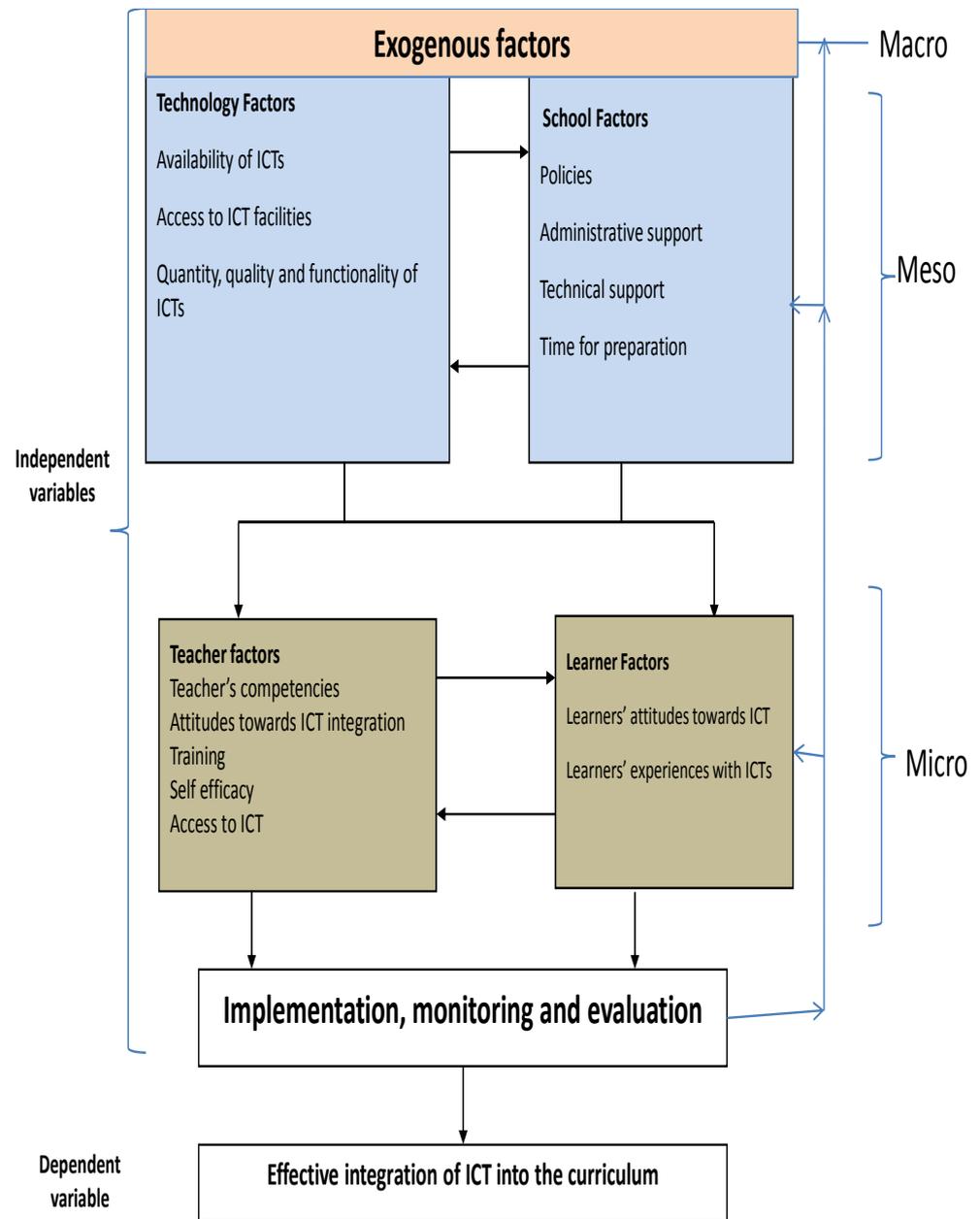
Forgasz and Prince (2001) found out that the uptake of technology and its implementation in education is dependent on a number of factors. These are skills and previous experience in using technology; time and opportunities to learn (pre-service education, professional development); access to hardware (computers and calculators), software, and computer laboratories; availability of appropriate teaching materials; technical support; support from colleagues and school

administration; curriculum and assessment requirements and how teachers interpret these for students perceived to have different abilities; knowledge of how to integrate technology into teaching; beliefs about the subjects offered; and beliefs about the role of technology in education. In Figure 1.1, the conceptual framework of the study, an attempt is made to show how effective integration of ICT in teaching and learning can be achieved. Drawing from other relevant frameworks such as those of Mojgan et al., (2009), Bhasin (2012), Heeok and Myunghee (2009) and Forgasz and Prince (2001), it is possible to argue that the optimal ICT integration into teaching and learning in schools is dependent upon multiple factors all of which play a role in the success or lack of success thereof. In this study, integration of ICT has been shown to be dependent on a variety of factors ranging from teachers' dimensions, learners' dimensions, technology dimensions and school dimensions.

It is also evident from the conceptual framework that all these factors are interdependent and not mutually exclusive. For example when the school administration supports teachers in their integration of computers into teaching, the teachers attitudes would be affected in a positive manner and their levels of confidence will with time go up. Similarly, when the school administration provides necessary ICT infrastructure in the school, including equipping the computer laboratory with personal computers and installing internet in the school, learners and teachers will have more and better access to ICTs. It is assumed that

in such a scenario, there is likely to be effective integration of ICT into the curriculum. Many studies especially in the developed world have focused more on determining whether these factors are available or not so as to describe the status of ICT integration. In this study, monitoring and evaluation of ICT integration processes was found necessary especially in a case like that of Kenya where ICT integration initiatives are being pursued vigorously by various stakeholders. It was found critical and more productive to focus on a particular initiative that has been distributing computers to schools while at the same time conducting training for successful integration.

Figure 1.1 The Conceptual model



Source: Mwangi, 2014

1.13 Definition of terms

Access – the reach by teachers and learners to ICT in schools for teaching learning

Computer - a machine that manipulates data according to a list of instructions

Computer laboratory - it is a room or space equipped with computers devoted to pedagogical use in an educational institution

Computer Programme – instructions for a computer to execute commands

Constructivism - The learner constructs knowledge; learning is a personal interpretation of experience; learning is active, collaborative, and situated in real-world contexts; and assessment of learning is integrated within the learning context itself

Courseware – Educational software designed especially for use with classroom computers

Curriculum – contents and processes of learning in schools as well as the outcomes of learning

Didactic teaching - traditional pedagogy of a teacher-centered teaching strategy

E-Learning - the intentional use of networked information and communications technology in teaching and learning

Hardware - is the physical part of a computer

Information Communication and Technology – forms of technology that are used to transmit, process, store, create, display, share or exchange information by electronic means

ICT Integration in education – a comprehensive process of applying technology to the educational system to improve teaching and learning

ICTs in education - refers to education models that employ ICTs to support, enhance and enable the delivery of education through computers internet, television or radio

Information literacy - is the combination of knowledge, understanding, skills, and attitudes that students need to fully contribute to the society in the information age.

Instruction - a form of communicated information that is both command and explanation for how an action, behaviour, method or task is to be begun, completed, conducted, or executed.

Instructional Technology - the theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning

Internet – A communication network of computers, allowing diffusion of knowledge and sharing of information, experiences and resources at great speed

Knowledge Economy – it is an economy that is driven by knowledge and information technology and whose markets and products are more global

Learning Society - one in which learners adopt a learning approach to life, drawing on a wide range of resources to enable them to support lifelong learning as a condition of individuals in the contemporary period

M-Learning - the intersection of mobile computing and e-learning: accessible resources wherever you are, strong search capabilities, rich

interaction, powerful support for effective learning, and performance-based assessment.

Pedagogical Integration of ICT – the practical use of ICT in teaching and learning in schools by teachers and learners

Pedagogy - the correct use of teaching strategies

Software - a collection of computer programmes, procedures and documentation that perform some tasks on a computer system

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter contains literature analyzed by the researcher. The literature is summarized into ten broad sub-topics namely: ICT trends in education, Computer studies in secondary schools in Kenya, Levels of ICT integration, Policy considerations in pedagogical ICT integration, Factors promoting adoption and use of ICT in education, Benefits of ICT in education, Teachers attitudes and self efficacy of ICT use, Teacher professional development for pedagogical ICT integration, Barriers to pedagogical ICT integration and Relevant and related studies on pedagogical ICT integration.

2.2 Trends of ICT use in education

Schleicher (2010) posits that we live in a fast-changing world, and that producing more of the same knowledge and skills cannot suffice to address the challenges of the future. Schleicher argues that a generation ago, teachers could expect that what they taught would last their students a lifetime. Today, however he argues that, because of the rapid technological, economic and social changes, schools have to prepare students for jobs that have not yet been created, technologies that have not yet been invented and problems that we do not yet know will arise.

According to Kruger (2012) whereas the content that is taught in schools is changing regularly especially as new innovations and knowledge continues to shape the future, the methodologies of teaching and the instructional technologies used in schools has unfortunately remained outdated. The situation is even more profound in rural areas especially in sub-Saharan Africa where the trend of classroom and textbook based educational system is becoming more and more outdated as ICT is being widely embraced elsewhere in the world.

2.2.1 A brief History of ICT use in education

An in-depth review of literature on the evolution of ICT in education illustrates that there are distinct periods of educational computing based on the predominant computer technologies and computer functions of the time. According to Aslan and Reigeluth (2011), three distinct periods can be discerned from history. These periods are the "Mainframe Period", the "Microcomputer Period", and the "Internet Period". Aslan and Reigeluth however look further ahead and posulate that the next period of ICT uses in education will be the "Personalized Computing Period."

Taking the past and current trends into account and considering such shifts in society as moving from standardization to customization and personalization, from proprietary resources to open resources and from using different tools for different functions to convergence of functionalities in one tool, Aslan and

Reigeluth propose that, the next educational computing period "Personalized Computing Period", in which the predominant computer technology will be "Personalized Integrated Educational Systems" that will serve four major functions to support the information-age paradigm of education: Record-keeping, planning, instruction, and assessment, as well as such secondary functions as communication, general student data, school personnel information and system administration.

Aslan and Reigeluth (2011) argue that the mainframe period fell between the late 1950s to late 1970s. Beginning about 1958, the earliest applications of computers emerged as programmes for teaching certain specific subjects. IBM's Teaching Machines Project is considered to be the pioneer implementation of this application. Initially, the IBM 650 computer was used for simulating a teaching machine for teaching basics of binary arithmetic (Venezky and Osin, 1991). There was a great effort to develop various educational programmes working on these machines. Venezky and Osin (1991) used the term "Age of Engineers" (late 1950s and early 1960s) to illustrate that there was a period of computer-assisted instruction in which the computer provided mechanical implementation of instruction.

Following the "Age of Engineers", Venezky and Osin (1991) identified another age called the "Acronym Age" of CAI (middle 1960s). In this age, government-

and military-funded projects took place, such as SOCRATES (System for Organizing Content to Review and Teach Educational Subjects) and CLASS (Computer-based Laboratory for Automation of School Systems). CLASS was basically a drill system, and SOCRATES was a computer-based tutorial system. This age was followed by the “Age of Titans” (late 1960s through the late 1970s) (Venezky and Osin, 1991), in which the most well known projects received extensive funding and public interest. There were a lot of research studies and critical evaluations on them.

From late 1970s to the end of 1990s, Aslan and Reigeluth (2011) classified the period as the micro-computer period. With the introduction of cheap desktop computers, these machines were placed at the top of the list of educational trends (Cuban, 1986). In the early 1970s, micro-computers were introduced in kit form. Soon after that, pre-assembled computers such as the Commodore Pet, Apple, and TRS-80 took their places in educational settings. Venezky and Osin (1991) called this period “The Age of Small Wonders” (the late 1970s through the late 1980s), referring to micro-computers as small wonders. After this introduction, workshops were offered to teachers to learn how to programme computers and to use these machines in classrooms. Research shows that in 1985, at least one computer was available for instruction in 92 percent of all secondary schools in the USA.

In the Mainframe period of educational computing, computer literacy had been a problem because stakeholders were not familiar with these new machines. Therefore, it was difficult to expect an effective utilization of computers in classrooms during that period. However, in the Micro-computer period, computer literacy became less of an obstacle, since the availability and use of computers had increased. Strikingly, students became much more knowledgeable than their parents and even in some cases than their teachers in this period of use (Aslan and Reigeluth, 2011).

Drill and practice was a common type of computer use in the 1980s. In these applications, computers presented a stimulus, such as an addition problem, to the students to enter the correct response. The computer was designed to then give feedback through text or some kind of eye-catching graphics. Therefore, drill and practice applications were typically not used for teaching new content, but instead for retaining and reinforcing previously presented content (Morrison et al., 1999).

Another less common use of technology in education during the Micro-computer period was “Intelligent Tutoring Systems” (Jonassen, 2000). Intelligent Tutoring Systems (ITSs) were developed in the 1980s and 1990s by researchers working on Artificial Intelligence to teach procedural knowledge and problem solving skills. ITSs were sometimes called intelligent CAI. There were many criticisms of these systems. Jonassen (2000) emphasized that giving simple textual feedback in

Intelligent Tutoring Systems cannot replace sensitive feedback by a human tutor. According to Aslan and Reigeluth (2011), these systems were generally implemented in universities, and there was not a significant implementation in the secondary schools.

In the early 1990s, many other applications of computers in education appeared. Word processing applications were a predominant form of computer use among students during that period because students could finish their work more easily than using pen and paper, and they could change the text easily (Morrison et al., 1999). Another application was the electronic spreadsheet. Educators recognized the value of spreadsheets as being strong instructional tools beyond their number-crunching value. Therefore, students started to manipulate and analyze data in spreadsheets (Morrison et al., 1999).

Database management systems also became popular in the Micro-computer period. Morrison et al., (1999) described that teachers were using database applications for lesson objectives focused on critical thinking skills. With the help of database management systems, students could store, organize and manipulate data for their classes. Aslan and Reigeluth (2011) illustrated that one way of using database management systems was to use them as “study guides.” Students were expected to analyze short stories and fill in the database worksheets with their findings. Drawing tools were another popular application of computers in

education. After research showed the value of visualization in instruction, these tools gained even more popularity. Morrison et al., (1999) described successful use of drawing tools as teaching students to draw what they observe. This helped students to visualize and retain their understanding of new material. After the 1990s, literature reveals the following trends related to educational computing:

2.2.2 Internet in education

In recent years, the number of Internet users has increased worldwide. In 2011, 30.2% of the world's populations were Internet users (2,095 million). Of those, 44% were in Asia, 22.7% were in Europe, 13% from North America and 5.7 were in Africa (Internet World Stats, 2010). Internet has now become one of the most powerful educational tools in education (Ivers, 2003). According to Kruger (2012), whereas previously research information was centred on conventional libraries, print media and archives, today the internet has become one of the primary research tools especially because of its convenience. Internet has been documented to have many benefits in education. According to Ivers (2003) for instance, students can not only can communicate with their peers located in different geographical locations but they can also gain from others' knowledge and experiences, participate in chatrooms, share ideas and solutions and learn about the many diverse cultures out there. Parents can also become more involved in their children's education by connecting the school with homes, libraries or other access ports. Teachers can adjust to the different learning styles in the

classroom. With the internet, teachers can also set their own pace of teaching. Individual teaching techniques can become more available, which has been proven to be a factor in student achievement. Also, the Internet enables administrators and teachers to spend less time on administration and recordkeeping. This would also give them more time to spend with their students (Ivers, 2003). Kruger (2012) postulates that in Africa, the internet is even more relevant because of “book famine”. He believes that the internet has a major role to play in transforming the educational environments in Africa to more globally acceptable levels through collaboration and information sharing.

2.2.3 Open source technology

Another trend that is revolutionizing education worldwide today is the open source software. This is the software that is distributed at no cost to the acquirer and with the acquirer having the right to modify source (Kruger, 2012). Open source applications have changed the way educators plan, receive and deliver knowledge, assess achievement, and manage classroom activities. Camichael and Honour (2002) argued that open source software is an appropriate and affordable alternative to the currently prevailing dependency on large commercial organizations and proprietary products in the field of education as it offers an opportunity to all users to participate in the development of the resources to meet their own requirements. Open source software offers one approach to addressing the technical problems in providing optimal delivery of online learning.

Camichael and Honour (2002) propose the use of open source software to create on-line communities through which, for example, curriculum materials and teaching and learning methods, especially those concerned with the subject specific applications of ICT, could be created, tested, discussed and revised. Kruger (2012) argues that open source software allows schools to customize materials for educational changes that are relevant to their needs.

2.2.4 Mobile learning

Mobile learning is another trend that is also revolutionizing education. UNESCO believes that mobile technologies can expand and enrich educational opportunities for learners in diverse settings (UNESCO, 2013). According to UNESCO there is a growing body of evidence suggesting that ubiquitous mobile devices especially mobile phones and, more recently, tablet computers – are being used by learners and educators around the world to access information, streamline administration and facilitate learning in new and innovative ways. The use of mobile devices for communication and information access through ICT applications has increased exponentially in the last decade (Laudon and Laudon, 2010). Specifically, the rate of use of mobile technologies in Africa's developing countries is among the highest in the world and there may be almost 300 million mobile users in Africa (Sutherland, 2010). From an economic perspective, mobile learning reduces costs of infrastructure since it does not require the facilities and physical materials that traditional classroom learning requires. It has been highly

recognized as a strategic tool that has the potential to enable global access to educational materials and improve the quality of education.

2.2.5 Social networking in education

Social networking is another versatile trend that is also revolutionizing education. This is an online service for communities of people who share an interest with one another to collaborate (Kruger, 2012). While most social network services are web based, providing a variety of options for users to interact, most service focus on building online communities of people who share similar interests and activities (Koehler and Mishra, 2006). Popular Social Networks are Face book, Friendster, LinkedIn, MySpace and Ning. According to Kruger (2012), students spend almost as much time using social networking services and Web sites as they spend watching TV. Social Networks in Education, provide a casual place of learning, encourage students to express their own thoughts, provide effective collaboration and communication, enhance students' learning experiences, and build an online learning community.

In addition educational social networking sites allow students to find and share educational resources, allows one to create study groups, to communicate with classmates about course-related topics, encourages learner-centered activities, provides collaborative learning opportunities and gives one a sense of belonging (UNESCO, 2005). As these technologies become more widespread, the

boundaries of social networking continue to expand. While social networking is not a new phenomenon, it is something that is slowly and newly starting to be embraced in education. Social networking is a vehicle that has the potential to open up information to more people than has ever been possible at any point throughout human history (Kruger, 2012).

2.2.6 Blogs in education

Blogs are becoming increasingly popular with teachers and teacher education (Anderson, 1997). Many experts predict that blogs will eventually become more successful teaching tools than web sites. Anderson defines a blog as a web page made up of usually short, frequently updated posts that are arranged chronologically-like a “what’s new” page of a journal. The contents and the purposes of blogs vary greatly, from links and commentary about other web sites to news about ideas, project updates or even fiction.

According to Mojgan et al (2009), the use of blogs in instructional settings is limited only by one’s imagination. Teachers can therefore use blogs in many diverse ways to include content-related blog, networking and personal knowledge sharing, instructional tips for learners, course announcements and readings and annotated links. More importantly, blogs can be used for knowledge management. Learners can also take part in blogs by reflective writing, assignment submission, collaborative work, e-portfolios and sharing course-related resources. For

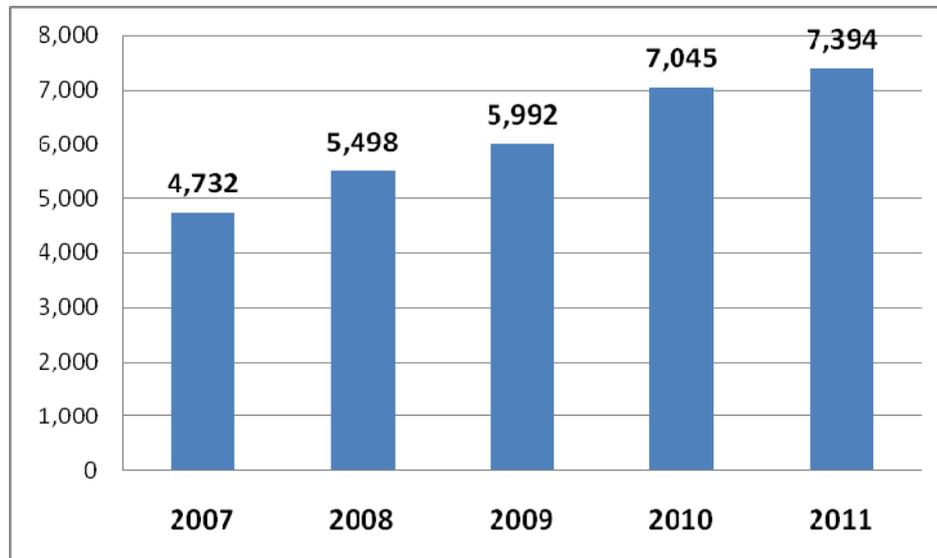
teachers, blogs are attractive because it needs little effort to maintain, unlike more elaborate classroom web sites. Teachers can build a blog or start a new topic in an existing blog by simply typing text into a box and clicking a button. Such ease of use is the primary reason to predict that blogs are more successful teaching tools than web sites (Mojgan et al, 2009).

It is clear from the trends of ICT use in education that educational systems have to evolve and adopt ICTs in pedagogical practice in order to for the systems to be relevant and to offer quality learning experiences. In this study there was need to find out what ICTs are in schools and how they are being used. This was particularly important because as the trends show, it is necessary to gauge where institutions are in order not to be digitally disadvantaged or left behind.

2.3 Computer studies in secondary schools in Kenya

In Kenya, computer studies are offered as an elective subject in secondary schools. It was examined for the first time in the Kenya Certificate of Secondary School Education (KCSE) in 2006 and the trend of candidature in computer studies in KCSE from 2007 to 2011 is reflected in figure 2.1.

Figure 2.1 Number of candidates sitting computer studies in KCSE, 2007-2011



Source: KNEC, 2011

It is clear from the table of statistics on students who sat for computer studies in KCSE over the five year period indicated that more and more students have been selecting computer studies as an optional subject in schools. This may partly be explained by the increasing relevance of the subject in the information age where computing and information literacy are gaining even more recognition. Some of the objectives of computer studies as a subject in secondary schools are: to enable learners to develop skills among them for use of application packages; acquire basic knowledge, skills and attitudes necessary for adapting to a fast changing technological world; and to appreciate the impact of computer technology on society.

2.4 Levels of ICT integration

It is understood that practicing teachers develop a teaching style that blends with their own philosophy of teaching and learning into the general philosophy of the school in which they teach, also taking into consideration the characteristics of their students (UNESCO, 2005). According to UNESCO, effective teachers realize that teaching is a work-in-progress and that one never quite knows everything. Teachers, therefore, draw upon a wide range of instructional strategies, including content knowledge, pedagogical understanding and, in the case of ICT, specific technical skills. According to UNESCO (2002), considerable research has documented the various stages in integrating ICT into the school and in learning about ICT, as well as the principles for effective use of ICT in teacher education. According to UNESCO (2002), the four stages are the emerging, applying, infusing and transforming phases. Emerging means that administrators and teachers are beginning to explore the potential of ICT. Applying means that teachers may be using computers for word processing, databases and to explore subject-specific software. Infusing means that a variety of ICT tools are being used and ICT is becoming integrated into the curriculum. Transforming involves a major reconstruction of the classroom into one that is learning-centred and where ICT is used to explore a variety of real-world problems. A transformed classroom is an inquiry oriented learning environment.

Kotrlik and Redmann (2002) proposed a four phase technology integration model. The first phase in the model is exploration. Teachers at this level, begin to think about using technology. Teachers seek to learn about technology and how to use it. In the second phase, experimentation, there is an attempt to begin to use technology. Physical changes start to occur in classrooms and laboratories. Teachers also focus more on using technology in instruction by presenting information using presentation software and doing a few instructional exercises using spreadsheets, databases, word processors, games, simulations, the Internet, and/or other technology tools. At the third phase, also known as the Adoption phase, technology is used more regularly. Also, physical changes are very evident in the classroom and/or laboratory with technology becoming a focal point in the classroom and/ or laboratory organization.

Teachers employ presentation software and technology-based instructional exercises using games, simulations, spreadsheets, databases, word processors, the Internet or other technology tools as a regular and normal feature of instructional activities. Student-shared responsibility for learning emerges as a major instructional theme. At the fourth phase of the Kotrlik and Redmann (2002) model, advanced integration, technology is used innovatively. Teachers at this level pursue innovative ways to use technology to improve learning. Students take on new challenges beyond traditional assignments and activities. Learners use technology to collaborate with others from various disciplines to gather and

analyze information for student learning projects. The integration of technology into the teaching/learning process leads to a higher level of learning.

According to Sandholtz et al., (1997), technology integration may be at five stages: entry, adoption, adaptation, appropriation, and invention. According to Sandholtz et al., each stage has its own patterns of change and support requirements. At the entry phase, teachers use primarily text-based materials. Instruction is traditional, with teacher-directed activities. Some common instructional technologies include blackboards, textbooks, workbooks, and overhead projectors. According to Sandholtz et al., the support needed for educators at the entry phase includes providing time for planning with peers and opportunities for staff to share experiences with non-participant colleagues.

In the adoption phase, teachers are said to begin to show more concern about how technology can be integrated into daily lesson plans. Traditional whole-group lecture still dominate instructional strategies. Nevertheless, technology is now being used to teach children how to use technology. Common activities include keyboarding, word-processing, or drill and practice activities. Technical support and training for computer-assisted-instruction and word-processing software are necessary at this stage (Sandholtz et al., 1997).

At the next phase of, integration of new technologies into traditional classroom practice occurs. At the next phase, adaptation to and integration of new technologies into traditional classroom practice occur. Lecture, seat work, and recitation continue to dominate classroom practice; however, during 30% to 40% of the school day, students use word processors, databases, some graphic programmes, and computer-assisted-instruction packages (Sandholtz et al., 1997). Productivity is a major theme. Teachers have learned to use computers to save time rather than create additional demands. According to Sandholtz et al., 1997, there are four support issues required at this stage. First, encourage peer observation and team teaching, and develop a flexible schedule that permits these activities. Second, introduce and discuss alternative pedagogies. Third, because productivity is important at this stage, train staff to use such software tools as spreadsheets, databases, graphics, hypermedia, and e-mail. Fourth, introduce videodiscs and scanners.

Sandholtz et al., (1997) describe appropriation as more of a milestone than a phase. Personal appropriation of the technology tools by individual students and teachers is the catalyst to this change in technology use. Teachers' personal attitudes toward technology become the benchmark for this milestone in instructional evolution. Teachers understand technology's usefulness, and they apply it effortlessly as a tool to accomplish real work. More interactions between students are observed, and students work with ICT frequently. There is evidence

of project based instruction, collaboration and cooperation, and creative schedules. At this milestone, encourage routine peer observations and group discussions. Discuss alternative assessments. Encourage professional growth through conferences and presentations. Finally, examine technology integration goals.

The highest level is the invention phase. At this phase, teachers experiment with new instructional patterns and ways of relating to students and other teachers. They reflect on teaching and question old patterns of instruction. Teachers begin to see knowledge as something that learners must construct rather than something to be transferred. Interdisciplinary project-based instruction, team teaching, and individually paced instruction are hallmarks of this phase. Classroom interactions change. Student experts surface to assist their peers and teachers with technology. Students work together in more collaborative ways.

In this study, the intention was to establish the level and manner of ICT integration and therefore, the UNESCO model and the Sandholtz et al. (1997) technology integration matrix were found suitable and comprehensive in determining the level of ICT integration.

2.5 Policy considerations in pedagogical – ICT integration

Policies provide a unified, authoritative source of guidance and information that can be used when making decisions. With suitable guidelines, the chances of relying on instinct for critical decisions are reduced because processes are then guided more decisively, accurately and consistently through policies (OECD, 2001). UNESCO (2007) and Farrell (2007) identify policy as necessary precondition for effective pedagogical ICT integration. They argue that policy factors can foster or hamper the implementation of pedagogical ICT initiatives.

Hinostroza and Mario (2009) argue that policies at the macro, meso and micro levels of education significantly influence the integration of ICT in teaching. To them, Macro variables relate to the education system, for example the national curriculum, meso variables relate to school-related factors such as ICT infrastructure and technical support while the micro variables are associated to what happens in the classrooms involving teachers and students, such as the pedagogical practices. Kozma (2003) makes a distinction between 'strategic' and 'operational' policies in ICT integration in education which he also argues as being pertinent in realizing the benefits of ICT integration in education.

It has been noted by Kozma (2003) that national ICT policies can serve several important functions. Firstly, ICT policies provide a rationale, a set of goals, and a vision of how education systems work if ICT is introduced into teaching and

learning, and they can benefit students, teachers, parents and the general population of a given country. Secondly, ICT policies are expected to provide guidance, and failure to do so means that individual school and classroom innovations would be unlikely to be sustained. Additionally, individual efforts are less likely to be felt across the country unless there is a shared vision clearly laid out in the policy.

From Kozma's perspective, strategic policies are set to define the goals, bases and rationale regarding the potential of education systems to innovate through the use of ICT and how the teachers can benefit from their use in schools. Strategic policies coordinate divergent efforts to deliver on objectives established at a higher level such as at the national level. According to Kozma, operational policies on the other hand put into practice the principles set by strategic policies. Operational policies establish and implement different plans, projects and programmes which organize and manage human and material resources in order to integrate teaching and learning with ICT activities. Without a well-grounded strategy to guide the integration of ICT in the classroom, Kozma cautions, that ICT can only take an operational role. Such a policy, he argues, adopts a techno-centric character which only ensures the provision of equipment and fostering of teacher training based on ICT tools while neglecting the appropriate pedagogical focus to promote educational innovation and in-depth school reform. Strategic policies can provide a rationale, a set of goals, and a vision for how education

systems might be with the introduction of ICT (Kozma, 2003). Farrell and Shafika (2007) argue that the main constraining aspect in most policies is the predominant focus in pedagogical practice. Secondly, Farrell and Shafika argue that some policies lack detailed implementation plans with priorities, timetables and measurable indicators.

Guttman (2003) and Haddad (2007) point out the importance of establishing a clear vision for ICT integration in the planning phase of technology use in teaching and learning. They recommend that educators would do well to begin by determining the educational purposes of technologies are introducing them in the classroom. This therefore means that educators need to be clearly guided by education policy, as this would provide a clear rationale and road map for technology integration.

All of the key components of ICT integration in education need to be integrated into a coherent plan with clearly specified targets, timelines, and costs. Moreover, the plan should first be implemented in pilot mode before rolling out full scale, in order to determine whether the various elements are effective or not. Conducive policy and careful planning for integration of ICT into education can harness the emerging role of ICTs in enhancing the process and outcome of School Education (UNESCO 2007).

At the meso and micro levels in schools, policies are documents that provide guidelines for action, and highlight the interventions that a school wants to take. According to UNESCO (2005), all schools should have an ICT plan in place and that it is the responsibility of the school principal to engage all teachers in preparing it. Anderson feels that by involving the teachers, the plan is not solely about having more ICT resources.

As more and more schools and educators are becoming convinced of the potential of Information and Communication Technologies for teaching and learning, schools should determine their plans for the inclusion of ICTs in the curriculum, as best suits their particular circumstances. According to UNESCO (2007), teachers, parents and management, should all be involved in the creation of the school ICT policy. Schools need to decide if / why ICTs are required in their particular school and to identify how they can impact on learners and educators. A proper plan should be put in place regarding computer maintenance. This is because computer breakdown may take time to be sorted out. According to UNESCO, targets also need to be agreed upon collaboratively and set for staff development so that staff will be able to use ICT skills in a range of instructional activities. There is also need to support staff to build and expand their knowledge of ICT use to enhance learner progress (UNESCO, 2007). Cuban (1986) examined the history of attempts to use technology to promote reform of schools and he concluded that most of these attempts failed to adequately address the real

needs of teachers in classrooms. He argued that most these efforts too often attempted to impose a technologist's or policymaker's vision of the appropriate use of the technology in schools and that teachers were provided inadequate assistance in using the technology, and the technology itself was often unreliable. As a consequence, the technology was not used by teachers or became very marginal to the schools' instructional activities.

2.6 Factors promoting the adoption and use of ICT in education

Despite the slow uptake of ICT in schools, there are various success stories which have been recorded through research on successful pedagogical technology integration in different settings around the world (Mumtaz, 2000). Kent (2010) carried out a study on the factors affecting teachers' use of ICT in an Irish secondary school. The study explored factors that affect secondary teachers' use of ICT in the teaching and learning environment. A case study approach was used in which case a questionnaire was issued to all teachers (n=70). A random sample of seven teachers was also interviewed on their ICT practices and attitudes towards using ICT. School management was also interviewed to ascertain their views on ICT use within the case study school. The results recorded revealed that there was a high level of ICT use in the case study school. The factors that were found to affect ICT use in the case study school were: positive attitudes towards using ICT, level of ICT training and support, time, presence of ICT policy, access and availability of ICT hardware and software and the teaching group.

Several studies (Becker, 1994; Sheingold and Hadley, 1990) used survey data to identify factors likely to be evident in teachers who to some extent have integrated computers into their teaching practices. Sheingold and Hadley (1990) conducted a nationwide survey of fourth to twelfth grade teachers in the USA. The three major factors involved in these ‘accomplished’ teachers’ success were: teacher motivation and commitment to their students’ learning and to their own development as teachers; the support they experienced in their schools; and access to sufficient quantities of technology. In addition, these teachers worked in schools where hardware and access to resources were twice the average, were comfortable with technology and used computers for many purposes. They perceived that their teaching practices became more student-centred with the integration of technology in their curriculum and they held higher expectations of their students. Sheingold and Hadley’s (1990) study also identified that the source of motivation for teachers to use technology included gains in learning and using computers for their own development as teachers. They foresaw wider success among teachers if ample technology, support, and time for teachers to learn the technology are provided, and if an academic and cultural structure exists to encourage teachers to take an experimental approach to their work.

Jones (2004), identified at the school level, important contextual factors such as socio-cultural setting of a school and structural characteristics like government ICT policy, ICT infrastructure and school type as important factors for ICT

integration. At teacher level, two types of barriers are common; external or first-order barriers, such as limited resources or lack of technical support, and internal or second-order barriers, which include teachers' attitudes to ICT.

Mumtaz (2000) points out that a lack of computers and software can seriously limit what teachers can do in the classroom with regards to integration of ICT. Mumtaz pointed out that access to ICT is a first and necessary step in the integration process even though mere access does not automatically lead to use of ICT for teaching and learning.

The International Society for Technology in Education (2009) developed 14 essential conditions that it deemed important to effectively leverage technology for learning. It is important in this study to interrogate whether in schools, these essential conditions are available. The conditions are:

- Shared vision - Proactive leadership in developing a shared vision for educational technology among all education stakeholders, including teachers and support staff, school and district administrators, teacher educators, students, parents, and the community
- Empowered leaders - Stakeholders at every level empowered to be leaders in effecting change
- Implementation planning - A systemic plan aligned with a shared vision for school effectiveness and student learning through the infusion of

information and communication technology (ICT) and digital learning resources

- Consistent and adequate funding - Ongoing funding to support technology infrastructure, personnel, digital resources, and staff development
- Equitable access - Robust and reliable access to current and emerging technologies and digital resources, with connectivity for all students, teachers, staff, and school leaders
- Skilled personnel - Educators, support staff, and other leaders skilled in the selection and effective use of appropriate ICT resources
- Ongoing professional learning - Technology-related professional learning plans and opportunities with dedicated time to practice and share ideas
- Technical support - Consistent and reliable assistance for maintaining, renewing, and using ICT and digital learning resources
- Curriculum framework - Content standards and related digital curriculum resources that are aligned with and support digital age learning and work
- Student-centered learning - Planning, teaching, and assessment centered around the needs and abilities of students
- Assessment and evaluation - Continuous assessment of teaching, learning, and leadership, and evaluation of the use of ICT and digital resources
- Engaged communities - Partnerships and collaboration within communities to support and fund the use of ICT and digital learning resources

- Support policies - Policies, financial plans, accountability measures, and incentive structures to support the use of ICT and other digital resources for learning and in district school operations
- Supportive external context - Policies and initiatives at the national, regional, and local levels to support schools and teacher preparation programmes in the effective implementation of technology for achieving curriculum and learning technology (ICT) standards

2.7 Benefits of ICT use in education

It is generally agreed that ICT is a crucial resource in education. Where a country has high levels of ICT skills and expertise, society will be better placed to combat social exclusion and the information divide, as well as to identify opportunities for economic growth (Hawkrige et al., 1990). Hawkrige also argue that from the individual standpoint, access to certain forms of ICTs may increase the choices available to individuals. With increased access to information, individuals are able to make more informed decisions.

UNESCO (2007) points out that ICTs are an important component for all in today's information society. In the area of education, UNESCO argues that ICT can be used to: improve administrative efficiency, disseminate teaching and learning materials and improve the ICT skills of teachers and students and allow them to access to sources of information from around the world. Roblyer and

Edwards (2000) suggested five important reasons for teachers to use technology in education: (1) motivation, (2) distinctive instructional abilities, (3) higher productivity of teachers, (4) essential skills for the Information Age, and (5) support for new teaching techniques. Similarly, Plowman et al., (2006) note that encounters with ICT accompanied by guided interaction can enhance three key areas of learning: dispositions to learn, knowledge of the world and operational skills. They also believe that ICT can help to develop learners' dispositions to learn by increasing self esteem and confidence, or by supporting independence and persistence in the face of initial difficulties.

Glennan and Melmed (1996) presented some meta-analysis evaluation conducted by James Kulik and Dexter Fletcher on the effectiveness of computer technology on teaching and learning. On his part, Kulik had three major findings. First, that students usually learn more in classes in which they receive computer-based instruction. Secondly, they found out that students learn their lessons in less time with computer-based instruction. Thirdly, he noted that students prefer classes where they receive computer support. Dexter on the other hand found out that through repeated analyses, on average, technology reduces by about 30% the time required to reach criterion levels of knowledge and performance. These estimates are similar to those reported by Kulik for reduced instructional time.

Advocates of technology use for classroom instruction argue that computers and the internet offer more than just faster access to more information. They believe that ICTs provide an opportunity to fundamentally change the processes of learning by particularly allowing teachers to create more constructivist learning environments (Orlando, 2011). Constructivist practices have been predicted as the most suitable for use of ICTs, and it has been widely assumed that the introduction of ICT will be accompanied, more or less automatically, by the adoption of this approach to teaching (Khirwadkar, 2007). Constructivist practices entail student-centred learning. In the practice, there is more of teacher-student and student-student collaboration and co-construction of knowledge, in contrast to teacher-centred practice which involves explicit instruction, knowledge transmission, linear knowledge development, and more directly observable learning outcomes. Constructivist teaching fosters critical thinking which is a 21st century skill (Orlando, 2011). According to Chapman and Lars (2004), the use of ICT resources in the classroom gives learners access to information resources in ways that allow them to search for relevant data, synthesize that information, and draw their own conclusions.

2.8 Teachers' attitudes and self-efficacy of computers

At the core of effective integration of ICT in teaching and learning, lie capacities which go beyond mere access and ICT literacy (Ertmer et al., 2004). According to them, there is little point in providing large quantities of equipment if teachers do

not have the attitudes necessary to change their classroom practices. It is thus clear that for technology to be effectively integrated in the curriculum, teachers' attitudes toward technology should be positive. Recent studies indicate that teachers' attitudes toward computers have significant implications for their behaviour in the use of computers for teaching (Naser et al. 2010; Huang and Liaw, 2005).

Drent and Meelissen (2008) conducted a study about factors which promote or limit the innovative use of ICT by teacher educators in the Netherlands. The study used questionnaires for 210 teachers. Their findings showed that several factors such as a student-oriented pedagogical approach, a positive ICT attitude, computer experience, and personal entrepreneurship of the teacher educator have a direct positive influence on the innovative use of ICT by the teacher. Also, comparison between these factors in predicting computer use identified that attitude toward computers contributed more in explaining ICT use by teachers. Harrison and Rainer (1992) found that participants with negative computer attitudes were less skilled in computer use and were therefore less likely to accept and adopt technology than those with positive attitudes.

Apart from attitudes, self-efficacy has been found to influence choice of whether to engage in a task, the effort expended in performing it, and the persistence shown in accomplishing it (Compeau and Higgins, 1995). The greater people

perceived their self-efficacy to be, the more active and longer they persist in their effort (Murphy et al., 1989). Murphy et al., argue that self-efficacy may be an important factor related to the acquisition of computing skills. Computer self-efficacy is a specific type of self-efficacy. Self-efficacy is defined as belief in one's ability to "mobilize the motivation, cognitive resources, and courses of action needed to meet given situational demands. Thus, computer self-efficacy is a belief of one's capability to use the computer (Compeau and Higgins, 1995) and participants with little confidence in their ability to use computers might perform more poorly on computer-based tasks. On the other hand, previous computer experience may lead users to believe computer applications are manageable.

First, the magnitude of computer self-efficacy refers to the levels of support needed. Users who possess high magnitude believe that they can accomplish tasks with less support. Second, the strength of computer self-efficacy is the confidence in beliefs of their capabilities in using computers. Lastly, the generalizability refers to the levels of beliefs in using computers in various platforms such as various software and operating systems (Compeau and Higgins, 1995)

A number of survey instruments have been developed to assess computer self-efficacy. For example, Kinzie et al., 1994 developed a survey which had 46 items to measure computer self-efficacy of various types of computer applications. Murphy, et al., (1989) developed a survey which had 32 items to evaluate three

subscales, namely, beginning, advanced, and mainframe computer tasks. Their studies showed that users who have greater computer self-efficacy tend to have higher beliefs in perceived ease of use of computers, less computer anxiety, greater beliefs in perceived usefulness, and more computer use.

Moreover, various studies point out factors that affect levels of computer use such as computer experience, age, computer usage, computer anxiety, computer attitudes, and gender (e.g., Torkzadeh and Koufterous, 1994; Murphy et al., 1989). As computer technologies become a crucial part of academic systems, computer attitudes and computer self-efficacy still need researcher studies to keep investigating these issues.

2.9 Teacher professional development for pedagogical ICT integration

The recent curriculum framework of the secondary school education system in Kenya emphasizes connecting knowledge to life, shifting from rote learning to constructing knowledge, providing a wide range of experiences for the overall development of the learner and introducing flexibility in the examinations (GOK, 2005). Pedagogical ICT integration holds great potential in meeting the demands of such a curriculum framework. As ICT continues to be an integral element for educational reforms and innovations at secondary schools, this situation calls for an enhancement of teachers' skills for pedagogical ICT integration. Recognizing that schools can be no better than the teachers who work within them, teacher

professional development is therefore a key component in almost every improvement plan for education and constitutes a main component of educational reform programmes. Educating teachers on how to effectively integrate ICT in classroom practices for the purpose of improving education and reforming curricula has been one of the main goals of national and international school reform efforts in various countries (Kozma and Anderson, 2002; Pelgrum and Law, 2003).

Professional development of teachers for successful and effective integration of ICT in classroom practices is undoubtedly complex. A number of studies have shown that a variety of approaches have been adopted over the years to prepare and support teachers in integrating ICT in classroom practices, although the results have not always been positive. For example, Rodrigues (2003) states that teacher professional development with respect to ICT and science has not promoted any real change in classroom teaching.

Also, according to Majumdar (2005), many teachers, who received ICT training as part of their professional development, still lacked the confidence needed to integrate ICT in teaching and learning. A review of the literature also indicates that for the most part, ICT professional development has focused on learning about ICT. The main focus of learning about ICT has been on skills regarding the use of various computer applications, such as word processing, spreadsheets,

email, Internet and graphics. The failure of teacher professional development programmes therefore to adequately prepare teachers to integrate ICT in teaching and learning could be attributed to various factors. According to Margerum-Rays and Marx (2003), one major contributing factor is the lack of a conceptual framework to systematically guide the integration of ICT into teachers' pedagogy.

According to Zhiting and Hanbing (2006), teacher education programmes in China and other parts of the world mainly train teachers in two clusters of technology courses. The first cluster falls into what he calls ICT basics, including modules such as computer basics, programming, software tools, and network applications; the second cluster is related to educational technology, including modules such as instructional media, computer-based instruction, and multimedia authoring. Zhiting and Hanbing (2006) noted that, a number of problems have been found with such an approach for training teachers to use technology because:

- (i) The ICT basics courses only focus on technical issues and have nothing to do with pedagogical uses of technology;
- (ii) The courses of educational technology are taught in rather traditional ways and show few evidences of using new technology to support instructional innovations; and
- (iii) Teachers fail to use new technology in their classroom instruction when they begin practicing because they lack previous practices of applying ICT into curriculum.

To address these problems with training teachers to use technology, Zhiting and Hanbing (2006) indicated that, the teacher education programmes worldwide traditionally consists of four main parts:

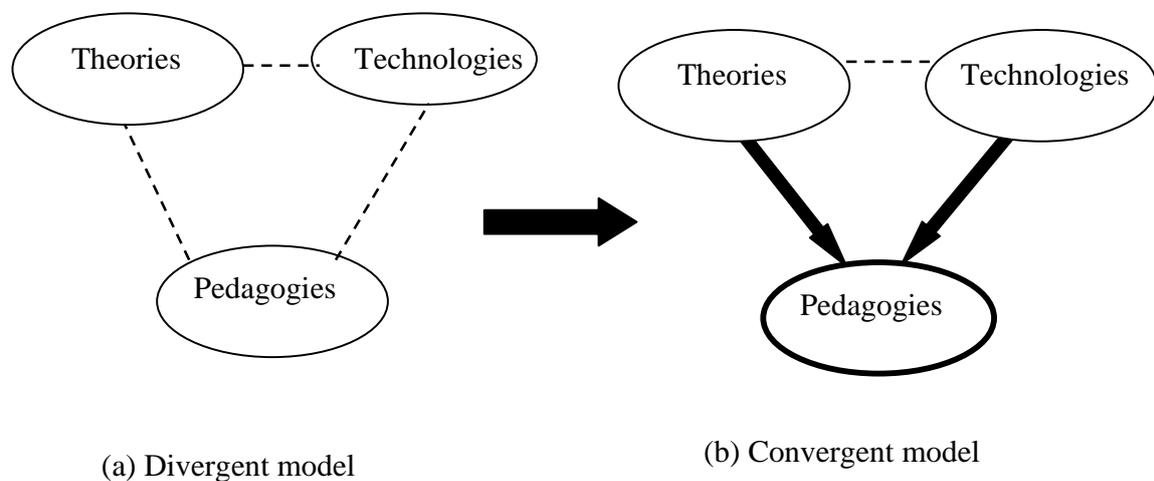
- (i) Basic courses, which set up a common foundation for all students;
- (ii) Specialist courses, which build up respective knowledge bases for students of different specialties;
- (iii) Educational courses, which contribute to acquisition of educational theories for prospective teachers and;
- (iv) Educational practice or internship, which usually takes place in the last year of study when the students go on probation in schools for some months.

According to Zhiting and Hanbing (2006) this type of structure for teacher education programme diverge theories, technology and pedagogical practices (Divergent model) in other words; theories of education, technology and pedagogy are treated in isolation. To remedy this problem, they proposed a convergent model for training teachers in technology (Figure 2.2).

The convergent model recommends that theories of educational practices and technology courses must be focused on pedagogy. This can be achieved by training teachers in the methods of using ICT in education through hands-on practices associated with the study of modern pedagogical theories and allowing

them to do authentic ICT pedagogical integration practices in microteaching (Zhiting and Hanbing, 2006).

Figure 2.2: Model of technology integration in teacher education



Source: Zhiting and Hanbing (2006)

Khirwadkar (2007) categorized the approach that has been adopted to train teachers for pedagogical use of ICT as;

(a) *ICT skills development approach:*

Here importance is given to providing training in use of ICT in general. Student teachers are expected to be skilled users of ICT for their daily activities. Knowledge about various software, hardware and their use in educational process is emphasized.

(b) *ICT pedagogy approach:*

Emphasis is on integrating ICT skills in a respective subject. Drawing on the principles of constructivism, pre-service teachers design lessons and activities that center on the use of ICT tools that will foster the attainment of learning outcomes. This approach is useful to the extent that the skills enhance ICT literacy skills and the underlying pedagogy allows students to further develop and maintain these skills in the context of designing classroom-based resources

(c) *Subject-specific approach:*

Here ICT is embedded into one's own subject area. By this method, teachers/subject experts are not only exposing students to new and innovative ways of learning but are providing them with a practical understanding of what learning and teaching with ICT looks and feels like. In this way, ICT is not an 'add on' but an integral tool that is accessed by teachers and learners across the curricula.

(d) *Practice driven approach:*

Here emphasis is on providing exposure to the use of ICT in practical aspects of teacher training. Focus in on developing lessons and assignments. Using ICT and implementing it in their work experience at various levels provides students an opportunity to assess the facilities available at their school and effectively use their own skills.

Khirwadkar further indicated that in majority of teacher education institutions in India, the syllabi exhibit less weight to practical than theoretical aspects in technology training.

From the broad categorizations of the approach in training teachers for ICT integration indicated by the studies above (i.e. Zhiting and Hanbing, 2006; Khirwadkar, 2007), the training of teachers in Kenya with specific reference to technology can be easily understood. It is obvious from these studies that there are general approaches to training teachers in ICT integration common to teacher education programmes, regardless of the subject area.

However, one obvious critical problem in various technology courses is that they have not adequately prepared future teachers to understand how to integrate pedagogical and technological knowledge (Koehler and Mishra, 2006). Research works (Angeli and Valannides, 2009; PanAfrican Research Agenda on the Pedagogical Integration of ICTs, 2011) in the field of educational technology have also shown that in spite of the many efforts that researchers and educators put over the years in preparing teachers in the educational uses of technology, teachers still lack the skills and knowledge needed to be able to teach with technology successfully. Koehler and Mishra argued that, most teacher training programmes have failed to train prospective teachers effectively in the pedagogical use of technology due to the following reasons;

- *The rapid rate of technology change*

Training teachers to use specific software packages not only makes their knowledge too specific to be applied broadly, but it also becomes quickly outdated. Technology is changing so fast that any method that attempts to keep teachers up to date on the latest software, hardware, and terminology is doomed to create knowledge that is out of date every couple of years.

- *Inappropriate design of software*

Most software tools are rarely created as solutions to pedagogical problems (Margerum and Marx, 2003). The software tools available today are designed for the world of business and work, not education. Usually, they are created as potential solutions to problems in the world of business as anticipated by programmers and other developers. Converting these general tools for classroom teaching is not easy. It requires the teacher to engage with the affordances and constraints of particular technologies in order to creatively repurpose these technologies to meet specific pedagogical goals of specific content areas. An emphasis on merely learning the technology may lead to an emphasis on students learning technology as the subject and content of learning rather than the subject matter that they are supposed to learn.

- *The situated nature of learning*

The general approaches to technology courses at the teacher training institutions encourage nonspecific solutions to the problem of teaching.

However, technology use in the classroom is context bound and is, or at least needs to be, dependent on subject matter, students' level, student background, and the kinds of computers and software programmes available.

- *An emphasis on what, not how*

Standard checklists of technological skills are very efficient means of listing what teachers need to know, but offer little suggestion on how teachers are to achieve these skills. This often leads to the development of technological learning situations that adhere to the letter of the standards but go against the spirit of true technology integration. Teachers have often been asked to learn to apply these skills in their own classrooms by themselves usually through trial and error.

However, Koehler and Mishra suggested that to solve these problems, prospective teachers should be given the opportunity to experience real educational problems to be solved by technology during their training and that also there should be continuous in-service training for teachers in technology integration. Developing an appropriate range of pedagogical skills in using ICT is a process of long-term experiential learning, rather than short-term conceptual learning and this requires teacher education programmes with built-in key technology elements, in-service teacher training and on-going support for professional self-development, with

teachers taking greater responsibility in learning core competencies in technology-pedagogy integration (UNESCO, 2005).

2.10 Constraints and barriers to pedagogical ICT integration

An examination of literature on ICT integration reveals that ICT is not being used to its full potential in education. A number of researchers have cited various barriers that curtail the effective use of ICT to enhance the quality of teaching and learning. According to Mumtaz (2000), among these are insufficient or obsolete hardware and software, inadequate facilities and support services, lack of time and money, un- appropriate reward system, lack of information about good practice, and underestimation of the difficulty in adopting new information technologies. Means et al. (1994) argued that although so much has been done to increase the technological infrastructure in schools, institutions are “far short of providing a seamless, convenient, robust, and reliable technology support structure for all students and teachers. In Kenya, the Ministry of Education points out that the 1: 120 computer to student ratio is a major barrier to effective ICT integration.

Gilbert and Green (1997) identified no stability, mismatched rates of change, unrealistic expectations, faculty attitude, and mismatch of resources as part of the obstacles to full-scale academic integration of ICT. No stability is associated with unpredictable changes in the kinds of ICT applications for educational uses; a

mismatched rate of change is the difference between times taken for arrivals of new ICT applications. This was compared to new experiments in approaches to teaching and textbook publishing. Unrealistic expectations that technology is about to transform education happens every now and then with the support of the media. Teachers' attitude is central where they feel vulnerable, disempowered, and frustrated when confronted with new technologies that may not be easy to use or reliable. These include mismatches of resources that make students caught in a bind due to insufficient knowledge of student-owned technology resources and insufficient coordination among teachers and technology support personnel.

Carter (1998) found that the lack of computers in the classroom and lack of time to learn how to incorporate the computer into the curriculum as the two most common barriers faced by faculties. Carter also found that only large lecture halls and classrooms dedicated to specific purpose had computer equipment ready for use. All other classes have no computer facilities. Scheduling classes in computer labs were also difficult because of competing classes, and time conflicts with scheduling equipment and classrooms.

The findings of a study by Hirschbuhl and Faseyitan (1994) showed that the technical orientation of the teachers, their computer self-efficacy, belief in the usefulness of the computer, and general attitude toward computers are the significant predictors of adoption. The results showed no significant difference

between computer adopters and non-adopters in their personal attributes of age, gender, rank, length of service, and research commitment.

Carter (1998) argues that many teachers do not incorporate ICT into key aspects of their work because for them, digital technology requires too much time and effort, supplies too many distractions, and produces minimal value for the investment. Geoghehan as cited in Baldwin (1995) sees non-adoption as a matter of social and psychological factors that hinders the use of technology and believes it is not an aversion to technology itself that hinders adoption. It is considered the avoidance to risk a low tolerance for discontinuous change, and insufficient administrative support. The adoption of ICT-based innovation is a function of available resources, accepted value the person places on the innovation, and communication with other adopters.

Reiser and Salisbury (1995) identify a number of barriers to ICT integration. Firstly, they cite access to hardware and software as well as funding as one of the major constraints to technology integration. Secondly, they argue that time for planning; personal exploration, online access, and skill development are a limiting factor. Thirdly, technical and administrative support and resources hinder proper integration. Closely related to this is training and expertise which affects the users of technology in education.

Many others studies have pointed to the practical constraints operating within the working contexts in which teachers currently find themselves. Innovation and adaptation are costly in terms of time; developing effective pedagogy around ICT involves significant input in terms of planning, preparation and follow-up of lessons (Cox et al., 2003). Other contextual factors which can act as barriers include: lack of confidence, experience, training, access to reliable technology resources (Hennessy et al., 2005). Some writers distinguish between ‘school level’ and ‘teacher level’ barriers, with ‘teacher level’ factors such as pedagogical beliefs, technical skill and confidence viewed as particularly influential (Mumtaz, 2000). According to Haddad and Draxler (2002) experience shows that effectively integrating technology into learning systems is much more complicated. It involves a rigorous analysis of educational objectives and changes, a realistic understanding of the potential of technologies, a purposeful consideration of the pre- and co-requisites of effectiveness of ICTs for education, and the prospects of this process within the dynamics of educational change and reform. According to Haddad and Draxler, acquiring the technologies themselves, no matter how hard and expensive, may be the easiest and cheapest element in a series of elements that ultimately could make these technologies sustainable or beneficial.

2.11 Related studies on pedagogical ICT integration

Various studies have been undertaken across the globe whose content or methodology relate to this study. A sample of related studies is reviewed herein.

One such study is the survey of ICT use in education in Europe commissioned by the European Commission to benchmark access, use and attitudes to ICT in schools in 31 countries across Europe (European Commission, 2013). Based on over 190,000 responses from teachers, students and head teachers, the survey came up with a number of key findings. First, there were between three and seven students per computer on average in the European Union. Also about 2/3 of computers were located in computer labs. Secondly, most schools were connected at least at basic level as shown by the presence of websites, local area network and virtual learning environments. Despite the presence of various forms of ICT including laptops, tablets and notebooks, teachers still considered insufficient ICT as a major obstacle to ICT use and integration. Thirdly, no overall relationship was found between high levels of infrastructure provision and students' and teachers' use, confidence and attitudes.

In terms of pedagogical ICT integration, the study revealed that for some time now, teachers were familiar with ICT for teaching and learning but still used it first to prepare their teaching. Only a few use it and still to a limited extent to work with students during lessons. On average at the European Union schools, students reported undertaking ICT based activities between several times a month and never at all. Digital resources such as exercise software, online tests, data logging tools and computer simulations were rarely used during lessons. Interestingly, students ICT based activities related to learning at home were more

frequent compared to ICT activities at school. Such a finding underlines on the one hand the extent of informal or non-formal learning actually taking place out of school, and on the other hand students' interest in spontaneous self-directed learning.

With regard to school policies, support strategies and attitudes on average at the European Union level, 50% of the schools have formalized school policies that outline how to use ICT in general or specifically in subjects. The study found out that teachers and students had the highest frequency of ICT use in learning based activities in schools which combined policies about ICT integration, incentives to reward teachers using ICT as well as concrete support measures including professional development and presence of ICT coordinators.

The UNESCO Institute for Statistics (2009) undertook a survey of ICT use in education in Latin America and the Caribbean. The UIS aimed to assess e-readiness and preparedness of countries in the Caribbean and Latin America. The survey focused on ICT infrastructure, the availability of different forms of ICT assisted instruction in schools and teachers' preparedness to integrate ICT in education. The findings of the survey showed that Caribbean countries (particularly Anglophone) had higher integration levels of ICT assisted instruction, had essential ICT infrastructure including hardware, internet connectivity than most Latin American countries. The study also analyzed the

learner-to-computer ratio (LCR) in order to gain insight into the capacity to deliver computer aided instruction (CAI). The LCR ranged from 1:1 in Uruguay, where there were strong policies regarding the integration of ICT in education to 122:1 in the Dominican Republic. Although Cuba offered CAI in all schools, a LCR of 28:1 meant that each student actually had little time to benefit from it. Radio use in educational settings was also no longer much in evidence. Thus despite the potential benefits of radio-assisted instruction, there was little evidence that it was being used. This certainly reflects shifting priorities.

Strydom et al., (2005) carried out an evaluation research on the Intel Teach to the Future programme in South Africa. The Intel Teach project just like the Computer for Schools Kenya had been created with the intention to support teachers' integration of ICTs into the classroom and specifically into pedagogical practices. The study by Strydom et al., (2005) was drawn from a survey of 231 teachers. The survey instrument used was a standard questionnaire developed for the Intel® Teach to the Future project, adapted to reflect country-specific contexts, and administered annually in all countries implementing the Intel Teach to the Future programme. The survey was administered online, although some schools requested hard copies of surveys. Descriptive statistics and frequency counts generated through the Statistical Package for Social Sciences (SPSS) were used by the researchers to analyze data. Among other objectives, the study intended to establish the extent of access teachers have to ICT, and the role access plays in

relation to use; and the extent to which teachers and learners use ICT in learning. In terms of access to computers for teaching and learning, 93% of respondents in the study by Strydom et al indicated that they had computers for this purpose while seven percent of respondents indicated that they did not have computers. According to Strydom et al., (2005), this suggested that overall the participating schools were at the “Applying” stage, if not at the “Infusing stage” of the UNESCO model (UNESCO, 2002). A total of 79.1% of the sample reported having a computer laboratory at school, while 20.9% did not. In terms of learner access, this suggests the majority of participating schools are moving beyond the “Emerging” stage and that the teachers have the opportunity to operate within the “Applying” or even the “Infusing” stage as the schools are able to offer opportunities for learners to use ICT.

In terms of the extent to which technology-integrated lessons were being used, of the sample, 48.5% reported that they had learners use technology within their lessons more than once per month. A further 13.5% used ICTs in teaching and learning about once per month, while 9.2% used technology in their lessons less than once per month. In contrast 28.8% of the sample had yet to implement a technology-integrated lesson.

Wabuye (2003) investigated teachers’ and school administrators’ perceptions and experiences towards computer use in Kenyan classrooms. Results from in-depth interviews, participant observations and document analysis revealed that

both teachers and administrators viewed the use of computers in Kenyan classrooms as worthwhile; computer-using teachers were enthusiastic and spoke positively about computer use, whereas non-computer-users felt left behind technologically. Teachers reported feeling unprepared by teacher training colleges to use computers in the classrooms, and they expressed the need to provide both practicing and pre-service teachers with professional development opportunities in technology. The study suggests that teachers' and administrators' perceptions and experiences play a significant role in the use of computers in Kenyan classrooms and hence the need to provide pre-service and in-service training programmes to enable them to successfully teach using computers in the classrooms.

The National Council for Science and Technology (2010) undertook a baseline survey to assess the ICT capacities and competencies in Selected Kenyan secondary schools in 2007. The survey's aims were to: (1) describe the level of ICT use by students, teachers and administrators; (2) determine perceived competency and perception of ICTs; (3) describe the obstacles faced by teachers in ICT use, and (4) to identify teachers' training and support need. Its sampled localities and sample size were selected on a purposive method. It was based on qualitative as well as quantitative information. In this baseline survey both descriptive and explorative research designs were employed. Sample area of study was purposive selected from category of public national 18 secondary schools of

excellence where 810 respondents are students, drawn from each school across each stage cohort (form 1-3). It was considered that computer studies was an elective subject and that only one class was studying computers. A sample of 30 per cent of each class was selected from forms one, two and three. The survey showed that students in schools across Kenya shared computers at a ratio of 40 students for each computer. Teachers were also reported to be advancing skills in using ICT. NCST also discovered that teachers to a less extent use of ICT' in either daily and/or weekly teaching and instruction support – 35% in public and 6% in private schools. According to NCST, this revealed that though secondary school teachers acquired computer skills, they to a less extent made use of ICT for professional development and communication in the classroom.

2.12 Summary

From the reviewed literature, there is decisive evidence that technology use can lead to positive effects not only on student achievement but also on education as a whole. It is because of the widely acknowledged potential of ICTs to transform education at all levels that countries are investing heavily on ICT integration efforts that will potentially transform patterns and modes of learning and teaching. In Kenya, this investment is discernable through development of ICT in education policies, capital allocation towards ICT integration projects and training of teachers to support ICT in education initiatives. However, as these efforts are being undertaken, there are certain gaps that need to be addressed through

research. First, in analyzing the trends of ICT use in education, it is evidently clear that institutions need to keep up with the ICT infrastructure and resources in order to avoid creating a digital gap. One of the objectives of this study was to assess the ICTs available in schools in order to explain the status in secondary schools in Kenya and provide suitable guidelines in terms of equipping schools to ameliorate the challenge of widening digital divide. Secondly, the reviewed literature also points out the importance of both strategic and operational ICT integration policies. It was necessary thus to examine the nature of ICT integration in schools and see whether suitable institutional policies exist and also determine the processes through which such policies are formulated since the processes of development impact on teachers' ideologies and beliefs towards integration of technologies. Thirdly, despite the collaborative efforts enshrined in partnerships such as that of CFSK and public schools in Kenya, it was non-the-less critical to discover the barriers that impede not only such partnerships but also the realization of the objectives of ICT integration in schools. This was found important especially bearing in mind that CFSK as well as other organizations embark on ICT integration efforts with noble objectives and schools are also gradually investing significant amounts in procuring ICTs. It was also evident through the literature review that attitudes and self efficacy beliefs greatly determine pedagogical ICT use. It was therefore important to assess teachers' attitudes and self efficacy especially in schools that have ICTs. Significant though was professional development. Reviewed literature especially in Kenya did not

clearly point out the status of professional development of teachers in pedagogical ICT integration. Whereas a few efforts were noted in training teachers on ICT use in education, reviewed literature especially in Kenya did not seem to outline clear models that are used for professional teacher development. With regard to the professional teacher development structure, workshops, seminars, and conferences are considered the traditional form of activity types while reform types of a professional development programmes like the use of study groups, networking, mentoring, coaching, and regular school day meetings that may occur during the process of classroom instruction or planning time are lacking. But it was important to carry out a diagnostic analysis of the teacher professional development needs to determine teachers' needs which would then form a basis for creating a reform type of professional development model for pedagogical ICT integration suitable for use in Kenya.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The purpose of this study was to investigate the level and manner of ICT integration in secondary schools that collaborate with CFSK. According to Comber et al., (1998), it is important to identify the level of teachers' ICT integration because such important data allows for the introduction of necessary policies to enhance quality of teachers' ICT usage. They also argue that previous attempts to foster an 'educational revolution' through the introduction of computers largely failed because teachers were uncertain about how ICT could be integrated into the curriculum.

This chapter firstly explains the philosophical underpinnings of the research design. Secondly, the choice of the descriptive survey approach is discussed. Thirdly, particular attention is paid to how the participants were selected and how site visits were carried out. Fourthly, data collection procedures are laid out and these include how the research questions were related to the chosen methods. The construction and composition of the questionnaires that were used are described followed by an explanation on the use of interviews. Fifthly, the steps taken towards validating the instruments are discussed and the procedure of collecting data is explained in detail. Lastly, data analysis methods are explained before looking at the processes undertaken to verify the findings.

3.2 Research design

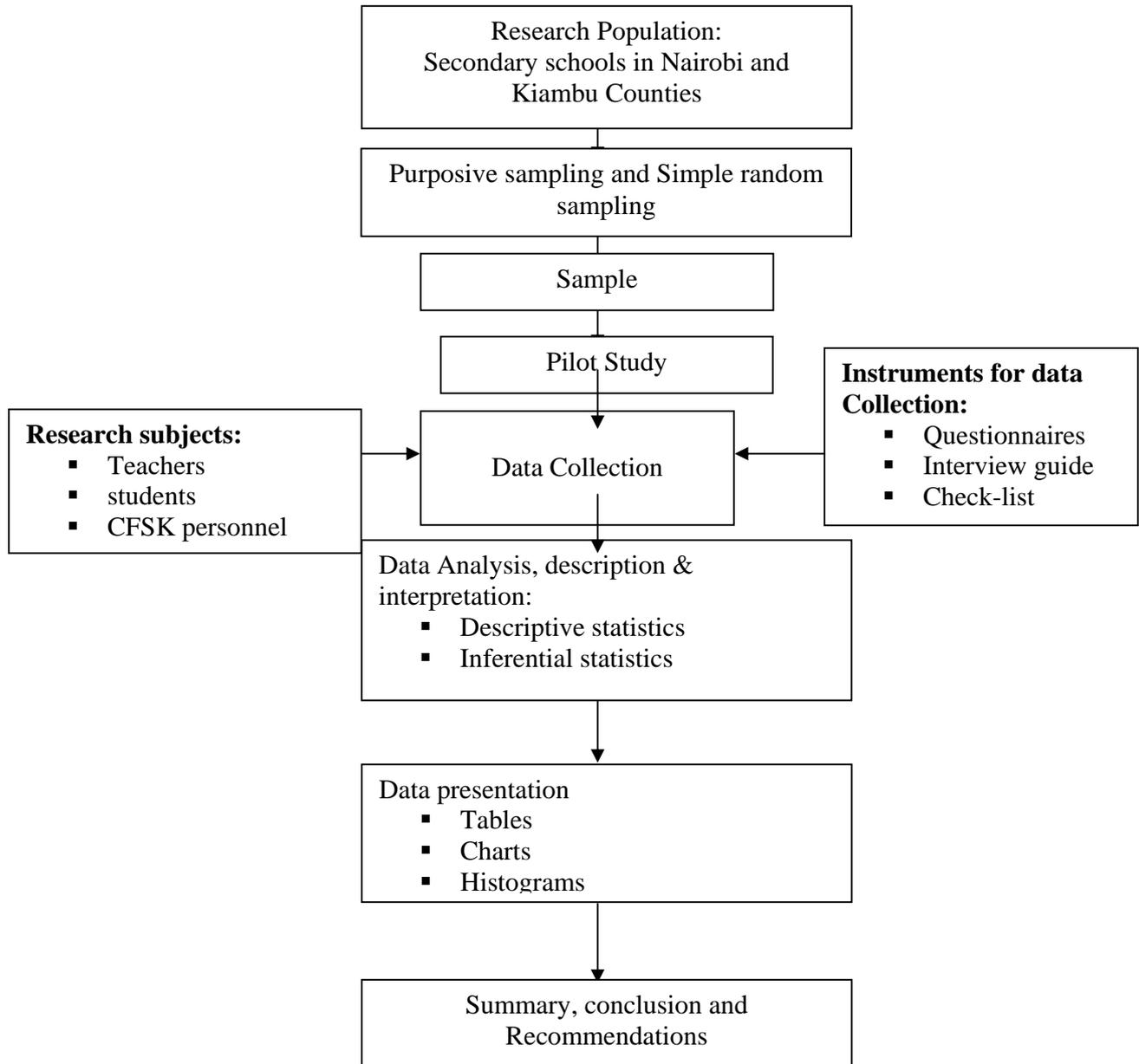
The chosen research design was guided by the goal of the study: Exploring the level and manner of ICT integration in selected secondary schools in Kenya. Descriptive survey design was adopted for this study. With the guidance of this research design, the relevant data on ICT integration was collected, analyzed and discussed and the status of ICT integration in selected secondary schools was conclusively reported. According to Anderson (1997), surveys are good for conducting research in sciences because they assist in describing the characteristics of groups of people. Since the practice of ICT integration in secondary education is still in its nascent stages in Kenya, descriptive survey design was found appropriate for describing the status of ICT integration in selected secondary schools in the country. Through a descriptive survey design, it was possible to gather facts about the state of affairs regarding the level, manner and challenges of ICT integration in secondary schools.

As opposed to an exploratory survey, whose variables are usually not well known, descriptive survey was found relevant for this study because the variables for investigation are known. Several studies have highlighted several variables as being important enablers of effective ICT integration in schools. These factors include: School variables, leadership, teacher factors, student related factors, infrastructure and policy guidelines (Rosnaini and Ismail 2008). This is elaborately discussed in the study's conceptual framework.

The study was also cross-sectional in nature. Cross-sectional studies entail the collection of data on more than one case at a single point in time in order to formulate a body of qualitative or quantitative data in connection with two or more variables which are examined to determine patterns of association or variation (Bryman, 2008).

Figure 3.1 is a diagrammatic representation of the descriptive survey design used in this study on the status of ICT integration in secondary schools. The diagram outlines the key steps and elements of the research process.

Figure 3.1 Descriptive research design used in the study



Source: Adopted from Bryman, 2008; pg 166

3.3 Operational definition of variables

In a descriptive study such as this one, there was need to define the variables by giving operational definitions clearly with indicators to measure knowledge, attitudes and practices (Cohen and Manion, 1998). According to Anderson (1997), no educational research whether practical or theoretical can be conducted without identifying, conceptually developing and operationally defining or describing in detail the research variables.

Much educational research consists of the conceptualization, description, or careful operational definition of educational variables. These descriptions enable educators to develop realistic depictions of persons, programmes, and contexts related to education and to analyze and understand more accurately what is happening in various educational settings (Anderson, 1997).

In this study, the main dependent variable was the integration of ICT in education. This was defined by indicators such as pedagogical ICT integration, ICT use for administrative functions, and ICT use for communication. Other than ICT integration, the other dependent variables were attitudes and self-efficacy towards ICT use. The independent variables in the study included availability and access to ICT facilities, teacher professional development and school support structures towards ICT integration.

3.4 Location of the study

The locale of the study comprised of secondary schools that have collaborated with Computer for Schools Kenya within the Nairobi and Kiambu counties. Since data from CFSK personnel was also important, their regional headquarters in Nairobi and Kiambu are also targeted. The choice of the locale was guided by the fact that CFSK began supporting schools in the two regions before expanding to the other regions of the country. The study was therefore keen on exploring the level and manner of ICT integration in schools that had benefited from CFSK for a fairly long period of time.

3.5 Target population

The target population included all secondary schools that had received CFSK support both in Nairobi and Kiambu Counties. The total population of the schools in the two regions was 58 and 30 schools were sampled from this total number of 58 CFSK supported schools. In the 30 schools, the total population of teachers was 952 while that of students was 17,572. According to CFSK statistics as at December 2008, CFSK was supporting 58 secondary schools within Nairobi and Kiambu counties.

3.6 Sampling technique

3.6.1 Purposive sampling

A purposive sample is a sample selected in a deliberate and non-random fashion to achieve a certain goal (Cohen and Manion, 1998). The selection of schools for this study was done purposively because this method of sampling applies to situations where certain individuals have the required information and the goal of data collection is description and interpretation of the information needed to address the aims of the study. Johnson and Christensen (2004) state that the purposive sample aims to select information, seeking data rich cases for in-depth study to investigate meaning, interpretations, processes and theory.

Purposive sampling was used to identify respondents from the CFSK project and the schools which are supported by CFSK. Using purposive sampling, the study focused on CFSK personnel especially those working in the training and ICT in Education department in the two regional centres, Nairobi and lower central centres. The researcher interviewed the CFSK personnel both at the headquarters and at the regional centres with the help of the interview guide (Appendix II).

3.6.2 Random sampling

Further, the schools were selected using stratified random sampling which selected three cadres of schools namely; Boys only, Girls only and Mixed Gender types of schools. Random sampling gives each and every member of the target

population a known and equal probability of selection, while stratification increases precision without increasing the sample size (Crawford, 1995). As a result of the heterogeneous nature of the population, the study employed both simple and stratified random sampling techniques to draw the sample. Simple random sampling was used to sample schools and teachers who responded to the teachers' questionnaire (Appendix I). The sample sizes for teachers and students were obtained using the table for obtaining sample size (see Appendix VI). Sample sizes of 278 and 375 were obtained for teachers and students respectively as shown in table 3.1. After selecting the schools and obtaining the samples, the researcher proceeded to the schools after obtaining permission from the National Council for Science and Technology. In the sampled schools, permission from the head teachers was sought to randomly sample teachers who were to complete the questionnaires. For purposes of corroboration, the sampled teachers were further requested to randomly administer students' questionnaires to 20 students in any of the classes they taught. The confidence level for the sample was 95%.

Table 3.1 Sampling frame

County	Schools		Teachers		Students	
	Population	Sample	Population	Sample	Population	Sample
Nairobi	23	12	459	134	8,175	173
Kiambu	35	18	493	144	9,491	202
Total	58	30	952	278	17,572	375

Source: CFSK, 2009

3.7 Research instruments

The instruments for the study were developed bearing in mind the need for utilizing widely accepted indicators of ICT integration in education developed by (UNESCO Institute of Statistics, 2009). Comparable statistics on access to, and use of, information and communication technologies (ICTs), are critical to formulating policies and strategies concerning ICT-enabled growth, for social inclusion and cohesion, and for monitoring and evaluating the impact of ICTs on economic and social developments. The rationale for using global core indicators for measuring ICTs in education such as those developed by UIS (2008), is useful in formulating a framework for collecting cross-nationally comparable data on ICTs in education (Partnership on Measuring ICT for Development (2010)). In the study, indicators developed by UIS like the ones on measuring access and use of ICT were referred to in developing the research instruments questions.

3.7.1 Teacher Questionnaire (TQ)

The aim of the teacher questionnaire was to collect information on the level and manner of pedagogical ICT integration in schools. It was assumed that teachers would take approximately 45 minutes to complete the questionnaire. The teachers' questionnaire had questions covering the following aspects: Demographic information, Availability and access of ICT, level and manner of ICT use and integration in schools, Challenges of pedagogical ICT integration,

Attitudes and self efficacy of ICT integration and Teacher professional development for ICT integration.

Before developing a survey questionnaire, Anderson (1997) recommends that researchers consult published compilations of survey questions, which not only give some useful ideas on how to develop your questionnaire, but can also provide relevant questions from surveys that reflect one's own research. The teacher questionnaire was constructed after reviewing literature on classroom teachers' use of ICT. A number of items for the Teachers' questionnaire were borrowed from tested instruments including the Questionnaire on Statistics of ICT in education (UNESCO Institute for Statistics, 2009), the Teaching, Learning, and Computing Survey (Becker and Anderson, 2001) and the Fast Response Survey System (NCES, 2000). These instruments have been used in large scale surveys on teachers' use of computers across different countries.

Appendix I is the teachers' questionnaire. In the Teachers' Questionnaire (Appendix I), the Likert scale used to measure teachers' attitude towards integration of ICT is a modified version of a scale developed from an earlier study by Roberts (1991) to measure the attitudes of pre-service teachers towards computers. The items under this construct measured on a five point Likert scale (1: Strongly Disagree; 5: Strongly Agree).

Some of the questionnaire items were closed-ended and were therefore expected to elicit similar meanings. Others though were open-ended and intended to elicit more elaborate information, including the feelings, attitudes and understanding of the subject. Since the second objective of the study was “to measure the level and manner of ICT integration by teachers”, open-ended questions were found necessary in order to elicit teachers’ own explanations on how they integrated ICT into their instructional processes.

3.7.2 Students’ questionnaire

A questionnaire specifically targeting students was developed to gauge the students’ attitudes and perspectives regarding ICT use in schools. The students’ questionnaire had few items which would be easily responded to by students. Additionally, the students’ questionnaire was used to assess the students’ perspectives on the level and manner of ICT integration. The rationale for the students’ questionnaire in the study was to corroborate information provided by the teachers’ questionnaire.

3.7.3 CFSK Personnel Interview Guide (CPIG)

The aim of the CFSK personnel interview guide was to collect information on CFSK’s type of support given to schools and the nature of professional development given by CFSK. It was assumed that the CFSK personnel would take approximately 30 minutes to respond to the interview questions. The

interview guide contained questions covering the following aspects: range of support given by CFSK to secondary schools, range of training for teachers, key lessons and challenges faced by CFSK. The interview guide was more effective in probing.

3.8 Piloting

To ensure that the research instruments fully addressed the objectives of the study, a Pilot Study was conducted in four (4) secondary schools. The aim of the Pilot Study was to validate the research instruments as well as to rehearse related logistical arrangements of the main study. Four schools that had received support from CFSK were picked for piloting using purposive sampling procedure. Two of the schools were from Kiambu County and two were from Nairobi County. During the main study, the pilot schools were not targeted.

The pilot showed that the chances of getting questionnaires returned increased significantly when a teacher in the sampled schools was appointed to take charge of the exercise. In addition, it was clear that for some types of schools especially the schools which were situated in urban areas, much greater effort was required to have the questionnaires filled and returned than for schools located in the rural areas.

3.9 Validity and reliability of the instruments

The content and construct validity of the research instruments were initiated right from the design stage considering that instrumentation is a major threat to internal validity. Validity is the degree to which results obtained from the analysis of the data actually represent the phenomenon under study (Mugenda and Mugenda, 1999). Wilson and MacLean (1994) suggested that, piloting is able to help in establishing the reliability, validity and practicability of the questionnaire because it serves among other things: to check the clarity of the questions, give feedback on validity of test items and also to make sure that the data required answered the research questions. The pilot study was conducted to establish not only the reliability of the survey questionnaire, but also to identify defective items to help correct any ambiguities that would be detected and get an idea of the expected response rate before administering it to the actual participants of the study. The response rate for the pilot study was 100% (4 schools, two from Nairobi County and two from Kiambu County). Their feedback helped to improve the quality of the questionnaires in terms of content coverage and content validity. Based on the pilot, one variable (pedagogical ICT integration) was added to the survey instruments in order get a clear perspective of the level and manner of ICT integration in schools. The reliability scales (Cronbach's Alpha values) for the survey instrument was .726 (Appendix D) which indicates a high degree of reliability of the items in the instrument (Fraenkel & Wallem, 2000).

The CFSK personnel interview guide and the schools checklist were scrutinized and approved by supervisors during discussion sessions to determine whether the items were logical and would provide the needed information.

3.10 Data collection procedure

Authority to conduct research was obtained from the National Council for Science and Technology of the Ministry of Higher Education, Science and Technology. After permission was granted, each of the selected schools in the sample were visited. The researcher first sought permission from the head teachers or their deputy head teachers where the former were absent. The meetings with the school managers were meant to explain the purpose of the research and to verify the Government's permission and consent to conduct research in their schools.

Having held the initial discussion with the heads of schools, the researcher met with the staff who were often introduced by the heads of schools. In each school, one teacher was chosen to help in collecting data and usually it was a member of staff who had been trained by CFSK on the use of the computers supplied to the schools. The researcher often explained the purpose of the study to the teachers. The researcher then distributed the questionnaires to the teachers and sought their permission to see the places where the computers were placed. With the guidance of the teachers selected for the study, the researcher would then proceed to inspect the ICT facilities in the computer rooms with the help of the checklist (See

attached Appendix IV). The teachers would then help in administering the student's questionnaire. The purpose of observing the computers was to assess their specifications was to collect data on the computer specifications.

3.11 Data analysis

The data collected using the teachers' questionnaire, students' questionnaire, school checklist and interview guide for CFSK trainers was arranged and edited. Gay (1992) argues that editing should be the first step to processing data. He states that the obvious reason for this is to ensure that the data analyzed are correct and complete. At the same time, editing can reduce bias, increase the precision and achieve consistency among various items. The edited data was then coded and analyzed using Statistical Package for Social Sciences (SPSS) and Ms Excel. Besides quantitative data, the research instruments also captured qualitative data some of which were analyzed based on the research questions of the study.

Descriptive statistics (Frequency distribution, percentages, measures of central tendency and variability) were used to describe the data. This methodology is typical in descriptive research (Bryman 2008). The quantitative data was supplemented with qualitative information. The results of the analyses carried out in this study are presented in Chapter Four.

3.12 Ethical considerations

First, a number of ethical considerations relating to the study are highlighted herein. The research participants in the study were not forced to participate in the study without their knowledge and consent. This study therefore did not involve participants who were unable to give informed consent. Secondly, the research also did not involve the obtaining of data that is sensitive, nor did it involve invasive, intrusive, or potentially harmful procedures of any kind. Thirdly, as part of the requirements for conducting research, permission was sought and the research aims and objectives were explained to ensure that the participants met the criteria for the sampled selection. In addition, they were assured that confidentiality and anonymity were to be maintained. No names or personal information were to be divulged and that the data were to be kept confidential and used for research purposes only. Additionally, research participants, teachers and CFSK personnel were informed that they could access the thesis (after completion) should they wish to do so.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

This chapter presents the analysis and interpretation of data collected from the field. The analysis and interpretation is based on the objectives and research questions of the study. The data was analyzed, discussed and presented according to the information obtained from the teachers' questionnaires, students' questionnaires, school information checklists and CFSK personnel interview guides. The chapter starts with the demographic data of the respondents who are mainly teachers and students. The chapter is then organized into seven key sections which are based on the five research objectives that guide this study namely to: (a) assess the availability of and access to ICTs by teachers in selected secondary schools; (b) determine the level and manner of ICT integration by teachers in secondary schools in Kenya; (c) measure teachers' perceptions towards ICT integration in schools; (d) investigate challenges faced by teachers in integrating ICT in education; and (e) assess teachers' professional development needs in pedagogical ICT integration. In this study, the required samples obtained from various populations were; 30 schools, 278 teachers, 375 students and two CFSK trainers. Except for the teacher questionnaires where 300 questionnaires were distributed and 278 collected (return rate of 92%), all the other instruments had a response rate of one hundred percent.

4.2 Demographic data

The demographic data comprised the respondents' gender, age, teaching load per week, highest education level, and teachers' teaching subjects. These were tabulated by frequency and percentage in some cases. In other instances, they were presented in graphic format.

4.2.1 Gender of respondents

Table 4.1 Gender of respondents

Respondents	Male	%	Female	%
Teachers	144	51.8	134	48.2
Students	221	58.9	154	41.1
Trainers	2	100	-	-

N=278 and N=375

Source: Teachers' and students' questionnaires

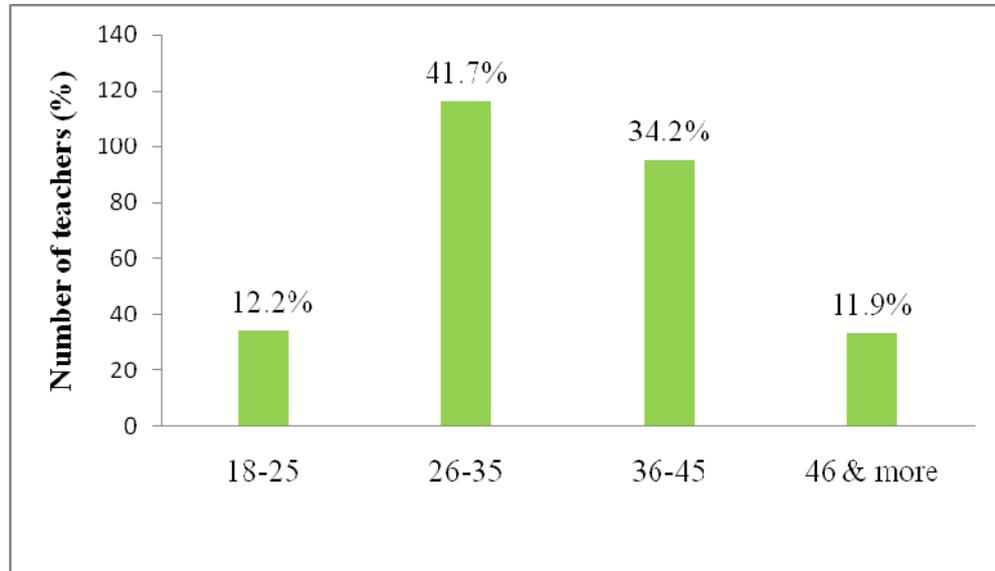
Presented in Table 4.1 is the gender of respondents who participated in the study. One hundred and forty four representing 51.8% of the teacher respondents were male while one hundred and thirty four representing 48.2% were female. For the student respondents, two hundred and twenty one (58.9%) were male while one hundred and fifty four (41.1%) were female. For the CFSK trainers, both were male. Despite obtaining a 50% sample for both gender among male teachers, it is evident from the data that ten more female teachers than male failed to return their questionnaires. It is possible to argue that a few of the teachers who did not return their questionnaires are averse to ICT use in schools. The data for the teachers

reveals that more male are inclined towards ICT training. There is possibly need to mount professional development programmes that target both male and female teachers so as to encourage all teachers across the board towards ICT adoption and use.

4.2.2 Teachers' age

There has been an existing myth about there being a generational gap related to ICT use such that the rising generations are said to be 'digital natives' in contrast to their elders who are said to be 'digital immigrants' (Prensky, 2001). In that view, a solution to the problem lies in generational change so that young teachers are expected to be better adopters and users of the new technologies and hence be the instruments for bridging the digital gap among populations. In this study, it was found necessary to determine the age differences among teachers and see whether they in any way accounted for their use and integration of ICT in schools.

Figure 4.1 Teachers' age



N=278

Source: Teachers' questionnaires

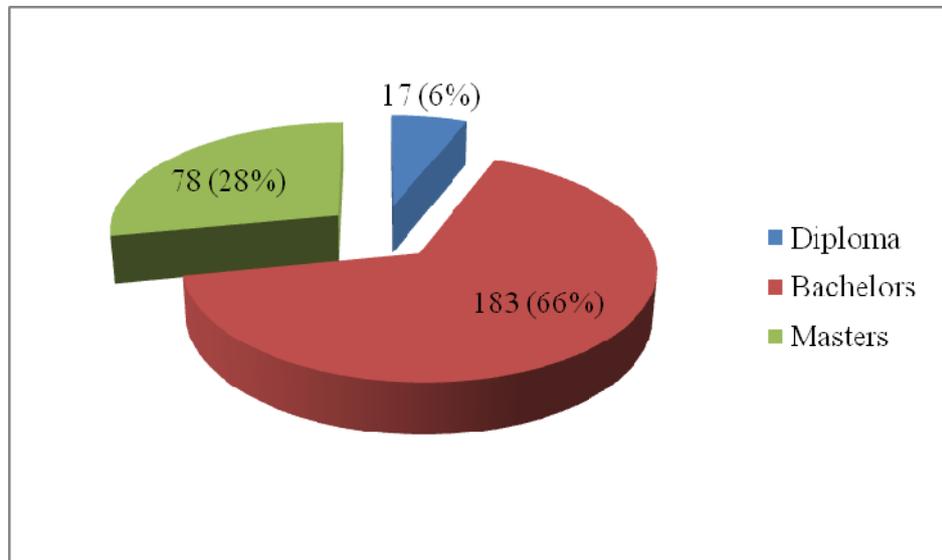
Figure 4.1 represents the distribution and summary statistics for teacher respondents' ages. The teachers' ages ranged from 23 to 54 years with a mean of 36.6 and standard deviation of 6.28. The findings revealed that majority (41.7%) of the teachers are those in the 26-35 age bracket while the least category of teachers (11.9%) are those in the 46 and more age bracket. From figure 4.1, it is discernable that more than half of the teachers who participated in the study (53.9%) were within the two age brackets, 18-25 and 26-35. These age brackets comprise a group that is defined as youth by the UNESCO, African Youth Charter. ITU (2008) reports that youth within a similar age bracket of 18-35 years in the Republic of Korea, the United States of America and Australia are more responsive and attracted to ICTs than people of a different age bracket.

According to UNESCO, people who fall within the ages of 18-35 are youth. It is therefore possible to argue that most teachers who currently teach in secondary schools in Kenya are in their youth hence the need to see their active role in bridging the generational digital gap that might be existing in schools. Previously, Bee and Chia (2008) observed that teachers in the age range under 40 years are found to be more knowledgeable and skilled in ICT compared to those above 40. Considering that ICT penetration in secondary schools in Kenya began in the late 90s, almost all of the teachers who were 35 years or less must have found computers in their working stations or even must have had pre-service training prior to being employed as teachers hence the need to see them effectively integrating ICTs in instruction.

4.2.3 Teachers' highest academic qualifications

Lately, many secondary school teachers in Kenya are pursuing further educational growth for various reasons (The Standard, 2009). In this study, it was found necessary to characterize teachers' ICT use and integration based on their educational qualifications. Figure 4.2 summarizes teachers' highest academic qualifications based on their responses.

Figure 4.2 Teachers' highest academic qualifications



N=278

Source: Teacher questionnaire

Figure 4.2 presents the distribution and summary statistics for respondents' highest education qualifications. Respondents with bachelors' degrees numbered 183 (66%), seventy eight (28%) had masters' degrees, and seventeen (6%) had diplomas. Two respondents reported to having masters' degrees and were working on doctoral degrees. It is clearly discernable from the data that majority of the teachers (66%) in secondary schools in the two locations of the study, Nairobi and Kiambu Counties have Bachelor's degrees. Although the minimum requirement for teachers in secondary schools by the Ministry of Education in Kenya is a Bachelor of Education Degree, it was interesting to note that a significant number (28%) of teachers are now pursuing Masters degrees. As a requirement, most universities that offer postgraduate degrees in Kenya require students at that level to use ICTs for various functions including research work,

academic writing and for presentations. ITU (2008) observes that people who have tertiary qualifications are more likely to be better ICT users than their counterparts with lesser qualifications. It was therefore assumed that the more teachers pursue higher opportunities of learning at postgraduate level, their enhanced ICT skills would be transferred innovatively into instructional practices.

4.2.4 Teaching load

A teacher's responsibility especially their teaching load in school impacts on their choice and opportunity to integrate ICTs in instructional activities. Teachers in this study were asked to state their teaching load and their responses are summarized in table 4.2.

Tale 4.2 Teachers' teaching load

Number of Lessons per week	F	%
1 to 6	11	4
7 to 13	45	16
14 to 20	78	28
21 to 27	113	41
28 and more	31	11

N=278

Source: Teachers' questionnaires

From table 4.2, most teachers, 113 (41%) indicated that they taught between 21 and 27 lessons per week. The next highest group of teachers (23) is that which teaches between 14 and 20 lessons per week. It is clear from these statistics that

the group that has the least number of teachers is that which teaches less than seven lessons which comprise 4%. The Ministry of Education, Kenya recommends that teachers should teach a maximum of 27 lessons and a minimum of 12 lessons per week. Therefore majority of the teachers in this study are those who teach fewer lessons than the recommended maximum load. It would therefore be expected that majority of the teachers in this study would have enough time to plan for and subsequently integrate technology in their lessons based on their teaching load in schools. The 8.2% teachers who have more than 30 lessons have too much teaching load that they may find it difficult to adequately plan for ICT integration in their pedagogical and other similar activities.

4.2.5 Teaching subjects

In Kenya's secondary schools, teachers are employed to teach two subjects except in a few isolated cases. From the study, majority of the respondents (113) who participated in the study voluntarily were those that have Mathematics as one of their teaching subjects. The subjects that had the least number of teachers in the study (68) were the Arts and Humanities (History, Geography and Religious Education) while among the languages, Kiswahili which is a compulsory subject at the secondary school level in Kenya had fewer respondents (23) than the English language. In terms of participation in the study, the results are consistent with what Mojgan et al., (2009) found out. Mojgan et al., found out that areas of

specialization can influence teachers' ICT readiness especially in terms of ICT knowledge (Mojgan et al., 2009). They argued that teachers who teach science and technology based subjects are found to be inclined more to using ICTs compared to their counterparts who teach humanities and languages. This is probably due to the fact that the scope of teaching technical subjects poses a greater demand on the teachers to be better equipped with manipulative skills which are also found in ICTs. However, pedagogical ICT integration which is the scope of this study is an element that ought to be embraced by all teachers irrespective of their teaching subjects across the whole curriculum.

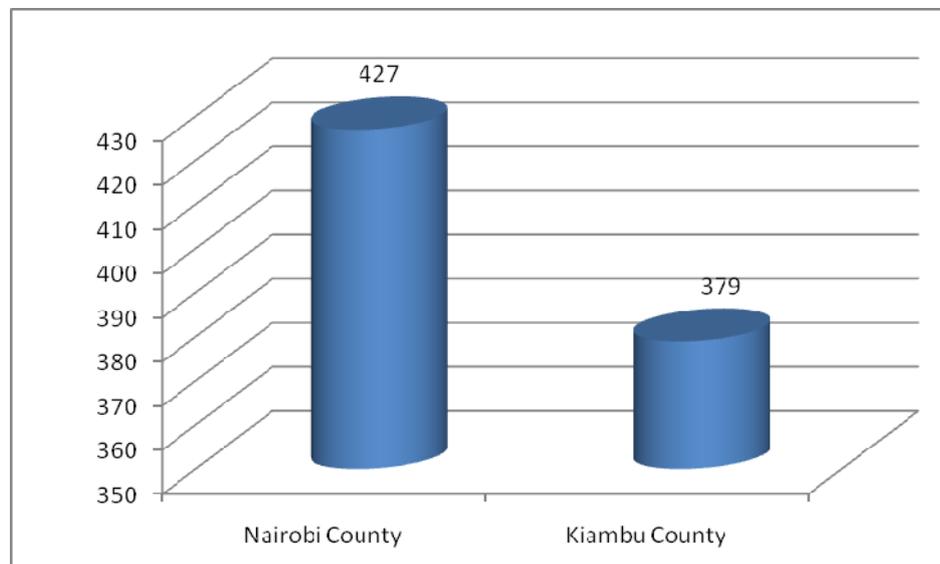
4.3 Availability of and access to ICTs

In this study, the availability of ICTs in secondary schools was measured with the objective of determining how well equipped and digitized schools are for the use and integration of ICTs and for constructivist pedagogical instruction. The availability of suitable hardware and software affects the level and process of ICT integration in teaching and learning (Becker, 1994 and Sheingold and Hadley, 1990). BECTA (2004) also indicate that lack of access to technology is a barrier to the integration of technology by teachers. Data presented in sections 4.2.1 and 4.2.6 summarizes information regarding the availability of ICTs in schools by quantity, functionality and quality.

4.3.1 Number of computers in schools

Using a checklist, the researcher made visits to the schools and counted the computers to establish the exact number of computers that were available in each of the sampled schools and the data is summarized in figure 4.3.

Figure 4.3 Number of computers in schools



N=806

Source: Schools checklist

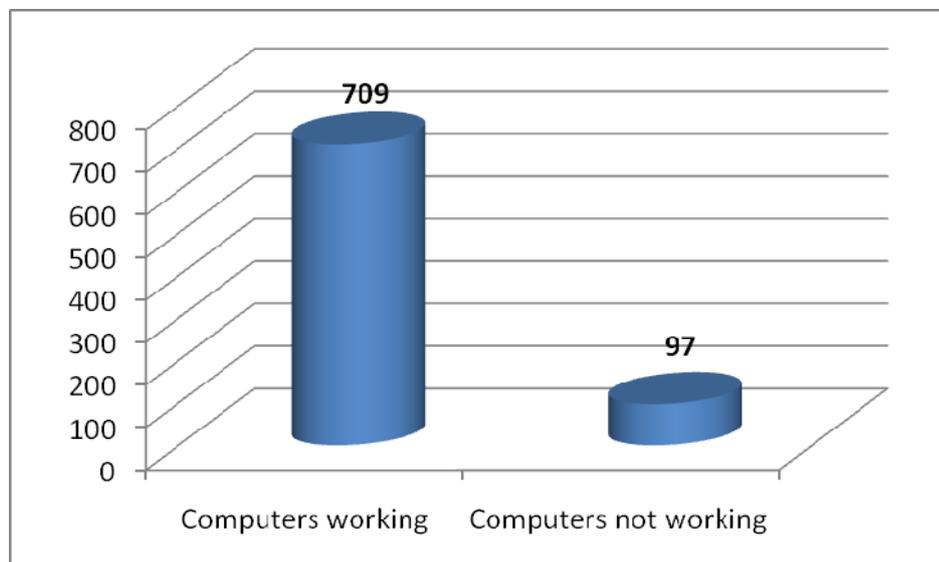
Figure 4.3 shows the frequency distribution of computers in schools. A comparison of the number of computers has been presented between the two counties where the data was collected. As shown, the total number of computers in schools located in Nairobi County was 427 while that of schools in Kiambu County was 379. Considering these absolute figures, the study found out that there were more computers in schools located in Nairobi than those in Kiambu County. This means that the location of schools in Nairobi, the Capital City and

the hub of most industrial and commercial activities places schools in the locality at an advantage in getting donations and support from both private and public organizations.

4.3.2 Functional status of computers

Apart from identifying the number of computers that were available in the schools, it was also important to check whether the computers were working or not. Information about the functionality of the computers is presented in figure 4.4.

Figure 4.4 Number of computers available against number working



N=806

Source: Schools checklist

In the study as shown in Figure 4.4, out of the total number of computers available in the schools (806) only 709 (88%) were working. The rest 97 (12%) were faulty. Out of the 97 faulty computers, 56 (57.7%) were in schools located in Kiambu County. It was further realized that there were more faulty computers in Kiambu County schools than in Nairobi County schools. Since most ICT companies are located in Nairobi, the Capital City, it is possible that schools in Nairobi easily sourced for ICT repair services and maintenance from such ICT companies. This also means that most of the ICT companies that supply ICTs to schools do not have good systems for maintaining ICTs especially in rural areas.

4.3.3 Students' computer ratio

When the students' computer ratio was computed for the schools based on the functional number of computers, the ratio stood at one computer to twenty five students (1:25). Whereas the ratio for computers to students in Nairobi County was 1:19, the ratio for Kiambu County was 1:25. Another study by Wims and Lawler (2007) in a research on the implementation of ICT projects in selected educational institutions in Kenya also found out that ratio of computers to students in the institution surveyed ranged between 1:25 and 1:32. In this study, the ratio was found to be much higher than the overall ratio of instructional computers to students in developed countries like in the United States of America whose public schools as at 2008 had a ratio of 1:3 (Warschauer, 2010). However,

the ratio in the sampled schools was nonetheless better than the national average of 1:120 for secondary schools in Kenya (Ministry of Education, 2006).

The ratio in the study schools therefore was far from the ideal ratio of 1 learner per computer or the compromised standard of 5 learners to 1 computer that has been adopted in developed countries. According to Warschauer, for what he refers to as high-level ICT integration countries such as South Korea and Singapore, almost all classrooms are equipped with computers and other ICTs and the student/computer ratio is 1:4. A comparison of the ratio in Kenya and that of the developed countries implies that, in Kenya, there is need for investment in ICTs in order to not only bridge the digital gap but also enhance opportunities for ICT integration in instruction. Nonetheless, the presence of computers in all the sampled schools even though few in number indicate that the schools are at least at the emerging phase of the UNESCO model (UNESCO, 2002). As noted in literature, schools at the emerging phase have few hardware and software but in which case learners have access to one or two computer laboratories in the school.

4.3.4 Placement of computers

The location and placement of technology in a school can greatly influence its access and use. Regarding the location of computers, majority (93%) of the schools visited in the study had computers placed in the computer laboratories. Only two schools did not have proper computer laboratories. In the study it was

realized that except for 11 (36.7%) schools which had more than one computer laboratory for students, all the other schools (18, 60%) had only one computer laboratory for use by students. According to Swain and Pearson (2001) placing computer equipment solely in computer laboratories has been a major obstacle to improving equity and access to ICTs. They argue that when computers and other technologies are restricted to a lab, students have limited access to the equipment. In addition, labs often reinforce the idea that computers are simply “extra” or “special” instead of being seen as an integral part of the learning process. However, since all schools cannot afford to put computers in every classroom, the computer laboratory might be the only option.

In one of the sampled schools, the computers were placed in a big room which also doubled as a science laboratory whereas in another school, the computers were put in the library. The idea of placing computers in the library poses challenges because for instance books in the library can be easily tampered with when learners are utilizing the computers. Secondly, the scheduling of library lessons and computer sessions may also be challenging. It is also possible that, in the science laboratory, during experiments, students could accidentally spill chemicals on the computers which would damage them.

In some schools though, there were computers in the staff rooms for teachers to use. Most of the schools however had computers in the

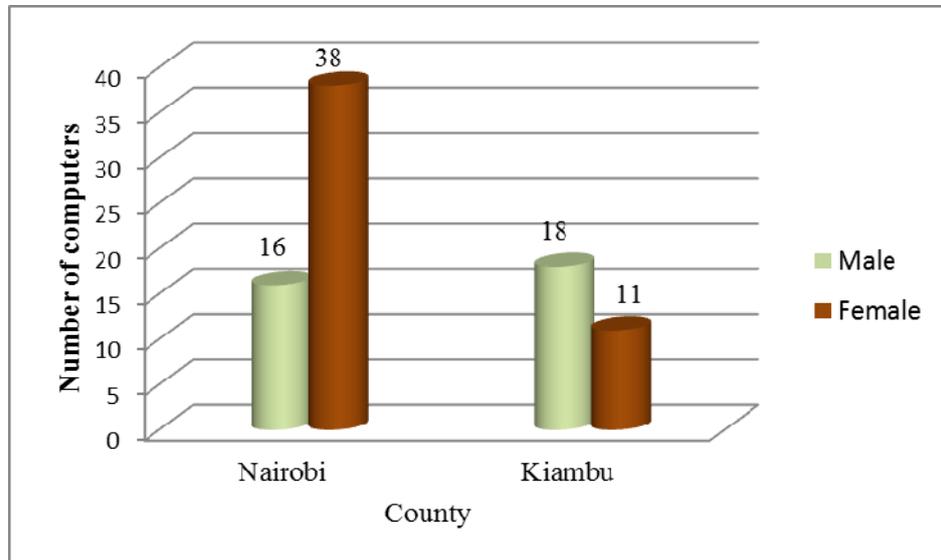
administration offices like that of the principal, deputy principal and the offices of the secretary and bursar/accounts clerk. In terms of placement of computers, the results of this study support the assumption that most of the students' and teachers' ICT-related activities are carried out in the computer laboratory. The lack of access to computers in the classrooms seems to suggest that integrating ICT within the learning areas or subjects may still be quite limited as teachers and learners do not have constant access to ICTs, indicating that the schools are at the "applying phase" of the UNESCO Model (UNESCO, 2002). In such schools, teachers and learners use computers that are placed in the computer laboratories while attending scheduled computer literacy classes. The idea of placing computers only in the laboratories restricts use.

It is apparent that schools need to invest more resources to develop infrastructure to accommodate ICT facilities for easier and efficient use by both teachers and students. But even more economical, viable and efficient is the idea of using easily portable ICTs which can be utilized even in the classrooms. The movable devices include laptops, Ipads and tablets. More often these devices come more flexible features that are user friendly and supportive of multiple learning opportunities.

4.3.5 Ownership of computers by teachers

The ownership of a personal computer is an important indicator of the level of confidence and value placed on the functionality of computers. Teachers who own computers are likely to hold better perceptions about ICTs and also be more confident in using them than teachers who do not (Mojgan et al., 2009). In this study, it was found necessary to establish the proportion of teachers who owned computers in order to not only measure ICT penetration among teachers but also to gauge the status of their availability beyond the school environment. This information is presented in figure 4.5.

Figure 4.5 Ownership of personal computer by teachers



N=278

Source: Teachers' questionnaires

As figure 4.5 shows, out of the 278 teachers that participated in the study, only 83 (29.9%) owned personal computers. Further, of the 83 who owned computers, 16

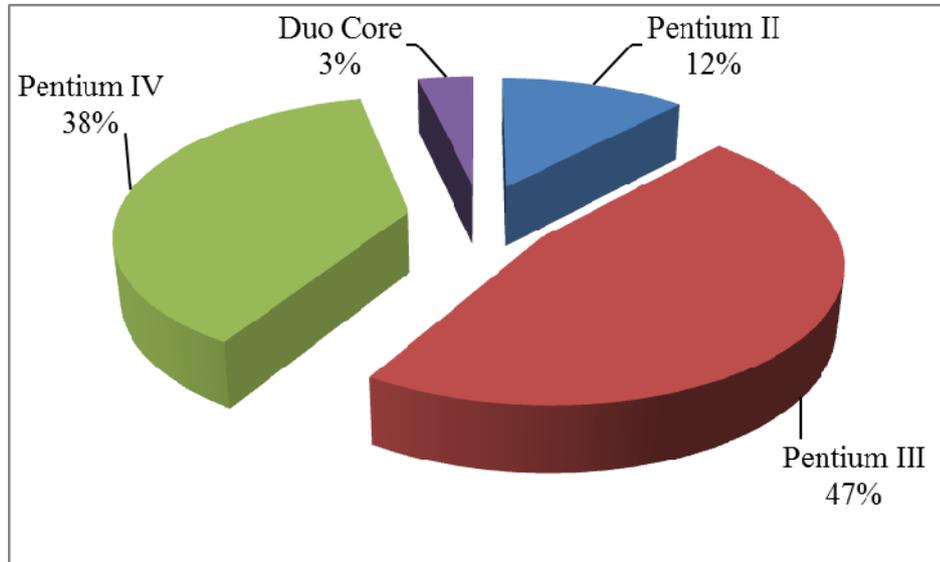
were male and 38 female teachers from Nairobi County. In Kiambu County, 18 male and 11 female indicated that they owned computers. It is evident from the statistics in figure 4.5 that more teachers from Nairobi own computers compared to teachers from Kiambu. Also evident in figure 4.5 is that more female teachers than male in Nairobi owned computers. The opposite is true for Kaimbu County. It is discernable from the data about ownership of computers that the level of ICT penetration among teachers is fairly high. In the schools sampled, eighty three (29.9%) teachers own computers. One would therefore expect the attitudes and confidence in using computers to be high especially among teachers who owned computers. This is especially so considering that research shows that computer anxiety can be related to lack of knowledge and skills about computers as well as computer ownership, and frequency of their use (Mojgan et al., 2009).

4.3.6 Computer specifications

4.3.3.1 Processor types

The technical specifications of computers are also a good indicator of the quality of educational technology available for educational use in schools. The extent to which a computer processor can be used to support various instructional activities with speed is important in any educational institution. Through a checklist, information about the processors of the computers that were available in schools was captured and is reflected in figure 4.6.

Figure 4.6 Computer processor types



N=709

Source: Schools checklist

Through the schools' checklist, the study revealed that most of the sampled schools in the study had Pentium III computer processors. For example, out of the 709 operational computers that were found in the schools in both Nairobi and Kiambu Counties, 47% have Pentium III processors. A substantial number (38%) also had Pentium IV processors. Only 3% of the computers were dual core types. Pentium III processors run at low speeds, between 200 MHz and 450 MHz, relative to contemporary processors that run at about 10 times that speed. The multimedia applications that are mostly used in education activities often combine text, audio, still images, animation and sometimes interactivity require higher versions of processors that are higher than the single pentium series. Therefore, some of the hardware found in the schools like the Pentium II processors cannot

support heavy activities associated with running multimedia educational applications. Considering therefore the importance of ICT integration into education and with the foresight of realizing its benefits maximally, there is need for higher investments by institutions to procure faster and high quality and modern ICTs capable of handling dynamic educational applications.

4.3.7 Software applications

Apart from hardware, the type and variety of software applications available in a school is also an important indicator of the capacity of an institution to support meaningful ICT integration. Through review of literature and subsequent to interviews with the CFSK trainers, it was found necessary to assess the types of software that was available in schools. This was in addition to the findings obtained from CFSK trainers who indicated that they supplied a standard suite of software to schools. Using a checklist, the researcher established the different types of software that were available in schools which are summarily presented in table 4.3.

Table 4.3. Types of software available

Type of software	%
Word processing	100
Spreadsheet	100
Presentation software	100
Graphics	79.3
Database	100
Encyclopedia/References on CD-ROM	81.4
Recreational games	100
Desktop publishing	81.7

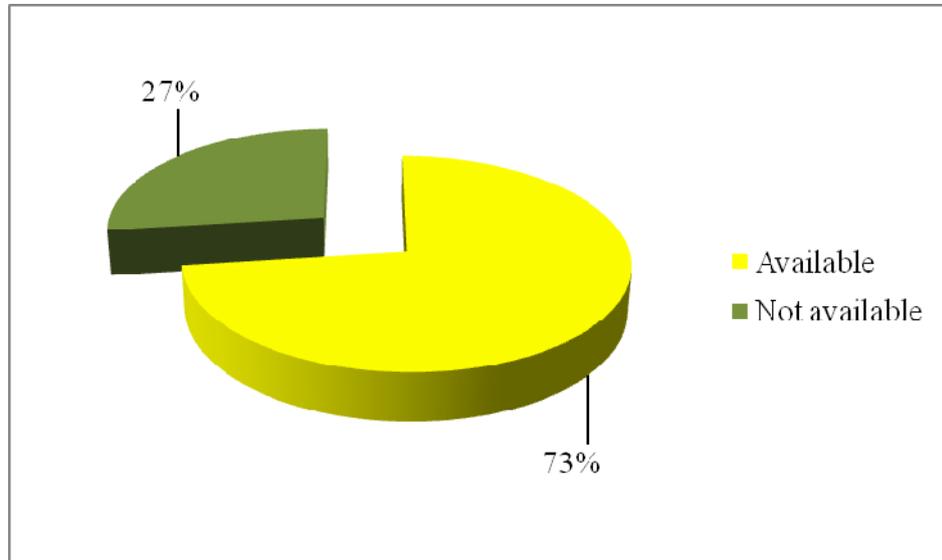
Tutorials	32.5
Internet browser	71.3
Educational games	57.8
Drill and practice programmes	58.5
Video/Audio/Authorware	73.5
Programming languages	35.4
Statistical / mathematical programmes	25.5
Simulations	8.7
N=278	Source: Schools checklist

Table 4.3 shows that the types of software applications that are available in schools are predominantly “office software” or “productivity tools” such as word processing software, spreadsheets and database management applications. There is relatively less variety in the available software especially the ones that are used for curricular and pedagogical practice (e.g., simulations, drill and practice, tutorials).

4.3.8 Internet connectivity

Considering the numerous benefits of the internet and its impact on education, it was found important to assess its availability in the sampled schools. The information about the availability of the internet is presented in figure 4.7.

Figure 4.7 Availability of internet in schools



N=30

Source: Schools' checklist

As shown in Figure 4.7, among the thirty schools that participated in the study, 22 (73%) had internet connectivity. However, when the individual computers were assessed, only 316 (39.2%) were connected to the internet. For some of the schools, the only computers that were connected to the internet were those in administrative offices. Others again restricted internet access to teachers and students. From the foregoing, it is evident that most of the students and teachers in the sampled schools did not easily access the internet while in school. It is possible to imagine that mostly, the computers were therefore accessed and used for other activities that are not supported by the internet. Most schools therefore in the study are those that miss out on the numerous benefits of the internet in education including up-to-date information, classroom related content,

communication and interactive platforms. Ivers (2003) argue that by connecting computers to the internet in schools, the computers are transformed into powerful communication devices with countless learning applications. There is need therefore for schools to invest in the installation of internet in schools. Schools' administrations need to be sensitized of the reducing costs of internet connectivity and the attendant advantages offered by the connection.

4.3.9 Internet access options

Apart from seeking to find out the availability of internet in the schools, it was also necessary to assess the types of internet connectivity options that are available in the schools. Considering that there are many internet access options that a school may opt to use, these were assessed to determine which ones were being used. The data is presented in table 4.4

Table 4.4 Internet connection by frequency and percentage

Internet access type	Frequency
Simulated internet	7
Dial-up	4
Cellular wireless connection	21
Internet via satellite	5
Optical fiber	3
No internet	8
N=30	

Source: Schools' checklist

Table 4.4 outlines the data on the type of internet connection available in schools. It is evident from the statistics that the most common type of internet connection

in schools is the cellular wireless connection. Twenty one out of the thirty schools in the study had cellular wireless connection, seven (7) had simulated internet which comprises downloaded material for use through VCD and DVD. The lowest type of connection is the optical fibre connection which was found in only three schools. Dial-up connection was also in only four schools. Dial-up internet access is becoming quite scarce even in other parts of the African continent as noted by Murphy et al., (1989). The reason for the low fibre optic connection may be due in part to the cost implications associated with the option as well as its novelty.

The fibre optic connection is a fairly new network mode which is only beginning to spread in most places in Africa. Its advantages though require that institutions invest heavily in it to harness the potential of internet services in education. Fiber optic is the fastest, most robust and more reliable data transmission system available which also has the advantage of symmetrical access- thus the speed of uploading is equal to the speed of downloading. It also provides the possibility for content distribution by application providers for their users, whose mobility is increasing with the popularity of telecommuting connections, telephones and other intelligent devices. Applications that use large amounts of data (such as Skype, which streams live video) can now be used to the full extent of their capabilities for the first time through fibre optic.

4.3.10 Teachers' perceived adequacy of ICTs in schools

Since teachers play a critical role in meaningful learning through constructive pedagogy with ICT integration, it was found necessary to measure teachers' perceptions of the adequacy of ICTs in their schools. To do this, teachers were asked to rate the adequacy of various aspects of ICTs available in their schools on a five point scale and their responses are summarized in figure 4.5.

Table 4.5 Perceived adequacy of ICT by teachers

Ratings	Hardware	Software	Internet	Other ICTs e.g radio
Very good	34	21	8	48
Good	48	33	15	65
Moderate	77	81	36	83
Poor	150	98	43	53
Very poor	39	45	176	29
N=278		Source: Teachers' questionnaires		

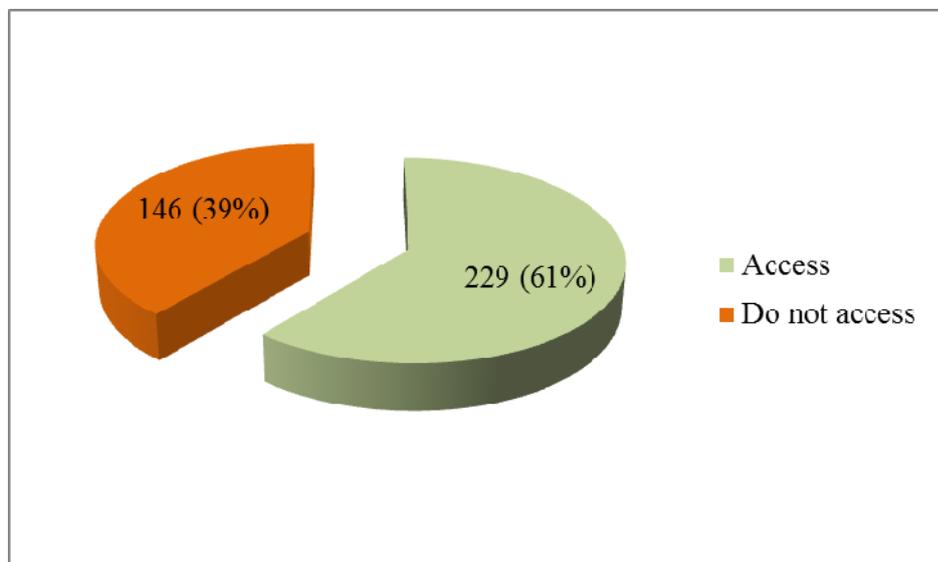
Table 4.5 shows that whereas other types of ICTs like video and radio received higher rating with 196 (70.5%) teachers indicating that they had satisfactory to very good digital resources, the item that received the lowest rating by teachers was the internet. It is possible to argue that other ICTs apart from computers and the internet were adequate because schools could afford buying them due to their relative cheap cost. On the other hand, the low internet rating by 219 (78.8%)

teachers may be due to perceived high costs of installation and maintenance by the schools.

4.3.11 Access to computers by students

Despite seeing computers in the schools surveyed, it was still necessary to find out from the students whether the computers were accessible to them for use. This was important because the mere presence of instructional resources in schools does not guarantee their access and utilization. Figure 4.8 reflects the students' access of computers in school.

Figure 4.8 Access to computers by students



N=375

Source: Students' questionnaires

From figure 4.8, it is evident that majority of the students (229 or 61%) access computers while 39% do not access computers in their schools. The status falls short of the constructivists requirements for ICT integration requirements that each and every student in school should have frequent access to computers. With the status quo, learners in these schools are not going to benefit from the promise of ICT in education. As a result they will continue to miss out on educational solutions offered by ICT, which limits their chances of tapping from the ICTs and ultimately from improving the quality of their lives.

4.4 ICT use and integration in schools

4.4.1 How often students use ICTs in school

Apart from asking the students whether they had opportunities to access computers while at school, they were also asked to comment on how often they used ICTs and this is presented in table 4.6.

Table 4.6 Frequency of ICT use by students

Response	Computer		Internet	
	Frequency	%	Frequency	%
Everyday	5	2.2	8	1.7
Weekly	79	34.5	28	12.7
Monthly	88	38.4	54	25.8
Rarely	57	24.9	139	59.8

N=375

Source: Students' questionnaire

Out of the 375 students, only five students (2.2%) indicated that they used the computers daily in school. The highest number of students was the one that used the computers monthly who account for 88 (38.4%). It is also significant that 24.9% of the students rarely used computers. As for the use of the internet, majority of the students (59.8%) rarely used the internet while in school. Only 1.7% of the students used the internet in school. When one considers that 73% of the schools in the study as shown in figure 4.7 have internet connection of one type or another, the low frequency of use reflected in table 4.6 by students shows that the internet in most schools is most likely used for other functions other than teaching and learning. It is also evident that rarely is the internet used by students. These results are consistent with a study carried out in Ghana on students' access to and experiences in the use of information and communication technology that found out that students are hardly given chances to use the emerging ICT tools (computer, internet, mobile phone) in schools. Students are denied a great opportunity to access the internet (Sarfo and Ansong, 2011).

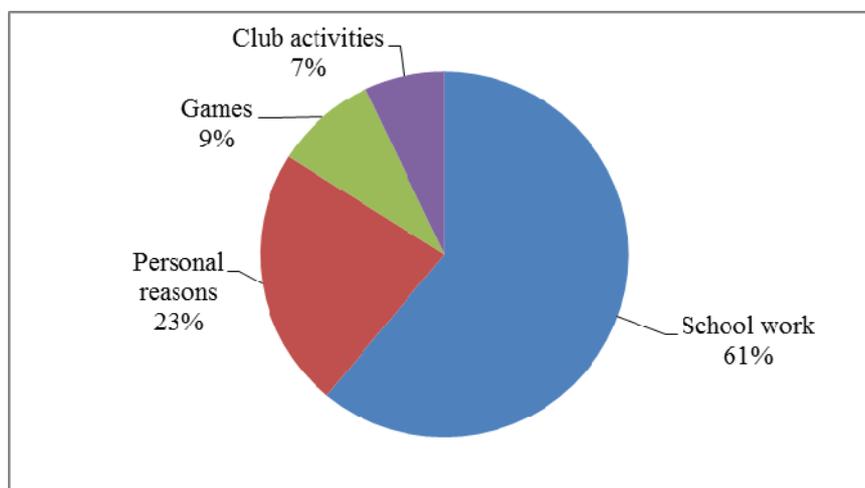
According to ITU (2008), young people between the age of 14 and 24 are likely to make better use of the internet for educational activities than other categories of the population especially if they are given a chance and guided to do so. Similarly to this study, ITU (2008) argues that there is concern that the opportunity to benefit from the internet and its applications is dismal in most schools in Africa, a situation that disadvantages most young people who grow up in the continent.

ITU goes on to point out that while this is happening in the developing countries, the scenario is much different in the developed economies where there is high quality internet available to both teachers and students in schools. The challenge with this scenario is that if its left to continue, it is likely to increase the digital divide between the developed and the developing economies. It is possible to argue that the low frequency of use of both computers and the internet in most schools is most likely aggravated by lack of good policies to guide the usage of ICTs in schools. It is therefore evident that most schools are still at the emerging phase of the UNESCO model (UNESCO, 2002), a phase at which computers, the internet and other ICTs are usually not often accessible to staff and students for use. There is therefore need for schools to create and implement clear pragmatic policies for technology-enhanced pedagogies. Sandholtz et al., (1997) advises that at this level, schools need to be supported to develop suitable plans to guide ICT integration in all areas of the school operations.

4.4.2 What students use computers for

In the study, it was found necessary to establish from the students themselves what they mostly used computers for while in school. Their responses were then summarized and are presented in figure 4.9.

Figure 4.9 What students do with computers



N=229

Source: Students' questionnaires

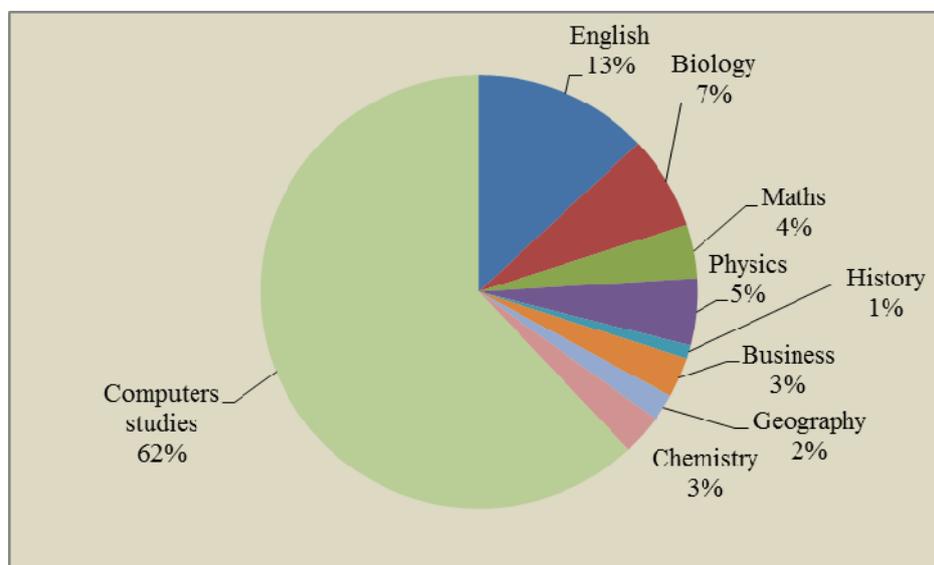
As shown in figure 4.9, majority of the students (61%) use computers to do school-related work. School work in this context includes typing, organizing and manipulating data. Students also used computers to do personal things which were non-academic like writing letters, drawing and painting, playing computer games, and communicating. In some schools though, students indicated that they participated in clubs like journalism and computer club. In such schools, clubs provided the students with opportunities to use computers meaningfully. In one of the schools for example, students observed that they used digital cameras sometimes to record field trips and the pictures would then be uploaded on their school websites with the help of the computer teacher. This example illustrates that there are schools within the study where teachers were innovative in their use of ICT. Students in such schools were being encouraged to build on their out-of-

class learning experiences through clubs, an idea that is useful in constructivist learning approaches. It is necessary for such best practices to be shared among schools for more and more teachers and students to learn from their peers the possibilities of innovatively using ICTs.

4.4.3 Use of computers in teaching

Students' responses to the question as to whether teachers used computers in teaching showed that only a small fraction of teachers used computers. Only 126 students accounting for 33.8% of the total number of students who participated in the study indicated that teachers used computers in teaching. Further, the study also sought to establish the subjects in which computers were used as pedagogic tools. The following subjects were mentioned and their proportions are displayed in figure 4.10.

Figure 4.10 Computer use in different subjects



N=375

Source: Students' questionnaires

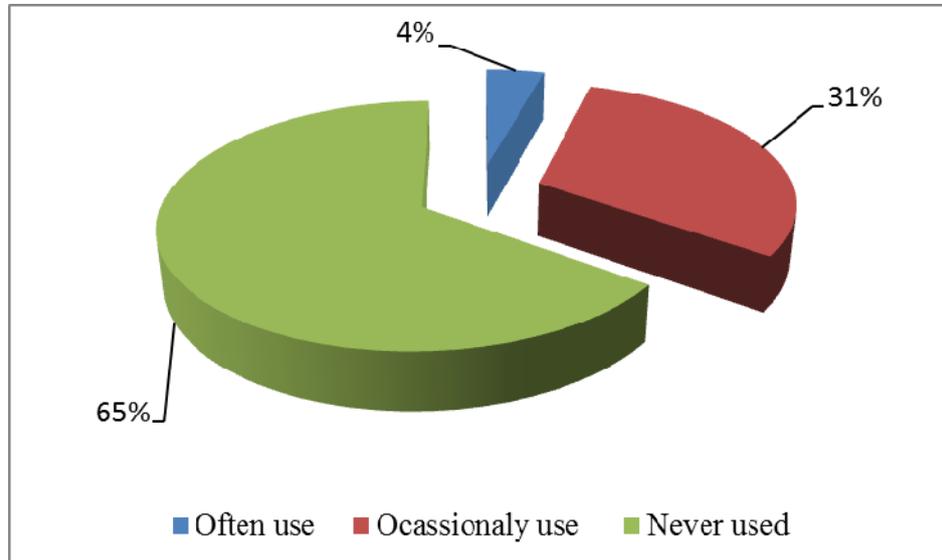
Use of computers for pedagogical purposes as seen in figure 4.10 was still a challenge. Figure 4.10 shows that the use of computers in teaching subjects, other than computer studies was yet to gain ground in all sampled schools. UNESCO (2002) classifies such schools where computers are merely used for teaching and learning computer studies as schools at the emerging phase. This could actually be a reflection of the broader Kenyan situation as was also found by Wabuye (2003). This shows clearly that computers are still being used for teaching computer studies rather than integrating them into the teaching of various subjects that are being offered in secondary schools. When teachers were asked why they found it difficult to teach using computers, they cited lack of e-content as the main reason for the dismal use of computers in the teaching of other

subjects. CFSK staff confirmed this during interviews. According to CFSK staff, the organization had just embarked on e-content development although the process was still at its infancy. From this, it is apparent that the Ministry of Education needs to embark on an aggressive process of e-content development and extensively involve teachers so as to make them buy into the idea of ICT integration in schools.

4.4.4 Use of courseware in schools

Apart from discovering the level of access to basic computer application software including word processing, spreadsheets and presentation software, it was also important to find out the frequency if any of teachers' use of subject specific courseware in schools. This was based on the fact that for schools to create suitable environments for ICT integration and innovative pedagogical practices there was need for them to have a wide range of general purpose as well as subject specific software. Teachers were asked to identify the frequency of use of various educational software applications in their schools and the information obtained is presented in figure 4.11.

Figure 4.11 How often teachers use educational software applications



N=278

Source: Teachers' questionnaires

As is clearly shown in Figure 4.11, most teachers (65%) had never used specific educational software applications. Only a very small fraction of teachers (4%) indicated that they often used educational software applications. This data shows that in most schools, teachers may be experiencing constraints in using educational software and by extension integration of ICT in instruction due to a shortage of educational software applications. In an earlier study on Computer for Schools Kenya, teachers cited lack of subject specific courseware as one of the reasons for their lack of pedagogical ICT integration in schools (CFSK, 2009). One would have expected that after several years of ICT development in the country, schools would now be having software for most of the subjects that are offered in the secondary school curriculum. Rusten and Hudson (2002) argue that the best educational return on investments in computer systems in schools comes

from using specialized educational software when used effectively by teachers. It is discernable from this study that majority (65%) of the teachers in the sampled schools miss out on the numerous benefits associated with educational software including: strengthening subject specific matter, providing drill and practice for different subjects and enhancing logical thinking and problem-solving skills which are some of the 21st century skills advocated for by the Partnership for the 21st Century Skills. There is therefore need for schools to invest in the procurement of educational software applications. Additionally, educationists need to also invest more in the production of educational software applications that are relevant to all subjects being offered in Kenya's secondary school curriculum.

4.4.5 Objectives for ICT use in schools

To be able to determine the most common purposes for ICT use in schools, it was necessary to establish the extent of computer use for various objectives. First, the objectives for which teachers choose to use ICT was established. This was done through a scale which tested the frequency of use of ICT for six different objectives outlined in table 4.7. The scale varied from Not at all (1), A little (2) to A lot (3).

Table 4.7 Objectives for using ICTs

	Not at all	A little	A lot	Mean
Create instructional materials	32	24	28	1.94
Gather information for lessons	32	40	12	1.48
Prepare presentations	36	40	4	1.6
For administrative record keeping	5	25	54	1.95
Communication	-	44	36	2.45
Post assignments	60	20	-	1.25

N=278

Source: Teachers' questionnaires

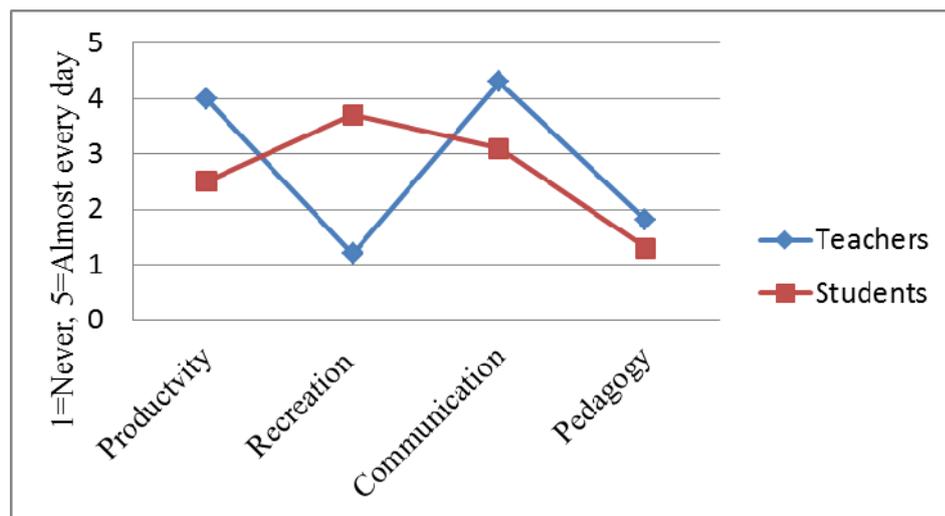
Table 4.7 presents the objectives for which teachers use ICT in schools. The teacher respondents cited use of computers for communication as the objective for which they mostly (Mean 2.45) use computers. The second objective in terms of rating of use was the use of computers for administrative record keeping which accounted for a mean of 1.95. The least use was on the use of computers for evaluation including posting of assignments which had a mean of 1.25. It is evident from the data in Table 4.7 that the objectives for which teachers mostly make use of computers are those that have little to do with instruction or what we may refer to as out of class activities. It is discernable from the data that in most schools, computers are used for tasks other than instruction which is classified by UNESCO (2002) as being at the applying phase and at the adoption phase of the Sandholtz et al., (19997) model. According to Sandholtz et al., teachers at this level require technical support as well as training for computer-assisted

instruction. Teachers predominantly used computers for either communication or administrative objectives.

4.4.6 A Comparison of teachers' and students' ICT use

In Figure 4.12 a summary of the frequencies of use of computers for four different types of activities by both teachers and students is presented.

Figure 4.12 Teachers and students use of ICT for different activities



Source: Teachers' and students' questionnaires

It is discernable from table 4.12 that for teachers and students, the frequency of use of ICT varies significantly. It is apparent for example that whereas students popularly use ICT for recreation, teachers do not. One notable and outstanding similarity among both teachers and students is that they rarely use ICT for pedagogical activities.

4.4.7 Use of ICTs to generate professional materials

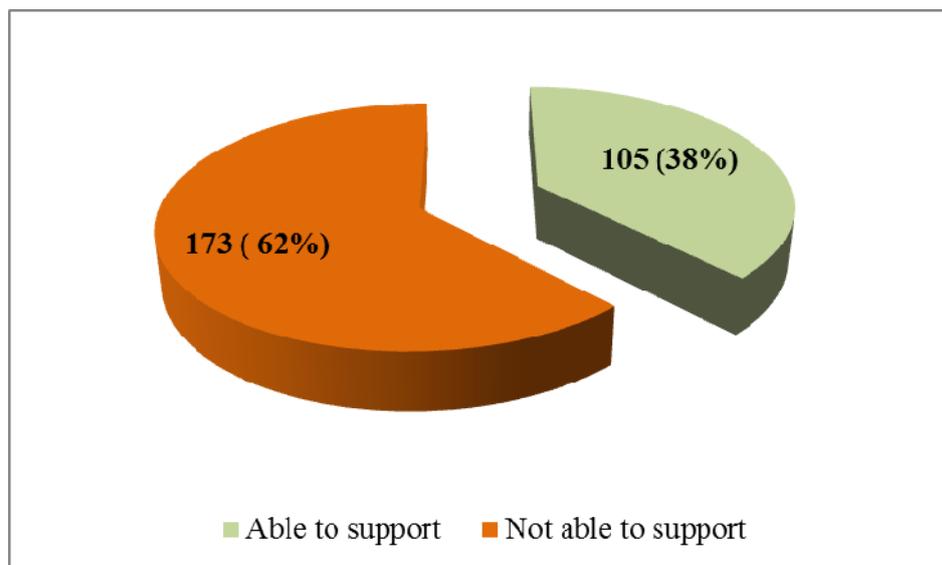
Due to the usefulness of computers in generating a variety of teacher professional tools such as lesson plans, students' handouts and databanks of examinations, teachers were asked to indicate whether they made use of ICTs to generate such materials. Since this was an open ended question, teachers gave multiple responses. When their responses were then grouped it was clear that majority of the teachers (73%) often used computers to create a databank of questions which they felt made it easy for them to set continuous assessment tests and examinations whenever it was necessary. Few teachers (34%) observed that they made use of the internet to access lesson plans from other sources. Fewer still (28%) used ICT to develop learning resources (teaching aids). It is evident from these data that despite the availability of ICT facilities in schools, teachers do not make use of the wide range of resources available to optimally improve their professional activities.

4.4.8 Teachers' ability to support student-centered computer activities

In the past, the design and development of student centered activities were largely left to the classroom teacher, but the new focus on constructivism has led researchers to exploit the emerging affordances of computers in order to develop programmes designed to be student centered. Teachers' implementation of technology-enhanced student-centered learning environments is affected by their beliefs about effective practices. Teachers in the sampled schools were asked to

state whether they had the capacity to support technology-enhanced student-centered activities and their responses are presented in figure 4.13.

Figure 4.13 Teachers' ability to support student-centered computer activities



N=278

Source: Teachers' questionnaires

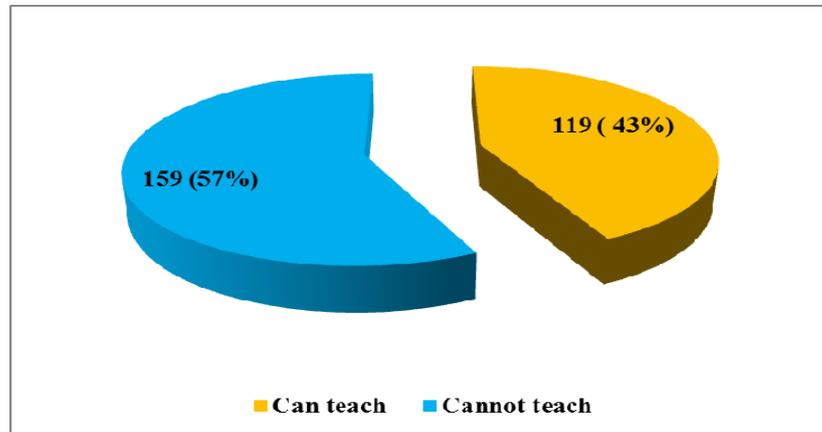
From figure 4.13, it is clear that the proportion of teachers in the sampled schools who can use ICTs to support student centered activities is relatively low (105, 38%). Majority of the teachers (173, 68%) had no competence to support student-centered activities. This shows that most teachers lack the capacity to use ICT to create classroom environments in which students are more active, share experiences through teamwork and computer activities. According to Fulton (1997), effective technology integration is a result of many factors but the most important of them all is the teacher's competence and ability to shape

instructional activities to meet students' needs. It is possible to imagine that majority of the teachers teach students the first level or basic technology skills but fail to integrate technology in their teaching for student-centred activities. It appears therefore that the current generations of youthful learners who are dubbed "digital natives" by Prensky (2001) often feel disconnected from the traditional teaching practices which fail to engage them actively in ICT use. Professional development programmes on how to integrate ICT for student-centered classroom practices need to be mounted for teachers. The professional development approaches should be the reform types which utilize peer interaction and collaboration often supported through online platforms like blogs. Since some teachers are already familiar with these ICT trends and activities, teachers should be encouraged and supported to share these best practices.

4.4.9 ICT for teaching creativity and higher order skills

As noted in the literature review, research shows that ICT is an effective tool for developing higher order skills and creativity (Anderson, 2011). Figure 4.14 shows a summary of responses about teachers' ability to use ICT to teach creativity and high order skills.

Figure 4.14 Use of technology to teach high order skills and creativity



Source: Teachers' questionnaires

Figure 4.14 summarizes the ability of teachers to use ICT skills in teaching higher order skills and creativity. Majority of the teachers 159 (57%) confessed that they did not know how to use ICT to teach creativity and higher order skills. Only 119 (43%) were comfortable teaching the two skills using ICT. The two skills, creativity and high order skills like critical thinking are classified as learning and innovation are classified as part of the 21st Century Skills (Anderson, 2010). Like in Grunwald and Associates (2010), in a survey on educators, technology and 21st century skills, this study shows that there are strong connections between technology use and the teaching of the 21st Century skills. Just as teachers seem not to predominantly use ICT in instruction, so do they also have problems in teaching 21st Century skills. The findings show that teachers need to be better prepared to integrate ICT in pedagogical activities and to equip students with relevant 21st century competencies and for better learning outcomes. Since the

learning and innovation skills are said to be critical in preparing students for an increasingly complex and dynamic world, the failure by teachers to instill them among learners is a big challenge that cannot be ignored. There is need therefore to develop innovative support systems within pre-service, in-service and professional development programmes to equip teachers with competencies for teaching these type of skills including creativity, innovation, critical thinking and problem solving.

4.4.10 Teachers’ pedagogical conceptions

In the studies of Hakkarainen et. al., (2001), a relationship was found between teachers’ pedagogical conceptions and technology-enhanced pedagogy. According to Hakkarainen et. al., (2001), there is a relationship between a teacher’s preferred methodology of teaching and their preference to integrate ICT in instruction. A questionnaire item was therefore developed to find out the teachers’ preferred methodology of teaching and the teachers’ responses to the item are summarized in table 4.8.

Table 4.8 Teachers’ preferred methodology of teaching

Methodology	Frequency	%
Largely teacher-directed (e.g. lecture)	87	31
Even balance between teacher-directed and student-centered activities	118	43
Largely student-centered (discovery learning)	73	26
N=278		Source: Teachers’ questionnaires

It is evident from Table 4.8 that majority of the teachers (43%) most preferred method is “even balance between teacher-directed and student centered activities” followed by largely teacher directed approach accounting for 26%. The least preferred method of teaching by teachers was “largely student-centered (discovery learning)” which was selected by seventy three (73) teachers. Evident from these data is the fact that most teachers still prefer sticking to the old methodologies of instruction. According to Sandholtz et al., (1997), most of the teachers who exhibit these characteristics are usually at the entry phase of the technology integration matrix. According to Sandholtz et al., teachers at this level prefer teacher-directed instructional activities over student centered practices. It is possible therefore to argue that minimal constructivist types of instructional activities are fostered by teachers in the sampled schools even with the availability of computers and other ICTs.

The results are consistent with the study carried out by Ertmer et al., (2004) in which they found out that despite the access of ICTs in schools by teachers, most of them were still conservative and predominantly rely on traditional teaching methods often citing challenges like shortage of time to plan and integrate technology in their classroom activities. From these experiences, it is not appropriate to imagine that using technology to simply support largely teacher-focused instruction like lecture method will transform learning. Teachers need to be empowered to understand how to use technology to facilitate constructivist

practices and meaningful learning. Constructivist type of pedagogy according to Khirwadkar (2007) enables students to construct deep and connected knowledge. To use technology to support student-centred instruction, teachers need additional knowledge of the content they are required to teach, the pedagogical methods that facilitate student learning and specific ways in which technology can support students' learning.

4.4.11 Barriers to ICT integration in schools

Barriers or obstacles to ICT integration in education pose a great challenge towards any technology based initiatives in schools. To find out the most common and pressing barriers, teacher respondents were asked to indicate in terms of level of significance the barriers that they encounter while using ICT in school.

Table 4.9 Barriers to integrating ICT

	Frequency
Lack of time and heavy school workload	239
Lack of access to ICTs	212
Lack of knowledge and competence on ICT use	203
Inadequate technical and administrative support	173
Inadequate and poor training on ICT use	161
Poor model of computers	123
Internet unreliable	57
Lack of interest in the use of computers for teaching	32
Rigid syllabus structure	26

N=278

Source: Teachers' questionnaire

The results in Table 4.9 show that there were different types of barriers that affected the integration of ICT in the sampled schools. It is clear from table 4.9

that time was the most critical barrier faced by teachers in the sampled schools. Time as a barrier cut across schools both in Nairobi and Kiambu Counties. Two hundred and thirty nine teachers (239) cited lack of time as a major challenge to their integration of ICT. Teachers felt that with their regularly scheduled classes, they lacked enough opportunities to practice using computers in their classes because of the heavy workload and extra curricula activities responsibilities. Also, lack of time scheduled on the timetable to use computers with students is a factor that was mentioned by teachers as a barrier to integrating computers in teaching. Even though some teachers had a genuine need to integrate computers in their classroom activities, teachers felt that they lacked adequate time to integrate ICT into their teaching.

The result is consistent with the finding of Mojgan et al., (2009) who revealed that lack of time to explore ICT and prepare ICT resources as a teacher-level barrier in implementing ICT in schools. According to Mojgan et al., (2009), teachers are sometimes unable to make full use of technology because they lack the time needed to prepare ICT resources for lessons. As seen in the literature review, Mumtaz (2000), lack of time is a factor that hinders technology integration in schools. This barrier becomes manifest in two ways: (a) release time and (b) scheduled time (Mumtaz, 2000).

The second most cited barrier by teachers was the lack of access to ICTs (cited by 212 teachers). This barrier consisted of many aspects cited by teachers such as shortage of software, e-content, and hardware devices. According to BECTA (2004), the inaccessibility to ICTs is not always merely due to the non-availability of the hardware and software. BECTA argues that it may be as a result of one of a number of factors such as poor organization of resources, poor quality hardware, inappropriate software, or lack of personal access for teachers.

Thirdly, lack of knowledge and competence in the use and integration of ICT in instruction was also highlighted by many teachers as a barrier. Two hundred and three teachers (203) felt that they lacked knowledge and skills to use computers and were therefore not enthusiastic on integrating these technologies in instruction. The results were consistent with what Pelgrum (2001) found out in a worldwide survey of nationally representative samples of schools from 26 countries which found out that teachers' lack of knowledge and skills was a serious obstacle to using ICTs in schools. It is possible evident to deduce from the current study and other studies evaluated through literature review that lack of competence may be one of the strong barriers to the integration of technologies into education.

Another barrier that was highly cited by teachers was the lack of technical and administrative support which was highlighted by 173 teachers. As pointed out by

Mojgan et al., (2009) and Cuban (1986), the lack of technical support is likely to prevent teachers from using ICTs. Since for instance teachers may find it difficult to sort out any technical challenge or fault in the computers, they therefore avoid taking up the challenge of using ICTs in teaching. Most of the teachers were uncomfortable with the repair and maintenance schedules of their schools which they considered to be not only irregular but also sub-standard. CFSK was accused of being too slow and less concerned with the repair of computers. Majority of the teachers though blamed their school administration for complacency in maintaining the computers and other ICT equipment in schools. One recurring challenge outlined by teachers in the study was that the refurbished and donated computers by CFSK are significantly unreliable for use in the long run. Some teachers felt that the refurbished computers in fact contain many hidden costs that make their usage more expensive over time than the purchase of new computers. The barriers of ICT integration can be classified as either being teacher-level, school level or system level barriers. From table 4.9, it is evident that the most common barriers are school level barriers and teacher level barriers. This shows that efforts for enhancing pedagogical ICT integration may have been exclusively focusing on the higher levels such as the national level without impacting the low, but equally critical level of schools and teachers.

Mechanisms therefore, need to be put in place to ensure that teachers have adequate access to technical support. It is suggested that a teacher with ICT

competency be appointed as ICT coordinator in each school to provide technical and pedagogical support to teachers. This is crucial in order to support teachers to make full use of ICT in classroom, and not lose time thinking about or attempting to fix ICT technical problems.

4.5 Attitudes and Self-efficacy

4.5.1 Students' attitudes towards computer use

In addition to the cognitive measures of learning, Wagner et al., (2005) point out that ICT is known to have affective consequences as well. These can include student motivation and attitudes about a particular school subject, about school in general or learning. As observed in literature review, several studies indicate that the actual usage of computers and effective ICT integration in education is dependent on the attitudes of the users (Naser et al., 2010; Huang and Liaw, 2005; Becker 1994). In this study students' and teachers' attitudes were evaluated using likert scales and the results of the two evaluations are presented in tables 4.10 and 4.11 respectively.

Table 4.10 Students' attitudes towards computers

	SA	A	N	D	SD	Mean
I have trouble understanding text, numbers or graphs in computers	-	10.1	-	39.9	50	1.72
I am used to working in a team when using computers	1.7	14.6	2.2	26.9	54.6	1.84
I use computers to find information from sources	3.5	17.9	2.3	24.9	51.4	1.14
Learning about computers is a waste of time	-	1.7	5.1	30.3	62.9	1.46
I think working with computers would be enjoyable and stimulating.	23.2	71.7	2.3	2.8	-	4.11

N=375

Source: Students' questionnaires

Table 4.10 is a summary of the likert scale used to measure students' attitudes towards ICT. The students' likert scale had five items. In the instrument, students were asked to report their opinions on a five point likert scale calibrated Strongly Disagree (SD), Disagree (D), Neutral (N), Agree (A) and Strongly Agree (SA). In analyzing the results, "Strongly Disagree" were rated as 1 while "Strongly Agree" were rated as 5. Majority of the students "strongly agreed" (23.2%) and others "agreed" (71.7%) that "working with computers would be enjoyable and stimulating". Additionally when the answers given to the two negative statements were reversed, the mean for these negatively worded statements fell on the strongly agree option. From these results it is evident that the sampled schools and the educational system in general need to leverage on the students' positive attitudes towards ICTs to enhance learners' active participation in learning processes for effective and positive learning outcomes.

When asked whether they worked in teams while utilizing computers, 54.5% students strongly disagreed and 26.9% disagreed to working in teams while utilizing computers in school. One would therefore conclude that the collaborative approach of integrating ICT in learning was rarely used in the sampled schools as reflected by the small number of students who selected strongly agree (1.7 %) and agree (14.6%) to the teamwork approach of ICT use. Considering the value and potential of using collaborative approaches in education, it is imperative that teachers and schools need to invest in pedagogical ICT integration approaches that allow students to collaborate in learning.

Table 4.11 Teachers attitudes towards integration of computers

Statement about computers	SA (%)1	A (%)2	N (%)3	D (%)4	SD (%)5	Mean
Computer anxiety						2.3
The challenge of teaching with computers is exciting	21	56	8	6	9	2.3
Anyone can learn to use computers if they are patient and motivated	53	38	4	5	-	1.6
Learning to operate computers is like learning any new skill; the more you practice, the better you become	49	36	-	11	4	1.9
I feel apprehensive about working with computers	19	17	23	21	20	2.9
I have difficulty in understanding the technical aspects of computers	15	28	6	46	5	3.0
Computer confidence						2.1
It scares me to think that I could cause the computer to destroy a large amount	4	7	-	46	43	1.8

of information by hitting the wrong key						
You have to be a genius to understand all the special commands used by most computer programmes	5	9		58	28	3.0
Given an opportunity, I would like to learn about and use computers	41	40	2	13	4	1.6
It would take too much time to learn how to use a computer successfully	-	15	-	45	42	1.9
Need for training						2.4
I try to keep informed about technological changes	24	32	25	19	-	2.4
I would like to take part in a computer course to learn more about computers	60	25	2	10	3	1.3
In-service training courses about computers should be made compulsory	25	-	-	41	32	3.9
I would like to learn more about computers as teaching aids	31	42	9	18	-	2.1
I don't mind learning about computers	25	37	20	18	-	2.3
Educational impact of computers						2.3
Computers are valuable tools for improving the quality of a child's education	55	19	7	9	10	1.7
Using computers in class leads to more productivity among students	29	26	3	18	24	2.8
Computers help to teach more effectively	35	47	8	5	5	1.9
The achievement of students can be increased when using computers for teaching.	39	30	14	9	8	1.7
The more I would use computers in the class, the less time I would have to concentrate on the (content of the) curriculum.	43	23	-	16	18	3.6
Using a computer in a classroom makes a subject more interesting	32	42	-	19	7	2.3

N=278

Source: Teachers' questionnaires

Table 4.11 tabulates data for the 20 likert-scale items used to measure the attitudes of teachers in four subscales, namely, computer anxiety, computer confidence, need for training, and educational impact of computers. Each subscale contains five items. The original survey with four-point items was modified to have five points. The neutral rating scale is added to gain more precise comments from teachers. The respondents rated their attitudes in using computer technology on the following scale: 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, and 5 = strongly agree. Among the 20 survey items, 6 statements of the survey were negatively worded. Scores of these negatively worded statements were reversed and therefore the scores of all the items were consistent. The lower scores indicate that teachers have more positive attitudes and less anxiety towards computers across the four sub-scales.

From the 20 items of the attitude scale, the survey responses were overwhelmingly positive (Table 4.11). In all the four subscales, namely, computer anxiety, computer confidence, need for training, and educational impact of computers, the mean was less than three (3). It is evident from the responses that teachers do not feel apprehensive about working with computers. Additionally, teachers also did not mind undergoing training on ICT use. It is evident that for all the items relating to training, majority of the teachers were receptive to the idea of learning about computers and ICT integration. However, as exemplified in table 4.12, only 16% of the teachers confessed to using the computers effectively.

Interestingly, and in contrast to the actual status of computer usage in schools, a substantial number of teachers (84%) agreed with the statement that stated that the educational system should make maximum use of computers. The positive attitudes registered by teachers in the study contrast with findings of a study where secondary school teachers were found to have good backgrounds on ICT but were reported to hold negative attitudes towards school related activities and programmes (Ndhine et al., 2010).

Considering that teachers just like students in this study exhibited positive attitudes towards ICT, it is important that this is used to leverage capacity for teachers to integrate ICT in learning.

4.5.2 Teachers' self efficacy

As evidenced by the reviewed literature, self-efficacy beliefs toward technology integration have been theorized to be a determining factor in how well a teacher is able to effectively use technology to improve teaching and learning (Arani, 2001). Teachers' self efficacy beliefs were measured and the data is summarily presented in table 4.12.

Table 4.12 Teachers' self efficacy beliefs on technology use

Statement	SD	D	N	A	SA	Mean
I feel confident working on a computer	4	9	7	38	23	3.83
I feel confident installing software	21	49	5	7	3	2.08
I feel confident organizing and managing files	5	12	9	35	22	3.69
I don't feel confident learning about computer hardware	24	28	4	16	12	4.57
I feel confident learning about computer software	3	31	14	25	11	3.12
I feel confident learning advanced skills of using computer programmes	4	28	24	24	4	2.95
I don't feel confident getting help on problems related to computers	7	33	20	9	16	4.93
I feel confident surfing the internet		5	12	40	28	4.07
I feel confident integrating ICT in instruction	20	27	19	14	4	2.46
I don't feel confident developing simple programmes for the computers	4	9	27	27	16	4.27

N=278

Source: Teachers' questionnaires

Table 4.12 summarizes the computer self efficacy scale which has ten items. Participants were asked to report their opinions on a 5 point likert scale “strongly disagree, disagree, neutral, agree and strongly agree”. In analyzing the result, “strongly disagree” is rated as 1 while “strongly agree” is rated as 5. The answers given to the negative statements were reversed. The results indicate that the teachers' level of computer self-efficacy is low (3.60) which falls on the “agree” option. As seen in table 4.12, some statements got high rankings. These are:

- ✚ I feel confident surfing the internet
- ✚ I feel confident working on a computer
- ✚ I feel confident organizing and managing files

It is notable however that the statement about integrating ICT in instruction received a lower rating (mean=2.46) indicating that most of the teachers in the sampled schools had a challenge in integrating ICT in instruction. The respondents have a lot of confidence in getting support related to using computers. From these findings, it is therefore imperative that teachers require support to help them integrate ICT for classroom instruction.

4.6 Teacher preparedness and professional development

4.6.1 Teacher preparedness for ICT integration

When teachers were asked whether they had received training on ICT integration at the teachers' training institutions where they received pre-service teacher training, 58% of the teachers indicated that they had not received ICT integration training. However, it was re-assuring to note that 54% of the teachers indicated that they had undergone ICT training in the past five years prior to the study with some of them attending workshops and training programmes sponsored by the schools like the CFSK training programmes.

Further to understanding the training profiles for teachers participating in the study, it was found necessary to assess the adequacy of teacher's training and preparedness to integrate ICT. Teachers' responses on their preparedness for ICT integration is summarized in table 4.13.

Table 4.13 Preparedness to use computers for classroom instruction

Level	Frequency	%
Not at all prepared	72	25.8
Somewhat prepared	157	56.5
Well prepared	29	10.6
Very well prepared	20	7.1

N=278

Source: Teachers' questionnaires

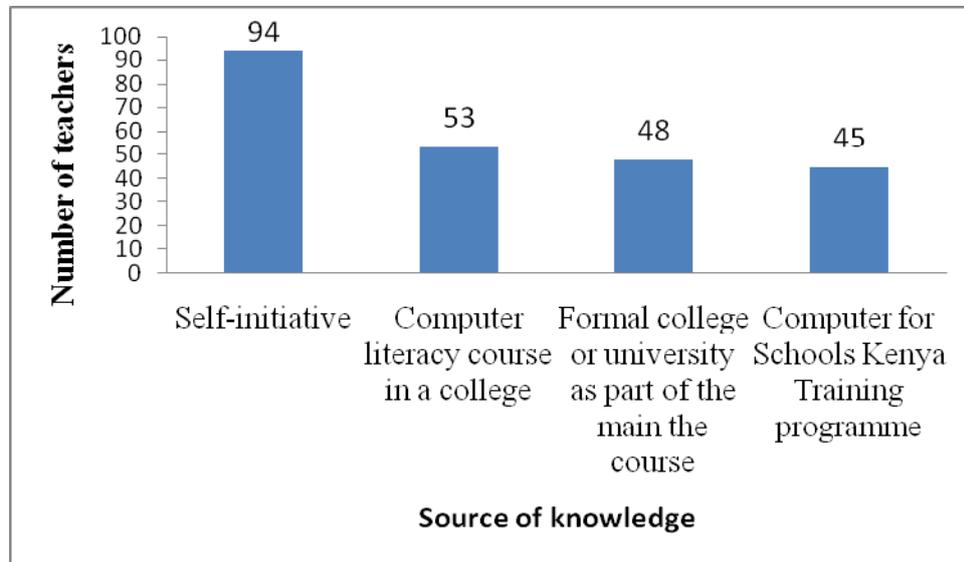
Table 4.13 represents statistics on teachers' level of preparedness towards the use of computers in classroom instruction. Most of the teachers accounting for 56.5% indicated that they were somewhat prepared to integrate ICT in instruction. Seventy two (25.8%) indicated that they were not at all prepared, twenty nine (10.6%) indicated they were well prepared while only twenty teachers (7.1%) indicated that they were very well prepared to integrate ICT in education. This finding is consistent with what Kiptalam and Rodrigues (2012) found out in a study on 11 secondary schools located in an urban area in Kenya that revealed that most of the young teachers who had served for few years in schools had received ICT training at college or university but that mostly the training is usually on computer applications rather than ICT integration. It is encouraging to note that the Ministry of Education has good intentions to ensure that ICT integration is mainstreamed in all teacher training programmes (Ministry of Education, 2006).

Teacher training at pre-service, in-service and in professional development courses should go beyond awareness and computer application skills. Teachers should be trained to expand their knowledge of pedagogical practices across multiple aspects of the planning, implementation and evaluation processes. According to Ertmer et al., (2004), teachers training should empower teachers to understand how to develop students' abilities to work collaboratively or to take control of their own learning in ICT – enhanced environments.

4.6.2 Source of knowledge for ICT use

Teachers' knowledge has been found to have significant impact on their decisions and actions (Mojgan et al., 2009). Teachers' competencies for ICT use is therefore an important factor in determining their level and manner of integration in instruction. To determine the sources of knowledge of ICT use, the teacher respondents were asked to rate the items in Figure 4.15 in order of significance (from the highest source to the lowest).

Figure 4.15 Source of knowledge for ICT use



N=278

Source: Teachers' questionnaires

It is evident from figure 4.15 that most of the teachers, ninety four (94) identified self-initiative as the means by which they learnt how to use computers. The second highest source of knowledge for computer use was identified as computer literacy training in college by fifty three teachers (53). Computer for Schools Kenya was identified by forty five (45) teachers as the highest source of knowledge. Other related sources of knowledge such as workshops and seminars were selected by nineteen teachers as an important source of ICT knowledge and skills. Apparently from this data, teachers attend professional development training workshops and seminars but it appears there is little evidence to suggest that the sessions meaningfully impacted on teachers' knowledge and competencies in integrating ICT in instruction. Therefore despite the availability

of professional development opportunities, teachers had more confidence on their own self initiatives on ICT capacity development. The data seem to suggest that workshops and seminars organized for upgrading teachers' knowledge and skills may not be fully effective hence the lower rating by teachers. This therefore dispels the assumption that teachers were not interested in pursuing their expertise in ICT. It is evident that most teachers (94) looked for their own avenues for ICT skills development, primarily utilizing their own time and seeking to add to their knowledge and skills through personal networks. There is need therefore to have a closer alignment between the amount of time given for professional development and its perceived importance.

4.6.3 Teacher professional development by Computer for Schools Kenya

Teacher professional development generally affords teachers ongoing learning opportunities to improve their skills and knowledge for better practice (Zhiting and Hanbing, 2006). The CFSK trainers were interviewed in order to understand how they train teachers on ICT integration and also to find out what constitutes the curriculum offered to teachers during their training sessions. It emerged from the interviews that the CFSK training offered to secondary school teachers focuses on the following modules: Basic User Proficiency, Hardware Maintenance, Computer Network Administration, ICT Integration in Teaching and Learning, Computerized Institutional Management, Web site administration, Short courses including SPSS, AutoCad, AchiCad and Quick Books. Except from

one module that is geared towards equipping teachers with ICT integration knowledge, all the other modules are computer application courses. The approach taken by CFSK followed the divergent model (Zhiting and Hanbing, 2006). As noted by Zhiting and Hanbing, this approach treats theories, technologies and pedagogies separately. Inappropriate training styles result in low levels of ICT used by teachers. Courses which lack pedagogical aspects are likely to be unsuccessful. Considering the perspective and approach used by CFSK, it is clear that in such ICT professional development courses, teachers are not often taught how to integrate ICTs into their pedagogical practices. This implies that after teachers had attended the ICT professional courses, they still found it difficult to integrate ICT in their teaching.

Professional development programmes should adopt a convergent approach in which theory and technology is focused on pedagogy. Skills taught to teachers should be within contexts of classroom practice and use. Emphasis should also be on the use of ICT in practical lessons rather than theory.

4.6.4 Source of support for ICT use

The presence or absence of support for the use of ICT devices determines the success of integrating these devices into various educational tasks. Teachers were asked to state their sources of support in the use of computers which is summarized in table 4.14.

Table 4.14 Frequency of support for ICT use

Source of technical support	Often	sometimes	never
Teacher for computers	45	76	157
Other teachers	9	48	221
Computer for Schools Kenya	7	25	246
Other out of school support	23	45	210

N=278 Source: Teachers' questionnaires

Table 4.14 presents the different sources of support for teachers in using ICT in schools. It is evident from the statistics that the most common source of support (45) is usually from teachers of computers in schools. Evident from table 4.14 is that the least source of support was that from Computer for Schools Kenya which was selected by 246 teachers. It is very clear from the data presented in table 4.14 that teachers from the sampled schools seldom get any kind of support as shown by the high number of teachers who confirmed that they never received support from any of the four sources enlisted in table 4.14.

From these data one is likely to conclude that the Computer for Schools Kenya does not have in place an elaborate support structure for schools where they supplied computers. Secondly, the most common sources of support are predominantly from teachers of computers in schools. This is encouraging because the existence of internal mechanisms of support in schools is an economical alternative and a readily available solution to some of the teething ICT related challenges in schools. UNESCO (2002) suggests that the provision of on-site, timely technical support is critical to the success of an ICT-based

educational program. In addition, Mumatz (2000) reviews literature on the use of Information and Communication Technology within an educational context. He mentions a case study in the UK that identified a number of factors that enable teachers to successfully engage in innovative practice. These were: support at senior management level for implementing new practices and addressing financial implications where appropriate; involvement of several members of staff; fostering a culture of collaboration within schools and mutual support; and lastly willingness to take risks. The role of school leadership is also central in meeting several of these preconditions. For effective ICT use and integration in schools, teachers require both technical and administrative support.

4.6.5 Teachers' ICT professional development needs

The continuous professional development of teachers sits at the heart of any successful educational system. Teaching is becoming one of the most challenging professions in our society where knowledge is expanding rapidly and modern technologies are demanding teachers to learn how to use these technologies in their teaching (Carlson and Gadio in Haddad W. and Draxler, 2002). The teacher needs-based professional development programmes maximize the effects of a professional development program, and help participants sustain their learning over the long term. To determine the professional ICT development needs of teachers in the sampled schools, an open ended question was developed which

elicited multiple responses that have been summarized under the following main thematic areas in table 4.15.

Table 4.15 Teachers’ ICT integration professional development needs

Need	Frequency
Computer hardware and software skills training	167
Internet use	48
How to integrate technology into teaching	223
Use of ICT to produce assessment tools	116
Use of technology for administrative work	51
Use of ICT for research	47
N=278	Source: Teacher questionnaire

In Table 4.15, teachers’ professional needs are summarized according to their frequency. Teachers responded to the open ended question “What do you see as your current needs for professional development in computers?” by giving different types of responses which are categorized as shown in Table 4.15. Teachers who were specific about the type of area for which they needed professional development identified integrating technology into teaching about twice as often as computer hardware and software skills. None of the teacher respondents in this study indicated that they did not require any type of training meaning that all of them felt deficient of technology related knowledge and skills. For example, one teacher pointed out that it was “pointless to do personal development without having regular access to a computer laboratory and appropriate software”.

Most of the teachers emphasized the need to receive training in order to satisfactorily confront the challenges caused by the implementation of ICT in teaching and learning processes. Almost all the teachers stated the need to acquire pedagogical training rather than technical skills; although sometimes they considered that they have to be aware of the potentialities of the tools in order to be able to use them properly. Most teachers felt that teacher training institutions were not doing enough to equip them with pedagogical ICT integration skills.

Some teachers expressed the need for better exposure to ICT use experiences. One teacher for example argued that it would be enriching for him to interact with his peers from private schools where ICT is regularly used in teaching and learning.

It was nonetheless interesting to note that some teachers were a step ahead because they were already interacting online with peers through blogs such as “*iLearn Technology, Emerging EdTec and Educational Technology Debate (ETD)*”. A further observation of these three blogs revealed that ETD seeks to promote a substantive discussion of how low-cost information and communication technology (ICT) device initiatives for educational systems in developing countries are relevant to the very groups they purport to serve – the students, teachers, and their surrounding communities. This is advanced through the conversation in weekly posts on a monthly topic of discussion. Participants

are encouraged to augment each post with comments, related information, and relevant news items. Participants are also encouraged to be moderators or discussants at any time. The activities embedded in the debate are categorized into four mutually supportive and inter-related focus areas, each building on the other namely; sharing information, sharing experience, discussing new innovations and solving problems to create a true industry- and continent-spanning community of practice (www.edutechdebate.org). The only challenge with such blogs is that that most of them are hosted abroad and therefore the content shared on them is foreign. Due to the foreign nature of the content, teachers feel distanced and out of tune with it.

From this example it was realized that there are now many examples of Internet and Web-based communication technologies, being used to support teachers' ongoing professional development and networking. Such types of websites provide online resources for teachers and facilitate teachers' networking based on the assumption that professional development should be an integral part of daily practice for all teachers and the use of the Internet would enhance continuous professional development activities of teachers, connecting teachers to larger teaching communities and allowing for interaction with expert groups. Teachers therefore need to be given incentives and facilitated to develop their ICT integration skills through a variety of strategies including online professional

development courses whose costs are often cheaper than face-to-face and even less interruptive of their daily schedules.

4.7 Policies for ICT integration

On the aspect of ICT use policies in schools, teachers were asked to state whether they had clear defined protocols for ICT integration in school activities including teaching and learning. Secondly, apart from availability of ICT policy in schools, teachers were also required to comment on their perceived usefulness of the ICT policy on the level and manner of ICT integration. It was noted in the study that majority of sampled schools in the study did not have written policies for ICT use. However, in seven of the schools participating in the study, ICT was identified as a chapter by teachers in the Schools' Strategic Plans. In only two schools, according to the teachers were there policies for ICT use. Interestingly though, even among the two schools that have written policies, still very few of them strictly adhered to the protocols. Further, teachers were also asked to comment on whether they were involved by the schools administrations in writing the schools ICT policies. This was important because teachers who participate in the development and evaluation of educational ICT policy at institutional level or beyond have been found through research to be competent and good mentors in ICT integration efforts (UNESCO, 2007).

Based on the low levels of ICT integration in the sampled schools and considering the importance of policies in guiding action in any endeavour, it is important for

schools to be supported and encouraged to develop suitable policies that are relevant to their institutions. Policies will provide suitable guidelines for action, and highlight the interventions that a school intends to take especially that which suits their particular situation. Schools differ in size, layout and the technical expertise of the staff, so there is no single solution that schools can follow to ensure that maximum benefit from the use of computers can be derived. They all need to develop individual policies. Additionally, schools have now become major targets for the marketing of ICT resources by companies thus it is important that schools should decide how they wish to use the emerging technologies to best meet their needs and not to merely conform to global requirements by buying ICTs just for the sake of being trendy. Investment in ICT infrastructure should be properly guided by their needs.

Thus, although the Government has invested heavily on the development of ICT integration policies at the national and strategic level, this has not properly and proportionately been cascaded to secondary schools.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The primary purpose of this study was to investigate the level and manner of ICT integration in secondary schools that had previously collaborated with CFSK. Whereas the fourth chapter presented the data analyzed and its interpretation, the fifth chapter consists of a summary of the findings, conclusions and the recommendations for action as well as future research.

5.2 Summary

5.2.1 Availability of and access to ICTs

Research undertaken elsewhere in the world on ICT integration in education reveals that the availability of and access to ICTs in school are key determiners of ICT usage and integration in instruction (Pelgrum and Law, 2003; Tearle, 2004; BECTA, 2004). In this study, the ICTs available in the sampled schools were desktop computers, LCD projectors, overhead projectors, radios, video equipment, digital videodisks (DVDs), compact disks (CD), laptops and digital cameras. All the schools in the study were sampled on the basis of having been equipped in some way by CFSK and therefore it was expected that they would be having computers. The study found out that there were 427 computers in the Nairobi County schools compared to 379 computers in the Kiambu County schools. Despite all the schools having computers, the study found out that the

student computer ratio in the sampled schools was poor and less than the UNESCO recommended ratio of one computer per student or even the ratio in the developed countries of 1: 5 (for USA as at 2009) or 1: 3 (for Australia as at 2013). But even among the 806 computers that were available in the schools, 97 (12%) were faulty. In terms of placement of computers, all the schools except two had computers placed in the computer laboratories for access by students and staff. With respect to availability of computer hardware in schools therefore, it was evident that all the schools had ICT presence but were predominantly at the “emerging phase” of the UNESCO model (UNESCO, 2002).

With regard to software applications, all the schools in the study had productivity software and operating system software. CFSK, it was noted, supplied a standard suite of software to schools whose use was rather general. When it came to specific educational software, a few schools (28%) in the study had in place subject specific courseware. Majority of the teachers (83%), felt that lack of relevant educational software was a hindrance to ICT-integrated pedagogy.

Availability of quality internet connectivity as evidenced by literature review is also a key determiner of ICT integration in schools (Pelgrum and Law, 2003). Shortage of internet in schools was noticed especially when only 316 (39.2%) of the computers were found to be connected to the internet. And even among these, majority of the computers were those that had cellular wireless connection which

was more often than not used only in administration for sending or receiving official e-mails. Fibre optic connection was the least available type of internet connection in schools with only three (3) schools having installed it. Other ICTs like video and radio were perceived by teachers to be more adequate than computers and the internet

In terms of access, whereas majority of the students (229 or 61%) indicated that they had access to computers while in school, a significant number (146 or 39%) do not access computers in their schools. This implies that despite most students relying on their schools to access ICTs, some students lacked the opportunity to access computers in school especially for learning. It is probable that the placement of computers in computer laboratories as was witnessed in majority (28) of the schools could be a stumbling block to access by students in most schools. Since most schools had only one computer laboratory for use by all students and staff, it is very likely that some students lacked opportunities to access computers especially those who do not take computers as an optional subject of study in school. Teachers also perceived internet in their schools as inadequate (Very poor=43; Poor=176). With poor internet access in most schools, it was evident that teachers and students lacked access to many online educational resources like social networking and blogging. Of note though among teachers in the two study locations, Nairobi and Kiambu, had fairly good ICT penetration level exhibited by the number of teachers who owned computers which stood at

29.9%. Interesting to note as well is that whereas more male teachers own personal computers in Kiambu County, the trend is different in Nairobi County where more female teachers own computers than their male counterparts.

5.2.2 The level and manner of ICT integration in schools

Despite the presence of ICTs in schools, it was necessary to determine the extent and manner of use of ICT by teachers and students. The study revealed that students did not particularly use computers and the internet as frequently as it would be desired. Whether the frequency was affected by intrinsic factors related to the students or extrinsic factors, the low proportion of students (2.2% for computers and 1.7% for internet) that uses the ICTs everyday is an indicator of low ICT-enhanced learning considering that teaching and learning are activities that take place in schools on a daily basis.

It was evident from the study that most schools still used computers for teaching computing. This was well reflected by students' responses in which majority of the students said that they mostly used computers in school to learn computing. The status was confirmed even more elaborately by teachers when 65% of them cited never having used educational applications to teach their subjects. This shows clearly that in most schools, computers are still being used for teaching computing as a subject in the secondary school curriculum rather than integrating ICT into the teaching of various subjects across the whole secondary curriculum.

Further, the respondents were asked to state the objectives for which they mostly used computers in schools, majority of them cited administrative work like record keeping. When a comparison was done between teachers and students in their use of ICTs, their responses revealed significant contrasts except for communication where both teachers and students had similar patterns for the use. However, for both teachers and students, their use of ICTs for pedagogical objectives was rated lowly.

Despite the potential advantage of using computers and the internet to generate instructional resources, very few teachers (28%) cited having used computers in generating them. It is possible that teachers lacked the skills to integrate ICT into their pedagogical activities as evidenced by the findings. Additionally, it is also possible that teachers lacked knowledge concerning ICTs potential to access many useful instructional materials which can be used in classrooms to enliven teaching and learning. When teachers' conceptions towards pedagogy and ICT integration were assessed, it was evident that teachers strongly believe in maintaining an even balance between teacher-directed and student-centered activities. This may partly explain the dismal ICT integration activities in schools reported by teachers. The minimal ICT integration efforts reported in schools accounts for the majority of teachers indicating that they lack the ability to teach creativity and high order thinking skills which are some of the most important skills advocated for by Partnership for 21st Century Skills (2004). The Partnership

for 21st Century Skills emphasizes that these skills are a blend of specific skills, content knowledge, expertise and literacies with innovative support systems to help students master the multi-dimensional abilities required of them in the 21st century.

5.2.3 Teachers' perceptions towards ICT integration

Considering that there are a number of internal teacher variables that explain ICT classroom integration, including teachers' constructivist teaching beliefs, teacher attitudes towards computers in education, teachers' computer motivation, 'teacher perception of ICT-related policies (Huang and Liaw, 2005), this study assessed teachers' perceptions in schools. This was meant to find out whether the provision of ICT facilities to schools by CFSK or any other source had impacted the pedagogical ICT integration in such schools.

In the study, it was noted that most teachers had positive attitudes towards ICTs in schools. To measure teachers' perceptions and attitudes, four main themes were assessed, computer anxiety, computer confidence, need for training to integrate ICT and the educational impact of ICT. In all of these four themes, teachers affirmatively showed positive attitudes. Overall, the teachers showed positive attitude towards technology usage, as shown by the mean score for each subscale being 2.0 and above (on a 5-point scale). The overall positive level of attitude towards technology could be attributed to the availability and accessibility to

computers and ICT equipment. This study found no significant differences in the attitude towards technology of teacher educators with respect to their gender. This finding does not support past research which suggested significant differences in computer attitudes by gender (e.g. Margolis and Fisher, 2002). Other studies have suggested that the masculine image of the computer has deterred females from benefiting from the technology and this has made them less confident or more anxious (Culley, 1988), resulting in females holding more negative attitudes to computers than males.

5.2.4 Challenges faced by teachers in pedagogical ICT integration

Lack of time and heavy school workload were predominantly cited by teachers as being the biggest challenges towards ICT integration in schools. Teachers stated that the burden caused by their heavy workload, exacerbated by extra-curricular activities and other school responsibilities, hindered their potential to effectively integrate ICT in teaching or to even try out innovative teaching approaches.

In the study, it was also evident that teachers found the school syllabus rigid to accommodate ICT-mediated practices. They perceived that the organization of knowledge in the syllabus required more a teacher-centered approach which does not favour the use of ICTs in teaching. Some also cited their commitment to didactic teaching as being influenced by the school requirements to prepare students for examinations. It was however realized that the teachers' didactic

approaches to teaching was also influenced by teachers' beliefs and philosophy. It is possible to argue like Orlando (2011) that their rigid philosophy and practice is a product of their formal and informal experiences and the influence of their teaching peers and school administration.

Poor access to ICT training, lack of relevant and quality educational software or courseware and lack of knowledge on the use of computers were cited by teachers as very significant barriers to ICT integration in instruction. These three significant challenges touch on teachers as agents of innovation, schools as facilitators of change and also technology experts as producers of relevant software for integration into instruction. On training, organizations such as Computer for Schools Kenya too have a responsibility to provide relevant pedagogical skills required to equip teachers with the capacity to infuse technology in their instructional activities.

On the part of students, majority of them cited shortage of ICT facilities and lack of opportunity to access the few available ICTs in schools as a significant impediment to ICT use for learning. The minimal use of computers in schools by both teachers and students reflects the magnitude of the challenge to institutions, the government and other stakeholders. If ICTs are to be fully integrated in instruction, all stakeholders need to work together to make it possible.

In the study, a number of barriers were identified by teachers. For ease of understanding, they have been classified into three categories. Firstly are the “School level.” Social norms describe how relevant others can influence individuals to behave in a certain way. The first barrier that belongs to this category is the lack of institutional support; it can be argued that there was a common feeling among teachers that the Ministry of Education does not provide enough institutional support for the process of ICT integration in education. For example, some teachers complained that the Ministry did not provide adequate software, policy guidelines and capacity for teachers to integrate ICT in their instructional activities. Another barrier pointed out by teachers that is associated with social norms is the lack of incentives and motivations. Some teachers cited lack of appreciation even when they attempted to use ICT in their teaching.

Another category of barriers noted in the study were teacher level factors. Facilitating conditions refer to the resources and opportunities that can facilitate or hinder the use of ICT in education. Some of these barriers include shortage of ICT facilities in schools and scheduling difficulties for classes that incorporate ICT use. Majority of the teacher respondents cited lack of time as a major impediment towards ICT integration. Teachers blamed heavy workload which they claimed denied them time to adequately prepare for ICT-based classes during the school time. Other teachers also highlighted poor internet connectivity in schools as a hindrance. Other barriers within this category are lack of sharing of

best practices. Teachers complained that they were deprived of workshops or conferences for sharing best practices especially those that relate to ICT integration in instruction. Lack of training emerged as a barrier as well. Teachers complained that the training offered to them on ICT was rarely on pedagogical ICT integration.

5.2.5 Teachers' professional development in pedagogical ICT integration

The necessity for professional development in relation to ICT skills and pedagogy is very clear. It is evident in the study that one main reason for lack of effective ICT integration in schools was the lack of competencies required to effect successful pedagogical ICT integration. Majority of the teachers indicated that they needed professional development especially in integrating technology into teaching. This type of professional development need was cited by about twice as many teachers as those who felt that they also needed computer application training. None of the teacher respondents in this study indicated that they did not require any type of training meaning that all of them felt deficient of technology related knowledge and skills as well as competencies for ICT integration in teaching and learning. The professional development approaches offered though workshops that teachers attended, it was very clear, hardly equipped teachers with the competencies for ICT-based activities and integration experiences for constructivist practices.

5.3 Conclusions

- ✚ It was realized from the sampled schools that there was relative ICT presence in schools. The ICT penetration level is fairly good considering the fact that all schools surveyed had desktop computers. However, the quantity of the computers in the schools was significantly low especially when one considered the computer to student ratios in the schools, notwithstanding that the same computers were also meant to be used by teachers. The average computer to student ratio for all the 30 schools was 1:25 a ratio that is higher than that in developed countries, for example 1:5 in USA or 1:3 in Australia as at 2009. However the ratio is lower than the national average (1:120).
- ✚ Apart from hardware, schools lacked educational software applications and e-content which are important for pedagogical ICT integration. Despite all the schools having a standard suite of productivity software applications and operating system software, there were few schools that had procured educational software applications for specific content areas in the curriculum. Therefore despite the Ministry of Education having put in place structures to develop e-content, the material is yet to reach the schools. Computer for Schools Kenya did not also supply schools with adequate e-content. According to the CFSK trainers, the e-content for schools at the time of the study was still being developed. The process of e-content development mentioned by CFSK was also found faulty because

it did not involve key stakeholders like teacher educators, practicing teachers and students.

✚ Despite the availability of some ICTs in schools, the level of access among teachers and students was low. When teachers and students were asked to comment about the frequency with which they accessed computers and the internet, majority indicated that they rarely accessed the resources. Therefore, in terms of availability and access to ICT infrastructure, schools in the study can be characterized as being at the emerging phase of the UNESCO model (UNESCO, 2002) and the entry level of the Technology Integration Matrix (Sandholtz et al., 1997). This implies that most schools in the study were at the beginning stages of ICT development in which case, administrators and teachers were just starting to explore the possibilities of using ICT for school management while the schools' teaching methodologies were still firmly grounded in traditional, teacher-centred practices.

✚ Despite the presence of ICTs in schools, teachers rarely integrated them in their pedagogical activities. It was evident in the study that majority of the teachers use ICTs either for personal related objectives or for administrative tasks like the storage of students records and computation of subject means. Additionally, the use ICTs to teach subject matter other than computing itself was almost completely absent. Rarely did learners have a chance to learn subject matter and to appropriate their own

educational experience through ICTs. Interestingly, even for teachers who taught computing together with another teaching subject, there was little evidence for the transfer of experiences from the computer lessons to the other subject. It was therefore noted that there was a disconnect in the use of ICTs by teachers especially between personal use and pedagogical use. Whereas some teachers often used ICTs for personal related objectives, this was not the case for pedagogical objectives. Thus, though there is relative computer presence in CFSK supported schools, this has been slow to translate into substantially changed practice or widespread use except in relatively straightforward applications such as email, word processing and presentation software, examples of what Norton and Wiberg (1998) describe as second generation technology use: applying applications to familiar problems and tasks. There were however a few isolated cases noted in the study of innovative ICT use by teachers. Some teachers actively engaged students in ICT use activities which sometimes went even beyond the classroom setting. It is evident from this that majority of the schools in the study are at the emerging phase of the UNESCO model (UNESCO, 2002).

✚ From the study, the availability of ICTs and computers application training must have played a significant role in improving the attitudes of teachers towards ICT. Teachers in the study exhibited high attitudes in all the four sub-scales that were used to measure teachers' attitudes. The

teachers' confidence towards ICT, need for ICT training and perceived educational impact of ICT were high. The study did not also find any significant difference in attitudes towards ICT integration between male and female teachers. Besides attitudes, teachers' self-efficacy towards pedagogical ICT integration was found to be low. This implies that perhaps teachers ICT training and professional development programmes did not adequately equip teachers with competencies for pedagogical ICT integration.

✚ There were many barriers to pedagogical ICT integration highlighted by teachers. The barriers were however classified into three main typologies. First is the social norm type of barriers. These barriers include lack of incentives and motivation for teachers who go beyond their traditional didactic teaching practices to creatively develop constructivist learning environments using ICT. Teachers also cited lack of supportive school environments as a limiting factor in ICT use. Secondly, teachers cited barriers related to facilitating conditions. These included lack of time for planning and executing ICT integrated lessons, lack of access to technology and also lack of opportunities for sharing best practices of pedagogical technology integration. Thirdly, there were barriers related to teachers' competencies. These types of barriers ranged from lack of opportunities for quality training, lack of generic ICT skills to difficulties in pedagogical ICT integration.

- ✚ It was evident from the study that most of the professional development programmes administered to teachers focused on generic or ICT application skills. The model used in teacher professional development programmes was largely divergent rather than convergent. The teacher professional development needs analysis clearly showed that teachers require training pedagogical on ICT integration for them to meaningfully integrate ICT in their instructional activities.

5.4 Recommendations for action

- i. Schools to be encouraged to develop ICT use policies that will guide strategic elements necessary for optimum integration of ICT for instance acquisition and installation of ICT and other relevant infrastructure, capacity development for teachers, maintenance of equipment and utilization of ICTs;
- ii. The Government should encourage and provide guidelines to schools to pursue Public-Private-Partnerships especially with the intention of equipping schools with relevant ICT infrastructure and teacher professional development;
- iii. Teacher professional development providers (at University, Teacher Training Colleges and other educational agencies) should expose teachers to practical examples of integrating ICT for constructivist teaching. By seeing teacher educators as successful role models and mentors, teachers

will build the confidence and capacity that is necessary for pedagogical ICT integration;

- iv. Prototypes of course materials/modules should be developed by higher education institutions/universities which would be used to train trainers of trainers (TOTs) at regional levels who would in turn train much larger numbers of teachers at other decentralized levels;
- v. To develop strong ICT institutional frameworks for efficient integration of ICT, there is need to develop regional centers charged with the operationalization and implementation of policies and strategies being instituted by the National Centre for ICT in Education (NACICTIE). The regional centers would be required to provide necessary support to schools and teachers
- vi. Teachers need to collaborate with and learn from peers. One avenue for doing this is through the establishment of professional learning communities to share experiences of using technology in teaching and learning. The groups can be formed within schools or among teachers from different schools and their interaction could either be face-to-face or virtually and online platforms like blogs and skype.

5.5 Recommendations for further research

- i. This study used a cross-sectional survey design to investigate the status of ICT integration in schools. Further research using a participant observation approach would allow researchers to see more clearly what is happening in the classroom and to understand the situation from a holistic and comprehensive perspective.
- ii. Since the findings of this study were influenced by a variety of characteristics and since observations in many settings would be difficult, it would be ideal if several researchers were collaborating in such a research project.
- iii. Research on a larger scale is needed to see if the findings of this study can be generalized to all schools that have collaborated with CFSK in Kenya. A thorough research should be undertaken to establish the relationship between ICTs and ICT in education policies.
- iv. Longitudinal studies are recommended that might be helpful to track changes in thinking processes and related teaching practices with educational technologies.
- v. Given the extensive use of digital media out of school by both students and teachers, it would be good to undertake a study with a broadened scope that includes out-of-school use of digital media;
- vi. Subsequent research is recommended to explore in more depth and other contexts trends and constraints on ICT integration in specific subjects

within the secondary school curriculum in Kenya and that could include classroom observational studies which were beyond the scope of this study.

- vii. The theoretical issues in integrating ICT into specific subjects in the secondary school curriculum and the teachers' enhanced role through professional development provide interesting pathways for further research.

Bibliography

- Ananiadou, K. and Claro, M. (2009).** 21st Century skills and competences for new millennium learners in OECD countries. Organization for Economic Cooperation and Development working paper no. 41. Retrieved from <http://www.oalis.oecd.org>.
- Anderson, G. (1997).** Fundamentals of educational research. London: The Falmer Press.
- Angeli, C. and Valanides, N. (2009).** 'Epistemological and methodological issues for the conceptualization, development, and assessment of ICT-TPCK: Advances in technological pedagogical content knowledge (TPCK)', *Computers and Education*, 52, pp. 154-168.
- Aslan, S. and Reigeluth C. (2011).** A trip to the past and future of educational computing: understanding its evolution. *Contemporary Educational Technology*, 2011, 2(1).
- Baldwin, N. (1995).** *Inventing the Century*. New York: Hyperion.
- Bandura, A. (1982).** Self Efficacy mechanism in human agency. *American Psychologist*, 37 (2) 122-147.
- Becker, H. (1994).** How Exemplary Computer-using Teachers Differ from Other Teachers: implications for realizing the potential of computers in schools, *Journal of Research on Computing in Education*, 26, pp. 291-321.
- Becker, H. and Anderson, R. (2001).** School investments in instructional technology. Irvine, CA: Center for Research on Information Technology and Organizations.
- BECTA (2004).** The impact of information and communication technologies on pupil learning and attainment. *ICT in Schools Research and Evaluation Series – No.7*. Retrieved May 10, 2010, from <http://www.becta.org.uk/>
- Bee, T. and Chia, H. (2008).** Exploring the extent of ICT adoption among secondary school teachers in Malaysia. *International Journal of Computing and ICT Research*, 2 (2).
- Bhasin, B. (2012).** Integration of ICT to enhance teaching and learning. *Contemporary Educational Technology*, 3 (2).

- Bryman, A. (2008)** Social research methods (3rd Edition). New York: Oxford University Press.
- Carmichael, P. and Honour, L. (2002).** ‘Open Source as appropriate technology for global education’. International Journal of Education. (22)1.
- Carter, C. (1998).** An assessment of the status of the diffusion and adoption of Computer-based technology in Appalachian college association colleges and universities (Unpublished doctoral dissertation) Virginia Polytechnic Institute and State University, Virginia, USA.
- Chapman, D. and Lars, O. (2004)** Adapting technology for school improvement: A global perspective. Paris: International Institute for Educational Planning.
- Chio, Y. (1992).** Attitudes toward and knowledge of microcomputers used for instruction among commercial high school teachers in Korea (Unpublished EDD dissertation) University of Georgia, Athens, GA, USA.
- Cohen, L., and Manion, L. (1998).** Research methods in education (4th Ed.). London: Routledge.
- Comber, C., Lawson, T. and Hargreaves, L. (1998).** From familiarization to adaptation: Teachers’ responses to the introduction of ICT into the classroom. Proceedings of IN-TELE.
- Compeau, D., and Higgins, C. (1995).** Computer Self-Efficacy: Development of a Measure and Initial Test. MIS Quarterly, 19.
- Computers for Schools Kenya (2008).** Newsletter (September, 2008 Edition).
- Cox M., Preston C. and Cox K. (2003).** ICT and Pedagogy: A Review of the Research Literature. London: Department for Education and Skills and British Educational Communications and Technology Agency.
- Crawford, R. (1995).** Managing information technology in secondary schools. New York: Routledge.
- Cuban, L. (1986).** Teachers and Machines: The Classroom Use of Technology Since 1920. New York: Teachers College Press.

- Culley, L. (1988).** Option Choices and careers Guidance: Gender and Computing in Secondary Schools. *British Journal of Counseling and Guidance*, 16, 72-82.
- Davis, F. (1989).** Perceived usefulness, perceived ease of use and user acceptance of information technology. *MIS Quarterly*, 13 (3), 319-40.
- Drent, M., and Meelissen, M. (2008).** Which factors obstruct or stimulate teacher educators to use ICT innovatively? *Journal of Computers and Education* 51 (1).
- Ertmer, P., Addison, P., Lane, M., Ross, E., and Woods, D. (2004).** Examining teachers' beliefs about the role of technology in the elementary classroom. *Journal of Research on Computing in Education*, 32(1).
- Evoth, C. (2007).** ICTs, secondary education, and the knowledge economy: Exploring the roles of the private sector in Post-Apartheid South Africa. *Journal of Education for International Development*.
- Farrell, G., Shafika I. and Trucano M.(eds.). (2007).** Survey of ICT and Education in Africa (Volume 2): 53 Country Reports. Washington, DC: *infoDev / World Bank*.
- Forgasz, H., and Prince, N. (2001).** Computers for secondary mathematics: Who uses them and how? Proceedings of the research in education conference. Retrieved 10 June 2010 from www.aare.edu.au.
- Fulton, K. (1997).** Learning in a digital age: Insights into the issues: The skills students need for technological fluency. Retrieved from 20th July, 2012 from <http://www.mff.org>.
- Gay, L. (1992).** Educational research: Competencies for analysis and application. New York: Macmillan Publishing Company.
- Gilbert, S., and Green, K. (1997).** Moving information technology into the classroom. In Enghagen, L. (Ed.). *Technology and higher education*. Washington, D.C.: National Education Association of the United States.
- Glennan, T., and Melmed, A. (1996).** Fostering the use of educational technology: Elements of a national strategy. Washington, D.C: RAND Report.

- Gooden, A. (1996).** Computers in the classroom: How teachers and students are using technology to transform learning. San Francisco, CA: Jossey-Bass.
- Government of Kenya (2006).** A National Information and Communication Technology Policy Strategy. Nairobi: Government Printers.
- Government of Kenya (2005).** ICTs in Education Options Paper Nairobi: Government Printers.
- Government of Kenya (2007).** Kenya Vision 2030: A Globally Competitive and Prosperous Kenya. Nairobi: Government Printers.
- Guttman, C. (2003).** Education in and for the Information Society. Paris: UNESCO.
- Haddad, W. (2007).** Decision makers essentials. ICTs for education: A reference handbook. Washington, DC: *info Dev/World Bank*.
- Haddad W. and Draxler A. (Ed.). (2002).** The dynamics of technologies for education. Washington DC: UNESCO and the Academy for Educational Development
- Harrison, A., and Rainer, K. (1992).** An examination of the factor structures and concurrent validities for the computer attitude scale, the computer anxiety rating scale, and the computer self-efficacy scale. *Educational and Psychological Measurement*, 44.
- Hawkrigde, D., Jaworski, J. and McMahon, H. (1990).** *Computers in Third-World schools: examples, experiences and issues*. London, Macmillan.
- Heek H. and Myunghee K. (2009).** Impacts of ICT use on school learning outcome. Luxembourg: OECD.
- Heinich, R., Molenda, M., Russell, J., and Smaldino, S. E. (2001).** *Instructional media and technologies for learning (7th Ed.)*, Englewood Cliffs, N.J: Prentice Hall.
- Hennessy, S., Deaney, R., and Ruthven, K. (2005).** Emerging teacher strategies for mediating ‘Technology-integrated Instructional Conversations’: a socio-cultural perspective. *The Curriculum Journal*, 16 (3).
- Hinostroza, J and Mario B. (2009).** ICT in education policy and practice in Chile: Does It Correlate? Santiago: Centre for Research in Educational Policy and Practice.

- Hirschbuhl, J., and Faseyitan, S. (1994).** Faculty uses of computers: fears, facts and perceptions. *T.H.E. Journal*, 21(9).
- Huang, H., and Liaw, S. (2005).** Exploring users' attitudes and intentions toward the Web as a survey tool. *Computers in Human Behavior*, 21(5).
- International Society for Technology in Education (2009).** Essential Conditions.
- International Telecommunication Union (2007).** World Telecommunication Development Report.
- Internet World Stats. (2010).** Internet Usage Statistics: The Internet big picture: World Internet users and population stats, from <http://www.internetworldstats.com/>
- Ivers, K. (2003).** A teacher's guide to using technology in the classroom. New York: Libraries Unlimited
- Johnson, R., and Christensen, L. (2004).** Educational research: Quantitative, qualitative, and mixed approaches (2nd ed.). Boston, MA: Pearson Education.
- Jonassen, D. (2000).** Computers as mindtools for schools: Engaging critical thinking (2nd edition). Columbus, OH: Merrill.
- Jones, A. (2004).** A review of the research literature on barriers to the uptake of ICT by teachers: British Educational Communications and Technology Agency.
- Karsenti, T., Harper T., Traore D., Mbangwana M., and Toure K. (2009).** The PanAfrican research agenda on the pedagogical integration of ICTs. OECD World Forum, Busan, Korea.
- Keengwe, J. and Onchwari, G. (2008).** Computer technology integration and student learning: Barriers and promise, *Journal of Science Education and Technology*, 17, (5).
- Kent, E. (2010).** An investigation into factors affecting teachers use of ICT in an Irish post primary school: a case approach. Master thesis, Department of Education and Professional Studies University of Limerick.
- Kenya National Examinations Council (2011).** The year 2011 KCSE Examination Report. Nairobi: Kenya National Examinations Council.

- Khirwadkar, A. (2007).** Integration of ICT in Education: Pedagogical Issues. Retrieved April 27, 2009, from [http://www.journal.au.edu/edu journal](http://www.journal.au.edu/edu%20journal).
- Kidombo H., Gakuu C., and Ndiritu A. (2013).** Institutional management and integration of information and communication technology in teaching and learning in selected Kenyan schools.
- Kinzie, M., Delcourt, M., and Powers, S. (1994).** Computer Technologies: Attitudes and Self-Efficacy across Undergraduate Disciplines. *Research in Higher Education*, 35(6).
- Kiptalam, G. and Rodrigues, A. (2012).** Accessibility and utilization of ICTs among secondary school teachers in Kenya. Retrieved from [www.computing milieu.co.ke](http://www.computingmilieu.co.ke)
- Kluever, R. et al (1994).** The computer attitude scale: assessing changes in teachers' attitude towards computers. *Journal of Educational Computing Research*, 11(3).
- Knezek, G., and Christensen, R. (2000).** Refining best teaching practices for technology integration: KIDS project findings for 1999-2000. Denton, TX: Institute for the Integration of Technology into Teaching and Learning (IITTL).
- Koehler, M., and Mishra, P. (2006).** Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108 (6), 1017–1054. Columbia: Columbia University.
- Kotrlik, J., and Redmann, D. (2002).** The Kotrlik/Redmann technology integration model. Baton Rouge, LA: Louisiana State University.
- Kozma, R., and Anderson. R.(2002).** Qualitative case studies of innovative pedagogical practices using ICT. *Journal of Computer Assisted Learning*, 18, 387-394.
- Kozma, R. (ed.) (2003).** Technology, innovation and educational change: A global perspective. New York: Information Society for Technology in Education.
- Krejcie and Morgan (1970).** Determining Sample Size for Research Activities. *Educational and Psychological Measurement*, 30.
- Kruger, K. (2012).** Learning to change, changing to learn. Keynote address EduTech 2012, K–12 IT Managers Conference Sydney Australia 31st May

- Kukafka, R., Johnson, A. Linfante and J. Allegrante (2003).** Grounding a new information technology implementation framework in behavioral science: A systematic analysis of the literature on IT use. *J. Biomed. Inform.*, 36: 218-227.
- Laudon, K, and Laudon, J. (2010).** *Management Information Systems*. New Jersey: Upper Saddle River,
- Majumdar, S (2005).** Regional guidelines on teacher development for pedagogy-technology integration. Bangkok: UNESCO.
- Margerum, J., and Marx, R. (2003).** Teacher knowledge of educational technology: A case study of student/mentor teacher pairs. In Y. Zhao (Ed.), *What should teachers know about technology? Perspectives and practices* (pp. 123-159). Greenwich, CO: Information Age Publishing.
- Margolis, J. and Fisher, A. (2002).** *Unlocking the Clubhouse: Women in Computing*. Cambridge, MA: The MIT Press.
- Means, B., Blando, J., Olson, K., Morocco, C., Remz, A. and Zorfas, J. (1994).** *Using technology to support education reform*. Office of Educational Research and Improvement, Washington DC: Department of Education.
- Ministry of Education (2006).** *National ICT strategy for education and training*. Nairobi: Government Press.
- Mojgan A., Kamariah B., Wong L., and Foo, S. (2009).** Factors affecting teachers' use of information and communication technology. *International Journal of Instruction*, 2(1).
- Moore, M. (1989).** Three types of interaction. *The American Journal of Distance Education*, 3 (2).
- Morrison, G., Lowther, D., and DeMeulle, L. (1999).** *Integrating computer technology into the classroom*. Upper Saddle River, NJ: Prentice Hall.
- Mugenda, O., and Mugenda, A. (1999).** *Research Methods: Qualitative and Quantitative Approaches*. Nairobi: African Centre for Technology Studies (ACTS) Press.

- Mumtaz, S. (2000).** Factors affecting teachers' use of information and communication technology: a review of the literature. *Journal of Information Technology for Teacher Education*, 9.
- Murphy, P., Anzalone, S., Bosch A. and Moulton, J. (1989).** Enhancing Learning Opportunities in Africa: Distance Education and Information and Communication Technologies for Learning. Washington DC: The World Bank.
- Naser J., Leong L., and Fong, S. (2010).** Teachers' attitudes and levels of technology use in classrooms: The case of Jordan schools. *International Journal of Education Studies* 3, (2).
- National Center for Education Statistics (2000).** Teachers' tools for the 21st century. Washington DC: US Department of Education.
- National Council for Science and Technology (2010).** ICT capacities and capabilities in secondary schools in Kenya. Nairobi: Government Printers.
- Ndhine E. Njoroge H. and Ogwel C. (2010).** ICT Capacities and Capabilities in Secondary Schools in Kenya. Nairobi. National Council for Science and Technology.
- Norton, P., and Wiberg, K. (1998).** Teaching with technology. Orlando, Florida: Harcourt Brace College Publishers
- Novak, J. (1998).** Learning, creating, and using knowledge: Concept maps as facilitative tools in schools and corporations. Mahwah, NJ: Lawrence Erlbaum Associates.
- OECD (2001).** Education policy analysis. Paris: Centre for educational research and innovation.
- Orlando, J. (2011).** ICT, constructivist teaching and 21st century learning.
- Pan African Research Agenda on the Pedagogical Integration of ICTs. (2011).** Orienting and supporting the pedagogical integration of ICT in African countries: 8 recommendations for policy makers, teacher trainers and other education administrators. Available at: www.ernwaca.org
- Partnership on Measuring ICT for Development (2010).** Core ICT Indicators. Geneva. International Telecommunication Union.

- Partnership for 21st Century Skills (2004).** Framework for 21st century learning. Retrieved July 15, 2009 from <http://www.21stcenturyskills.org/>.
- Pelgrum, W., and Law, N. (2003).** ICT in education around the world: Trends, problems and prospects. UNESCO- International Institute for Educational Planning.
- Plowman L., Stephen C., Downey, S. and Sime, D. (2006).** Interplay: Play, learning and ICT in pre-school education. Retrieved from on 7 March, 2011 from www.ioe.stir.ac.uk/.
- Prensky M. (2001).** Digital game-based learning. New York: McGraw-Hill.
- Reiser, R., and Salisbury, D. (1995).** Instructional technology and public education in the United States: The next decade. Englewood, CO: Libraries Unlimited.
- Roblyer, M., and Edwards, J. (2000).** Integrating educational technology into teaching. Upper Saddle River, NJ: Prentice-Hall.
- Rodrigues, S. (2003).** Experiences from the partnership in primary science project: Teacher professional development involving ICT and science pedagogical content knowledge. *Science Education International*, 14(2).
- Roberts, D. (1991).** Attitudes of pre-service teachers to computers (Unpublished MSc Dissertation). Curtin University, Perth, Western Australia.
- Rogers, E. (1995).** Diffusion of Innovations (4th Ed.). New York: The Free Press.
- Rosnaini, M., and Ismail, M. (2008).** Factors influencing ICT integration in the classroom: implications to teacher education. Conference Proceedings. Sazburg, Austria.
- Rusten, E. and Hudson H. (2002).** Infrastructure: Hardware, networking, software, and connectivity. In Haddad W. and Draxler A.(Eds.), *Technologies for education. potentials, parameters and prospects*. New York: Academy for Educational Development
- Sandholtz, J., Ringstaff, C., and Dwyer, D. (1997).** *Teaching with technology: Creating student-centered classrooms*. New York: Teachers College Press.
- Sarfo, F. and Ansong, K. (2011).** Ghanaian Senior High School students' access to and experiences in the use of Information and Communication Technology. *Education in a technological world*, 2 (4).

- Scheuermann, F., and Pedro, F. (Ed.). (2009).** Assessing the effects of ICT in education: Indicators, criteria and benchmarks for international comparisons. JRC/European Commission and OECD.
- Sheingold, K., and Hadley, M. (1990).** Integrating computers into classroom practice. New York: Bank Street College of Education.
- Strydom, M., Thomson, J. and Hodgkinson C. (2005).** Understanding ICT integration in South African classrooms. *Perspectives in Education*, 23(4).
- Sutherland, E. (2010).** **International Mobile Roaming in Africa.** Retrived on 12th March 2011 from <http://ssrn.com>.
- Swain, C. and Pearson T. (2001).** Bridging the digital divide: A building block for teachers. *Learning and leading with technology*, 28 (8).
- Swanson, E (1989).** Measuring user attitudes in MIS Research: A review. *International Journal of Management science*, 10 (2), 157-165.
- Tearle, P. (2004).** A theoretical and instrumental framework for implementing change in ICT in education. *Cambridge Journal of Education*, 34.
- The Standard (2009).** Teachers pursuing wrong courses for promotion. Sunday, August 23rd 2009.
- Torkzadeh, G., and Koufterous, X. (1994).** Factorial Validity of a Computer Self-Efficacy Scale and the Impact of Computer Training. *Education and Psychological Measurement*, 54(3).
- Trucano, M. (2005).** Knowledge Maps: ICT in education. Washington, DC: infoDev/World Bank.
- UNESCO (2002).** Information and communication technology in education. A curriculum for schools and programme of teacher development. Paris: UNESCO
- UNESCO (2007).** Technologies for education: Potentials, parameters and prospects.
- UNESCO Institute for Statistics (2009).** Guide to measuring ICT in education. Montreal: UNESCO Institute for Statistics.

- UNESCO (2010).** UNESCO science report 2010: The Current Status of Science around the World. Paris: United Nations Educational, Scientific and Cultural Organization.
- UNESCO (2005).** Regional Guidelines on Teacher Development for Pedagogy-Technology Integration [Working Draft] (Editor Shyamal. Majumdar). UNESCO, Bangkok.
- Unwin, T. (2004).** Towards a framework for the use of ICT in teacher training in Africa. *The Journal of Open and Distance Education on Open Learning in Less Development Countries.*
- Veen, W. (1993).** The role of beliefs in the use of information technology: Implications for teacher education. *Journal of information technology for teacher education*, 2 (2).
- Venezky, R. and Osin, L. (1991).** The intelligent design of computer-assisted instruction. New York, NY: Longman.
- Wabuye, L. (2003).** Understanding teachers and administrators perceptions and experiences towards computer use in Kenyan classrooms: A case study of two schools (Unpublished PhD dissertation), Ohio University, Ohio, USA.
- Wagner, D., Day, B., Tina J., Kozma, R., Miller, J., and Unwin, T. (2005).** Monitoring and Evaluation of ICT in Education Projects: A Handbook for Developing Countries. Washington, DC: infoDev / World Bank.
- Warschauer, M. (2010).** New Reports on Technology in US Schools: The Changing Divide. Retrieved from <http://papyrusnews.com>
- Wims, P. and Lawler, M. (2007).** Investing in ICTs in educational institutions in developing countries: An evaluation of their impact in Kenya. Available at: <http://www.ijedict.dec.uwi.edu/>.
- World Bank (2007).** Improving Secondary Education retrieved on 8 May 2009 from www.openknowledge.worldbank.org.
- Zhiting, Z and Hanbing, Y. (2006).** ICT and Pre-service Teacher Education: Towards an Integrated Approach. Retrieved September 14, 2009, from <http://www2.unescobkk.org>

APPENDICES

Appendix I: Research Questionnaire for Teachers

This questionnaire is part of my PhD study in Educational Communication and Technology that I am undertaking at Kenyatta University. One of my goals is to study secondary schools' experiences with the use of ICT. In that regard, the questionnaire is meant to collect information on how teachers integrate ICT in instruction. The knowledge that we will gain from your responses will help in providing useful data for my study as well as for informing policy decision making in the area of educational technology. All information you provide will be kept strictly confidential and under no circumstances will your individual responses be released to the school or any other people. Please omit your name and that of your institution. Respond to ALL the items as clearly and accurately as you can. Your professional experiences and opinions are crucial to helping us understand integration of ICT from the educator's point of view. We would greatly appreciate your taking the time to complete our questionnaire.

A.) Background Information

- 1.) What is your gender? Male Female

- 2.) What is your highest level of academic qualification? Check the one that applies to you.
 - a.) Certificate
 - b.) Diploma
 - c.) Bachelors degree
 - d.) Masters degree
 - e.) Others . Please specify _____

- 3.) What is the range of your age?
 - 18-25
 - 26-35
 - 36-45
 - over 46

- 4.) How many lessons do you teach per week? _____
- 5.) What subjects do you teach?
 - i.)
 - ii.)
6. (a.) What is the population of teachers in your school?
Male _____ Female _____

B.) Availability and access to ICT

- 7.) Do you have a personal computer at home?
Yes No
- 8.) If yes, what do you use it for?
 - i.)
 - ii.)

9.) Please indicate the level of adequacy of the following ICTs in your school for instruction.

	Very good	Good	Moderate	Poor	Very poor
Computers					
Software					
Internet					
Other ICTs like radio, video					

C.) ICT integration in teaching

10.) How often do you access the internet in school? Never Sometimes Often

11.) Rank the following uses of the internet according to the frequency for which you use it.

	Rank(1,2 or3)
Downloading and searching personal information	
Searching for information not available in books	
Communication (e-mail)	

12.) Apart from the general application software like Ms Word, Ms Excel and Ms Access, how often do you use educational software in school especially those that are meant for your teaching subjects. Never Occasionally Often

13.) From your experience, how regularly do you use ICT for the objectives outlined

	Not at all	A little	A lot
Create instructional materials			
Gather information for lessons			
Prepare presentations			
For administrative record keeping			
For communication			
To post assignments			

14. (a) Do you use computers to develop professional materials for teaching? Yes () No ()

15. (b.)If the answer to item 15 (a) is yes, please explain the resources that you develop for teaching.

16.) Can you use technology to support student-centered activities? Yes () No ()

17.) Can you use ICTs to enhance students' higher order thinking skills and creativity? Yes () No ()

18.) According to you, what is your most preferred method of teaching?

Methodology	Tick
Largely teacher-directed (e.g. lecture)	
Even balance between teacher-directed and student-centered activities	
Largely student-centered (discovery learning)	

19.) While using computers for instruction, how often do you use computers for the following activities?

Activity	Often	Occasionally	Rarely	Not at all
Drill and practice				
Games				
Simulations				
Problem solving				
Any other (specify)				

20.) Which statement best captures your philosophy of using computers? (Select one)

Philosophy of using computers	Tick
Using computers for teaching does not really fit my teaching style	
Computers have limited use in the secondary school classroom	
ICTs are best used for drill and reinforcement of skills taught in class	
Computers have considerable potential for allowing students to discover or construct ideas for themselves	

21 (a) Please read the descriptions of each of the six stages related to the process of integrating computer technology in teaching activities. Choose the stage that best describes where you are in the process by circling the corresponding letter.

A. Awareness

I am aware that ICT exists, but have not used it –

B. Learning

I am currently trying to learn the basics. I am sometimes frustrated using computers and I lack confidence when using them.

C. Understanding

I am beginning to understand the process of using ICT.

D. Familiarity

I am gaining a sense of self -confidence in using the computer for specific tasks.

E. Adaptation

I think about the computer as an instructional tool to help me and I am no longer concerned about it as technology. I can use many different computer applications.

F. Creative Application

I can apply what I know about technology in the classroom. I am able to use it as an instructional aid and have integrated computers into the curriculum.

21. Using the following scale, please indicate how often you use computers for executing the areas listed hereunder:

	Everyday	Occasionally	Rarely	Never
For typing work & record keeping				
For games				
Communication				
For teaching				

22 (b) In the next table, select the level that best describes your school in terms of ICT use in teaching and learning

Characteristics	Tick
There are computers in school but rarely used in teaching	
<ul style="list-style-type: none"> Computers are used periodically for word-processing and games Students may be using the internet occasionally for very broad Internet searches 	
<ul style="list-style-type: none"> Word-processing used most days for reading & assignments There is evidence of management systems in place Internet is used more for games and research 	
<ul style="list-style-type: none"> Students experiment with variety of digital equipment such as cameras, iPods and Interactive whiteboards Internet research skills are well developed. Students work well collaboratively with ICT devices 	
<ul style="list-style-type: none"> There are several computers in classrooms, other digital equipment such as iPods, tablets and cameras are also freely and confidently used Students are able to work collaboratively and co-operatively with others. Internet skills are highly developed 	

D) ICT policy and support

23. (a) Does your school have an ICT policy?

Yes _ No _

23. (b) If yes, are teachers consulted and involved in developing the ICT use policy?

23. (c) Apart from having an ICT policy, is there any other school document that contains the school's vision for ICT and guidelines for ICT use?

24.) How often do you receive support from the following? (Select one for each source)

	often	sometimes	never
Teacher for computers			
Other teachers			
Computer for Schools Kenya			
Other out of school support			

E.) Teachers' attitudes and self-efficacy

25.) Which of the following statements best reflects your view of the use of ICT in teaching and learning?

	Tick
A vital service	
An add-on service, secondary to other learning resources such as the library	
An unnecessary expense	

26.) Please rate your attitude towards the integration of computers in teaching using the following scale: **SA= Strongly Agree; A= Agree; MA=Moderately Agree; D=Disagree SD=Strongly Disagree**

Statement about computers	SA	A	N	D	SD
The challenge of teaching with computers is exciting					
Anyone can learn to use computers if they are patient and motivated					
Learning to operate computers is like learning any new skill; the more you practice, the better you become					
I feel apprehensive about working with computers					
I have difficulty in understanding the technical aspects of computers					
It scares me to think that I could cause the computer to destroy a large amount of information by hitting the wrong key					
You have to be a genius to understand all the special commands used by most computer programmes					

Given an opportunity, I would like to learn about and use computers					
It would take too much time to learn how to use a computer successfully					
I try to keep informed about technological changes					
I would like to take part in a computer course to learn more about computers					
In-service training courses about computers should be made compulsory					
I would like to learn more about computers as teaching aids					
I don't mind learning about computers					
Computers are valuable tools for improving the quality of a child's education					
Using computers in class leads to more productivity among students					
Computers help to teach more effectively					
The achievement of students can be increased when using computers for teaching.					
The more I would use computers in the class, the less time I would have to concentrate on the (content of the) curriculum.					
Using a computer in a classroom makes a subject more interesting					

27.) Please rate use the items in the following scale to rate your self-efficacy for the integration of ICT in teaching: **SA= Strongly Agree; A= Agree; MA=Moderately Agree; D=Disagree SD=Strongly Disagree**

Statement	S D	D	N	A	SA
I feel confident working on a computer					
I feel confident installing software					
I feel confident organizing and managing files					
I don't feel confident learning about computer hardware					
I feel confident learning about computer software					
I feel confident learning advanced skills of using computer programmes					

I don't feel confident getting help on problems related to computers					
I feel confident surfing the internet					
I feel confident integrating ICT in instruction					
I don't feel confident developing simple programmes for the computers					

28.) What challenges do you face in integrating ICT in teaching?

F.) Teachers' ICT integration professional development

29.) Which of the following best describes how you acquired your ICT skills?

	Tick
Formal college/university as part of main course	
ICT literacy course at college/university	
Self initiative at private college	
Teaching self on the job	
Workshops	
Sharing with others	

30.) Do you consider the training that you underwent on ICT sufficient for you to integrate ICT in instruction? Please explain your answer.

31.) In using ICT for instruction, more often than not one needs assistance. From whom do you get help?

	Sometimes	Often	Never
Computer teacher			
Other teachers			
Computer technician			

32.) How would you rate your computer literacy skills?

	Tick
A beginner	
An intermediate user	
A fairly experienced user	
A very experienced user	

33.) Supposing you had a chance for further training in the use of computers for teaching and learning, what do you see as your current needs for professional development in computers? (List three areas in order of priority)

Thank you for your time in responding to the questionnaire

Appendix II: Interview Guide for CFSK Personnel

Background Information

- 1.) What range of support do you give schools in the project?
- 2.) In the course of training teachers, what modules do you offer to the teachers?
- 3.) Briefly describe the response of teachers towards the use of computers in teaching.
- 4.) According to you, what are the main challenges towards the successful integration of computers into the secondary school curriculum?
- 5.) What types of software do you supply the schools?
- 6.) Would you say that the software properly fits with all the subjects being offered in secondary school curriculum?
- 7.) Other possible ideas to be explored:
 - Number of computers
 - Support
 - Attitudes of administrators

Appendix III: Students' Questionnaire

We need your help to learn about how technology is being used in your school. There is no right or wrong answer to these questions. Your answers to these questions will be of great benefit in helping to shape the use of ICT in education. They will be kept confidential and used only for this research. Please read the questions carefully and then write the most appropriate response.

Gender: Female Male

Grade Level: Form 1 Form 2 Form 3 Form 4

A) Please indicate your ability to use the following programmes to carry out the types of tasks shown

	I can do this myself	I would need some help to do this	I have never done this type of task
Communicate using E-mail program			
Online tools for surfing the internet			
Word processor to type documents			
Subject specific programmes			

b) Tick the relevant boxes to indicate your level of agreement with the following statements

Item	I totally agree	I mostly agree	I mostly disagree	I totally disagree	I do not know
I think that computers can improve my learning					
Learning with computers is very time-consuming					
I would like to study with a computer even if it is complicated					
Teachers use computers in teaching					
We are given					

assignments by teachers through the computers					
I am comfortable using the computer for doing my personal studies					

c) Are the computers in your school connected to the internet?

Yes () No ()

d) Are you allowed to use the internet to do your school assignments?

Yes () No ()

e) Do you send and receive messages on a computer chat room or bulletin board

Yes () No ()

f) Are you able to use databases to find information?

Yes () No ()

g) Are you able to use spreadsheets to organize information?

Yes () No ()

h) Are the numbers of computers in your school sufficient for use by students?

Yes () No ()

i) Are you familiar with social networking tools such as facebook?

Yes () No ()

K) Please rate how often you do each of the following at school by checking the appropriate box to the right of each item using the following scale — Never (N), Sometimes (S), A (A Lot).

I have trouble understanding text, numbers or graphs when they are shown on computers	
I work in a team with other students when I use technology	
I use computers to find information from sources	

Appendix IV: Schools ICT checklist

- 1) Name of the school

- 2) Type of school

- 3) Number of computers in the school

- 4) Location of computers

- 5) What types of software are available in the school?

- 6) Is there internet connectivity in the school?

- 7) What type of internet connection is available in the school?

- 8) What other ICT resources are available in the school?

Appendix V: List of CFSK Supported Schools

School	Gender
Starehe	Boys
Lenana	Boys
Aquinas	Boys
Nairobi School	Boys
St. Teresa's	Girls
Pangani	Girls
Precious Blood	Girls
Moi Girls	Girls
Hospital Hill	Mixed
Kahawa Gar	Mixed
St.Alloysius	Mixed
Kamiti Sec. school	Mixed
School	Gender
Murera	Mixed
Mangu	Boys
Alliance Girls	Girls
Ngarariga	Mixed
Ngenia	Boys
Kijabe Boys	Boys
Kamandura	Girls
Muthiga	Girls
Manguo	Mixed
Mirithu	Mixed
Ruaraka	Mixed
Rironi	Boys
St. Francis	Girls
Tigoni	Mixed
Uthiru High	Girls
Thika	Boys
Kiambu	Boys
St. Josephs, Githunguri	Mixed

Appendix VI: Table for Determining Sample Size

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	246
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	351
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	181	1200	291	6000	361
45	40	180	118	400	196	1300	297	7000	364
50	44	190	123	420	201	1400	302	8000	367
55	48	200	127	440	205	1500	306	9000	368
60	52	210	132	460	210	1600	310	10000	373
65	56	220	136	480	214	1700	313	15000	375
70	59	230	140	500	217	1800	317	20000	377
75	63	240	144	550	225	1900	320	30000	379
80	66	250	148	600	234	2000	322	40000	380
85	70	260	152	650	242	2200	327	50000	381
90	73	270	155	700	248	2400	331	75000	382
95	76	270	159	750	256	2600	335	100000	384

Note: "N" is population size
 "S" is sample size.

Source: Krejcie and Morgan (1970)